THE JOURNAL

OF THE

Canadian = Mining = Institute

(INCORPORATED BY AN ACT OF PARLIAMENT)

Volume II.

1899.

Containing the Proceedings, Papers and Reports presented at the Annual General Meetings, Minutes of Council, a Revised List of Members, &c.

"The Institute as a body shall not be responsible for the statements or opinions advanced in the papers which may be read or in the discussions which may take place at its meetings."—*Par. xi., Constitution and By-Laws.*

Edited and Published by the Secretary, by Authority of the Council

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SLATER BUILDING, OTTAWA, ONT.,
CANADA.

NOTICES.

Change of Residence.

The Secretary will be obliged if members will notify him promptly of any change in their addresses.

Subscriptions.

Members are reminded that subscriptions for the ensuing year were payable at the Annual Meeting 1st March, and should be remitted without delay to the Treasurer, Mr. A. W. Stevenson, C.A., Bank of Toronto Chambers, St. James St. Montreal.

Library and Reading Room.

The Library and Reading Room (Room 4, Windsor Hotel, Montreal) is open daily for the use of members from 10 a.m. to 6 p.m.

Corresponding Society.

The Council has made arrangements whereby members are permitted to purchase copies of the Transactions of the following corresponding Society at the rates named below :—

The Institution of Mining Engineers—

Vols. 1, 2 and 3, 25 shillings each, post free.

Vols. 4 to 15, 10 shillings each, post free.

All applications and remittances should be addressed to the Secretary.

Members' Certificates.

Members in good standing, who have not received their Certificates of Membership, are requested to communicate with the Secretary.

B. T. A BELL,
Secretary.

British Columbia Meetings and Excursion.

SEPTEMBER,, 1899

PROVISIONAL ANNOUNCEMENT.

The Summer Meeting of the members of the Institute will be held in the Province of British Columbia during the Month of September. The following programme is provisionally announced :—

Members will leave Montreal by C.P.R. train on Friday, September 1st, being joined at Toronto the following day by members from Ottawa, Toronto and eastern points.

The party will proceed by way of Owen Sound and the Great Lakes to Fort William, leaving there on Monday, September 4th, whence train will be taken for Revelstoke. It is proposed to spend Thursday, September 7th, at the Banff Hot Springs Hotel, arriving at Revelstoke on Friday, September 8th. Members of the Institute residing west of Revelstoke will join the party at that point.

From Revelstoke the party will proceed directly to Nelson, arriving in Nelson on Saturday, September 9th. It is proposed to spend three days in Nelson and vicinity, leaving Nelson on Tuesday, September 12th, for Rossland, arriving at Rossland the same day.

Two days, 13th and 14th, will be spent in Rossland and vicinity. Friday, September 15th will be devoted to an inspection of the Canadian Smelting Works at Trail; The same day the party will leave for Slocan, arriving at Sandon the following day, Saturday, September 16th. It is proposed to spend one day at Sandon, leaving on Monday, September 18th, via Slocan Lake and Slocan City, for Nelson.

On Tuesday, the 19th, the party will leave Nelson on the return trip, via Kootenay Landing and the Crow's Nest Pass, arriving at Fernie on the 20th. One day will be spent at the mines of the Crow's Nest Pass Coal Company, whence the journey will be continued easterly by rail, arriving at Rat Portage on Saturday, September 23rd.

If a sufficient number of members should desire to visit the Lake of the Woods District, arrangements will be made for a stay of one or two days at Rat Portage. The party will arrive in Montreal on Tuesday, September 26th, at 6.25 p.m.

By courtesy of the Passenger Department of the C.P.R., your Council is enabled to announce that fares, inclusive of sleepers and meals, from Montreal to Rossland and return to Montreal, will cost $121.80. It is estimated that the cost of hotel accommodation at Nelson, Rossland and Sandon will cost about $22.50 more, so that $150.00 should cover every expense incident to the trip for members leaving Montreal.

Negotiations are pending for a special rate to members coming from the Maritime Provinces and points east of Montreal, and also for members coming from points west to Revelstoke. The railways are showing every disposition to make these rates satisfactory, and a further announcement regarding them will be made in a second circular. Arrangements are also being made for special rates to points west of Revelstoke, should any of the eastern members desire to visit mines and mineral centres while out there. We are not now in a position to state these extra rates definitely, but we have every assurance that they will not exceed one-half the regular rates.

Members are requested to signify their intention of attending the meeting to the Secretary at once, as the number which can be taken upon this trip is limited, and in order to secure most favourable arrangements with the transportation companies, a definite number must be announced to them.

OFFICERS AND COUNCIL, 1899-1900.

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PAPERS.

NOTICE.

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The Institute as a body shall not be responsible for the statements or opinions advanced in the papers which may be read or in the discussions which may take place at its meetings.—*Section IX Constitution and By-Laws.*

Metallurgic Standards.

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By FREDERICK T. SNYDER, Vancouver, B.C.

It is perhaps because of its great antiquity and the force of established custom that modern scientific methods have been so slowly adopted in metallurgic work. The other industrial branches that have to do with the transformation of power into useful results are found to have standards of comparison complete in proportion, as the industry is young; perhaps the most complete being the youngest of all, the commercial utilization of electricity. There is available in the transactions of various associations of mining interests, a mass of records covering the operation of many plants under a wide variety of conditions; records that just miss being of great value, because they are expressed in units that are not standard, making the utilization of the experience they record impracticable. Speaking for my own department of the metallurgy of the precious metals, the great need is a group of standard units by which the results of one establishment may be utilized in planning and operating another under somewhat different circumstances. The most pressing of these are:—

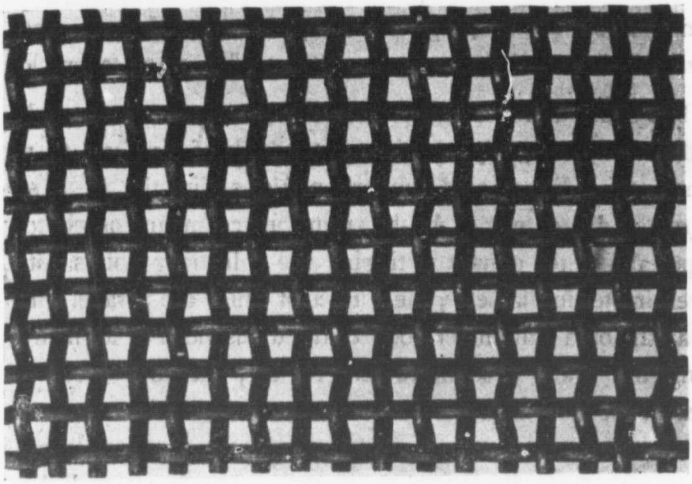
1st. A unit of weight.
2nd A scale of sizes for crushed ore.
3rd. A coefficient that shall represent the mechanical condition of the ore.

Of these, the second has to do with milling work alone; the first and third underlie the operations of both milling and smelting.

The unit of weight is in much the most satisfactory condition. To the extent of which it is individually a factor, results can be expressed in terms whose accuracy lies within the limits of error of the ordinary observation. Its usage and form leave much to be desired. The common unit of weight in metallurgic work is the ton. The question at once arises in considering a record, which of the four tons in extended use is it? Especially as their variation is too small to admit of the question being answered by a direct consideration of the records themselves. Fortunately, one of them, the metric ton is rapidly driving the others out of use. It is desirable that forethought should be used in aiding its introduction, that multiple standards of weight may end as soon as practicable. Of the value of its decimal notation little need be said. Its close correspondence with the present English long ton (2,205 lbs. in place of 2,240 lbs.) involves in its introduction the minimum change in one's standards of experience. An additional feature, of distinct value from our present point of view, is the correspondence it brings about between laboratory and mill calculations. It is desirable that all weights in metallurgic practice should be "dry weights," and that a definite statement of the determination of moisture should form part of each record. It should be understood that competent assays and analysis are always made on dried pulp, and that they are of value only as applied to "dry weights" of ore. The practice of obtaining the weight of ore by calculation from volume is to be condemned. Estimates made in this way are practically worthless as records. Fallacious values that lead to disappointing investments can frequently be traced to this practice. A scale can so readily be introduced at some point in any process on which the pulp can be actually weighed, that a desire to avoid complication can hardly be urged in extenuation.

When we turn to a consideration of units of size, for crushed ore, we are at once in contact with the illusive question of "mesh."

These concentrates were crushed through a thirty mesh screen. What does it mean? That it was a screen having thirty wires each way per lineal inch? Possibly that was originally what it meant, but the screen that these concentrates came through had no wire at all. It was an indented slot screen. Even if it had been a wire screen, who is going to tell how much of each thirtieth of an inch was wire and how much hole. Then was it a woven screen or a sewed one? If woven, was it double crimped or single? But grant that these are all known and made matters of record; that the available free area of the holes has been ascertained by a *Round* taper needle, will this tell what sized tetrahedron of quartz will go through that same hole. The accompanying enlarged photograph of a forty mesh screen, taken at an angle of sixty degrees to the surface of the screen, will illustrate the point. It also illustrates the point that the maximum area of the hole is not at right angles to the surface of a woven wire screen, especially so in the



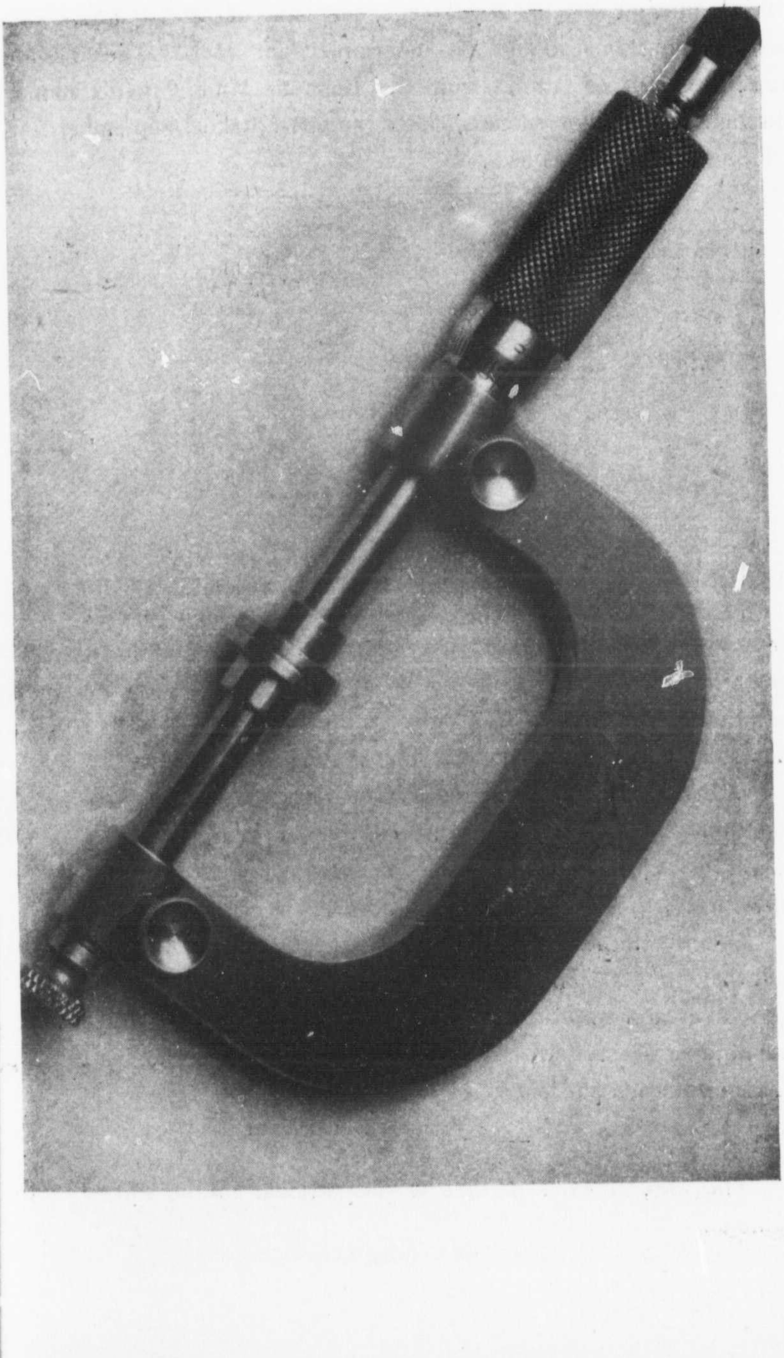
Forty-mesh Screen—Angle of 60°.

case of a double crimped screen. It is the almost universal use of this type of screen in laboratory check work that makes its consideration of importance.

The angle at which the material strikes a screen is a factor in determining the size of the particles that go through. This has been taken advantage of in that meritorious device, the Bertelett screen, by which forty mesh pulp (whatever that may mean) is produced by a twelve mesh screen by throwing the material against it at a small angle; a feature of great importance to leaching plants, where the possibility of dry crushing and screening often means the difference between success and failure. It serves to illustrate most pertinently, how wide a range of ratios the mesh of a screen has to the maximum size of the product passing through.

In stamp mill work another indefinite factor is the height of discharge. With the same screen the average size of the issuing pulp can be halved by doubling the height of the discharge. How are we to compare results? Because one battery with a thirty mesh screen and a four inch discharge, saves sixty per cent. of the gold in an ore on the amalgamated plates below, is it an inferior machine, because the next battery with the same thirty mesh screens, but an eight inch discharge saves seventy per cent. of the contained gold? A proper screen analysis of the pulp would explain the difference, and again illustrate what an indefinite standard " mesh " is, when taken alone.

The necessity for definite data in my own work has led me to abandon screens entirely as primary standards of size, and to measure the minimum diameter of the ore particles directly, by a specially constructed micrometer. As shown in the accompanying photographs, the special features consist in tipping the calipering points with disks one centimeter in diameter, the surface of which are parallel within one thousandth of a millimeter (one thirty thousandth of an inch) and in making the lower disk movable. In use, the micrometer is held vertically, the lower disk slid down and the ore particles, wet or dry, put upon it. It is then raised until the stop on the handle comes in contact with the adjustable shoulder S. The lower disk A is then locked in position, by the screw C. A series of tests has shown that this lower disk can be repeatedly replaced in the same position within one five hundreths of a millimeter, when working rapidly and without especial care. The upper disk B is then unlocked by the screw D and by the handle E is screwed down upon the ore particles. When the pressure on the ore particles reaches a predetermined and uniform pressure a ratchet in the handle E slips and the rotation of the barrel F and advance of the disk B stops. The amount of disks are separated and then read in hundreths of a millimeter on the scale at G. The upper disk is retracted by rotating the barrel F and the lower disk withdrawn and the ore particles removed. The range of the instrument is from one hundreth of a millimeter to about four centimeters, the precision being uniform over the entire scale, at about one five hundreths of a millimeter for groups of ten observations. It has been used so far entirely in the calibration of laboratory screens. A given material, to be examined, is screened and the minimum diameter of the maximum sized particles passed by the screen is determined by the micrometer. This is then marked on the screen and used in records where the mesh of the screen was formerly recorded. It should be



noted that the screen will not calibrate the same for different materials, having different systems of cleavage, such as coal and quartz. Independent constants should be determined for each. The following screen analysis of tailings from the Belmont Mine, Ontario, stamped through smooth slot screens, called 50 mesh, taken September 27th, 1898, will illustrate its use :—

Milligrams.	Per cent.	Maximum Size Millimeters.	Through corresponding mesh stamped on screen.
5,640	100	.83	(on 40
636	11.3	.50	40
432	7.7	.23	60
4,570	81.1	.17	80
5,638	100.1	. .	.

Concentrates crushed on a mortar through a one hundred mesh Greening wire screen gave an average of fifteen hundreths of a millimeter. It should be noted that from the construction of the micrometer and its method of use, that it is the size of the largest particle or the actual free area of the screen that is determined.

A definite unit of size once available, it becomes of interest to determine whether some coefficient cannot be arranged that will permit of legitimate comparisons being made between the work of different mills under different conditions.

Other conditions being the same, it is evident that the amount of gold that will amalgamate from any given ore will be proportionate to the total area of surface exposed by crushing. In a given weight of ore the number of particles is inversely proportional to the cube of the diameter of each particle.

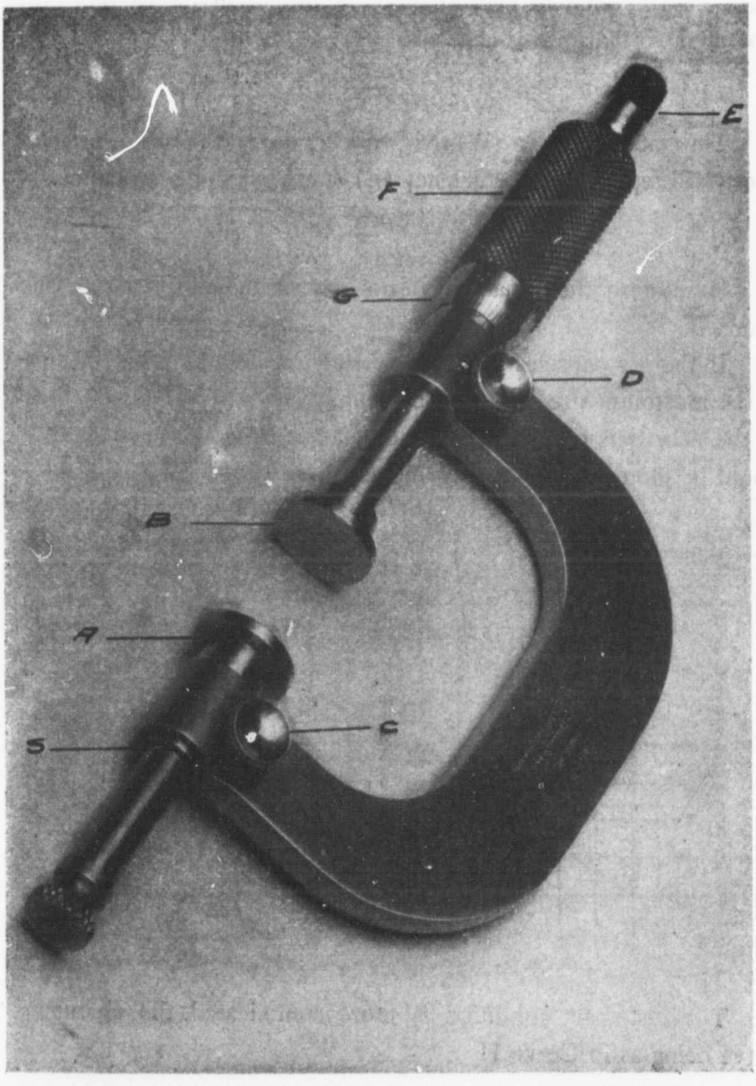
$$N = \frac{C'}{d3} \quad \text{Where } C' \text{ is a constant.}$$

The area of each particle is proportional to the square of the diameter.

$$A = C'' \, d2 \; C'' \text{ being a constant.}$$

Therefore the total surface area of the particles in any given weight of ore is inversely proportionate to the average diameter of the ore particles.

$$S = A\ N = \frac{C' \times C'' d^2}{d^3} = \frac{C}{d}$$



In a leaching proposition the metal dissolved is proportionate to the area exposed, other conditions being equal, so that in this case also

$$S = \frac{C}{d}$$

Where S may be called the coefficient of surface, C is an arbitary constant, and d the average diameter of the ore particles. It is evident that the work done in crushing ore is proportionate to the surfaces separated, so that in this case also

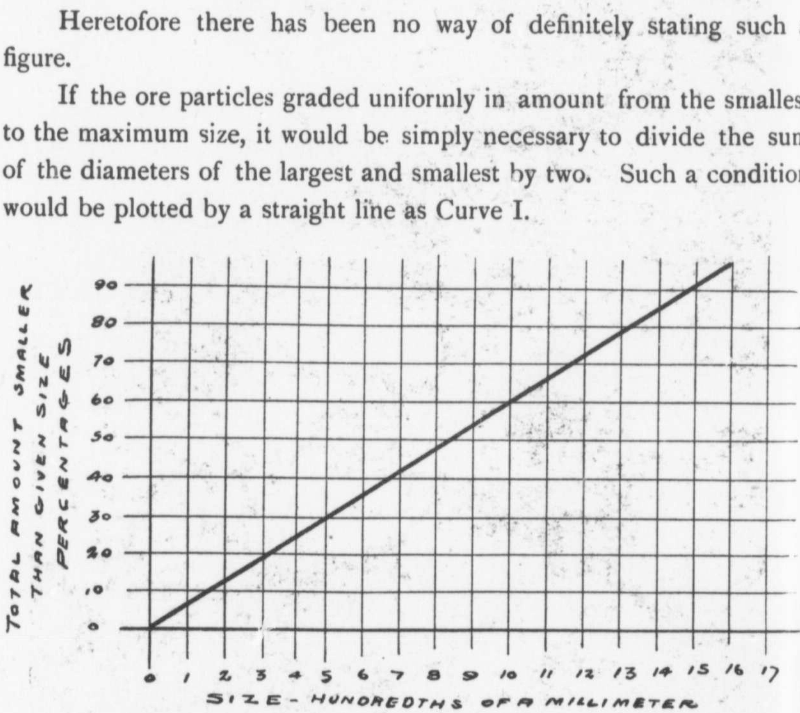
$$S = \frac{C}{d}$$

The ratio between (W) the work done and (S) the surface produced will represent the efficiency (E) of any crushing appliance.

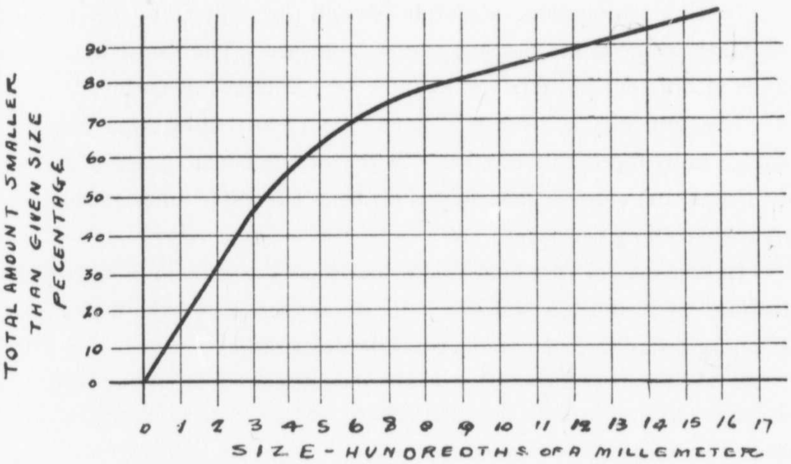
$$E = \frac{W}{S}$$

Heretofore there has been no way of definitely stating such a figure.

If the ore particles graded uniformly in amount from the smallest to the maximum size, it would be simply necessary to divide the sum of the diameters of the largest and smallest by two. Such a condition would be plotted by a straight line as Curve I.



The customary condition is more complicated, the characteristic curve being as in Curve II.



In this case it is necessary to divide the area under the curve into a series of sections and obtain the average diameter in each, afterwards weighting the diameter so obtained to correspond with the influence of the amount of that particular size.

The calculation from the screen analysis given above for Belmont tailings is as follows :—

$$\frac{.50+.25}{2}=.365$$

$$\frac{.23+.17}{2}=.\ 20$$

$$\frac{.17+.\ 0}{2}=.085$$

$$11.3 \div .365 = 31.0$$

$$7.7 \div .\ 20 = 38.5$$

$$81.0 + .085 = 953.0$$

Coefficient of surface...... 1022 5

By taking percentages in place of weights, the constant C can be neglected and a figure obtained, that will for all screen analysis be proportionate to the actual surface of the ore particles. And also a constant, under equal conditions from which the efficiency of any crushing, amalgamating or leaching processes or appliances can be definitely determined.

In this connection, attention should be called to the present indefinite methods of plotting screen analysis. The same data in the hands of different plotters would show very different results.

The difficulty is usually a failure to clearly state what the percentage units represent, whether it is the amount that passed through the screen, the amount that stayed on it, or the total amount that was larger than the given mesh.

In conclusion, it is desirable to emphasise the need of having the Institute by resolution warrant with its authorization, the use of such metallurgic standards as are sufficiently determined.

Notes on the Occurrence of Quicksilver in Canada.

—

By A. J. Colquhoun, Savonas, B.C.

The principal quicksilver producing countries so far have been Spain, Austria, Peru, California, China, Russia, Mexico and Tuscany. These countries have all added their quota to the world's production and I predict that in the near future when Canada has the benefit of the capital and brains required to make a great financial success of the working and treatment of low grade cinnabar ores, which has been the case in Russia and California, she will take her rank among the foremost in this important industry.

For the benefit of the prospector before proceeding any further, it will not be out of place to describe the ores from which quicksilver is produced.

Cinnabar.—This is the chief ore from which nearly all the quicksilver of commerce is derived. In colour the mineral is of a cochineal red with a lead grey and scarlet red tarnish, but has an unmistakeable scarlet read streak identifying it from the ochres or iron oxides, which, although brilliantly coloured, often give a dullish brown streak with the penknife. The composition is 86.2 per cent. of Mercury, and 13.8 per cent. Sulphur.

Native Amalgam is of rare occurrence, but in the mining of quicksilver ores is met with in Mexico.

Mercury Iodide is also rare and is met with in Mexico, having a reddish brown colour.

Selenide of Mercury has been found by many of the searchers for this metal and the writer has identified some crystals from the mercury properties of Hardie Mountain, Copper Creek, B.C. The ores of South America are dark steel grey in colour.

Cinnabar was first found about four years ago as float on the north side of Kamloops Lake at Copper Creek, but owing to the ignorance of the original finder, the specimens lay around the Savonas Hotel until an enterprising and learned prospector identified the ore which resulted in the location of the group of claims now owned by the "Cinnabar Mining Co."

The formation in which the cinnabar occurs in this section of the country consists of basaltic and dolomitic dykes traversed by veins of quartz and calcite in which the ore is found in some instances in a pure state, also finely disseminated through the gangue associated with pyrites and other foreign elements.

These dykes and deposits have a general direction of N.N W. and S.S.E. through what appears to be diabase porphyries, but it is impossible to determine the true nature owing to the surface decomposition.

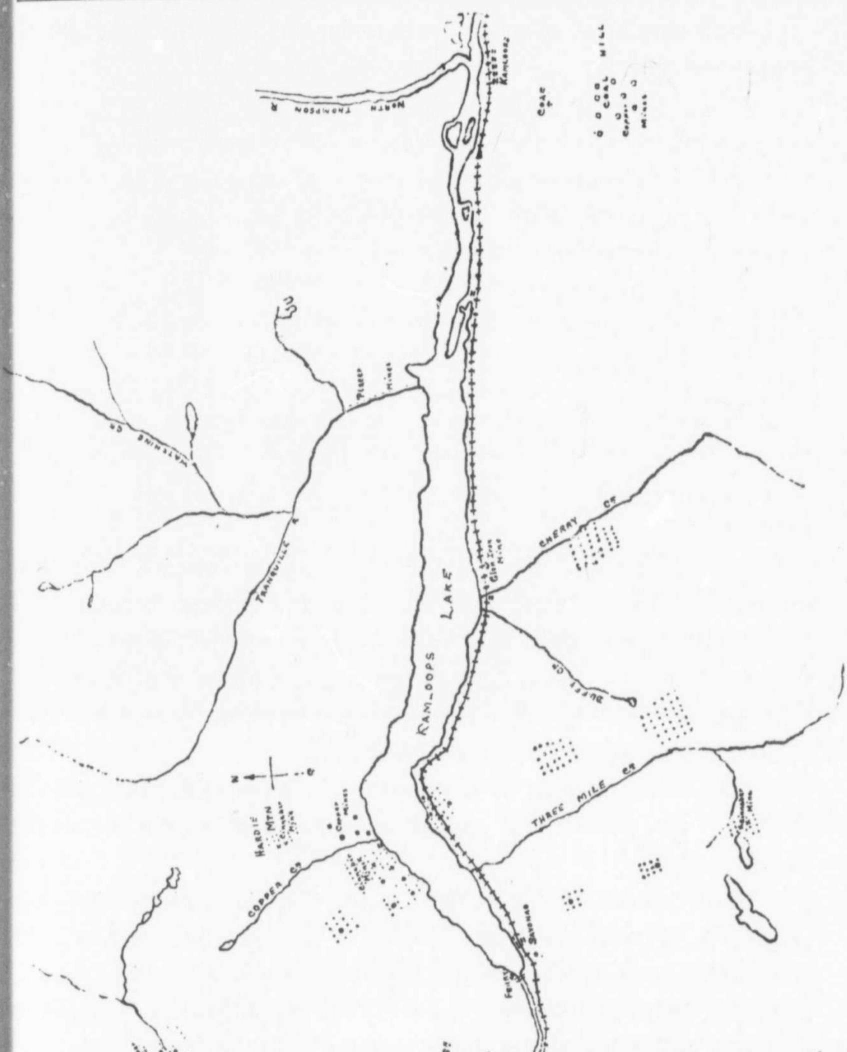
To the north of the company's properties cinnabar is also found in altered conglomerates on Hardy Mountain and in fine grained sandstone to the east on the Caledonia it is found desseminated in fine scarlet spots. Associated with the cinnabar we also find copper sulphide and carbonates and on the Hardie Mountain, as aforementioned, selenide of mercury which invariably carries a gold and silver assay.

During my trips in the Kamloops district last summer I discovered a deposit of cinnabar, some fifteen miles south, proving the southern extension of the belt, so that considering the Criss Creek deposits to the north we can state that the belt has been traced for thirty miles.

Notwithstanding the fact of the existence of large bodies of medium furnace ore 0.56 per cent. to 2 per cent. and over, exposed by the development of the "Cinnabar Mining Co." and other deposits of high grade ore hitherto untouched, they have not made a success.

It seems a pity that through the fault, ignorance and gross mismanagement of the concern the whole district should be held back in its progress.

About $50,000 has been thrown away in work and the erection of a Granza furnace, tramways, etc., and has only produced 128 flasks of quicksilver; of this amount 121 was produced by means of *cast Iron retorts* and 7 flasks by the Granza furnace.


MAP of CINNABAR BEARING DISTRICT AROUND SAVONAS. B.C.
By A.J. COLQUHOUN.
NORTH THOMPSON R.
KAMLOOPS LAKE
TRANQUILLE R.
CHERRY CR.
THREE MILE CR.
COPPER CR.
HARDIE MTN
DEADMAN R.
THOMPSON R.
MILES

As instances of successful treatment, the following data will be convincing.

At the Almaden works in Spain during one season of 197 days, two channel furnaces were kept running continuously, treating 17,210 tons each in 24 hours or 3,103,102 tons in all, at a cost of 60 cents per ton. The quantity of quicksilver produced was 178.25 tons. The expenses of calcination were as follows :

Labour about	$881.00
Coal	936.00
	$1817.00

Tuscany—At Monte Amiata the cinnabar bearing tufta carries from 0.35 per cent. to 30 per cent. and upward. The Carmak Spirck roasting oven is in use and is said to treat 0.4 per cent. ores at a profit.

In other parts of Tuscany the ore occurs in bedded marls and limestones in a very pure state also scattered through a network of fissures filled with calcite and averaging from 2 to 30 per cent. Here they treat the ore by washing in rectangular boxes with rakes and retorting the resulting mineral with an admixture of 20 per cent. lime to desulphurize and liberate the mercury.

Peru—The famous Huancavelica cinnabar mine has given a yield of 104,045,200 lbs. of mercury valued at $67,629,380 at a cost of $10,587,000.

In conclusion it is evident from the data given that low grade ores, of even one half per cent. can be profitably worked, and British Columbia only awaits the advent of a concern which can put this latent industry on its feet again by the employment of competent men who understand the business and are capable of overcoming the many difficulties attendant on the treatment of the different grades and classes of ore to obtain the best results

The district surrounding Savona is of peculiar interest to the geologist and miner, especially the occurrence of native copper and other copper ores in the tertiaries of Copper Creek and I believe another year will see both cinnabar and copper mines in full working order.

Across the Pitch Versus Up the Pitch.

By O. E. S. Whiteside, Anthracite, N.W.T.

The above title, tersely, directs your attention to a comparison of the getting of coal from breasts driven across the pitch, nearly in the direction of the strike, and parallel with the gangway, with the same operation in breasts at right angles to the strike, or straight up the pitch, under a few of the conditions that obtain in pitching seams.

In the Cretaceous measures at Anthracite and Canmore, the pitch may be said to vary from 30° to 50°, although at some parts worked, the seam is flat, and at others, pitches 90° from the horizontal, while, anticlinals and synclinals of coal are no uncommon thing.

Slopes are sunk to the depth desired on the seam, and in most cases it is necessary to do considerable grading to obtain a three hundred foot slope without a knuckle, or roof roller. Gangways are then started to the right and left, their course being directed by the proper gradient, and, the varying strike of the seam. The method adopted, for lowering the coal to the gangway, is in the main, by means of chutes, although back-balances or self-acting planes are, in special cases, resorted to. On the upper levels, where the "up the pitch," system of work had been adopted, gangways were driven twelve feet wide, and chutes eight feet in width were started up the pitch, leaving gangway stumps thirty-two feet along the gangway, by twenty feet up the pitch. These chutes were then widened to twenty feet, for the remainder of the way up, leaving pillars twenty feet wide, through which crosscuts eight feet wide were driven at intervals for ventilation. In this manner the coal was worked towards the boundary, the pillars being left to pull on the way back.

After working this system for some time, it was deemed necessary, if possible, to adopt some other which would lend itself more readily to the cleaning of the coal within the mine, and thereby lessen the cost of handling and transportation.

In a paper on "Subsidence Caused by Colliery Workings," by Joseph Dickinson, F.G.S., in the Transactions of the Manchester Geological Society, and reprinted in "The Science and Art of Mining," the author, in speaking of pillars left for support, says "Pillars for horizontal seams may be either square or oblong; but for inclined seams, oblong pillars lengthways between rise and dip are preferred, especially where well defined cleavage or slips run level course."

This "up the pitch" system then, left the preferred supports, the pillars were not so liable to be over-ridden and run out on a steep pitch as oblong pillars with their length across the pitch, especially where the coal is full of slips, and more especially if there is a well defined cleavage in the direction of the strike. Breast cars were not needed, the coal fell to the chute without handling, and if the chutes were kept full, neglecting the sizes in which it was mined, and the first ought to have been delivered to the gangway, with a minimum of fall, breakage for chute delivery.

The other system which made it an easy matter to separate the rock and other refuse from the coal at the working face, with ample room to gob the same, made it necessary that the length of the oblong pillars should be in the direction of the strike. Working the coal in this manner across the pitch, requires less labor and lumber for chutes, and as it is necessary to have a wall to separate the gob from the roadway, the ventilation of the face is accomplished by the same process, and the Ordinance requires the air to be kept within twelve feet of the face. This method reduces the work more nearly to that necessary on a flat seam and consequently does not require the skilled labor necessary for "up the pitch" work. This matter of skilled labor probably counts for more with us than in some older districts, because laborers from the ranching country are always plentiful, while miners are very often scarce, especially those skilled at working up a steep pitch.

With regard to the strength of the pillars, a defined cleavage was not a marked feature of any of the seams we have worked, consequently the change of system did not effect us as it might have some of the pitching seams of Pennsylvania.

In the "across the pitch" system adopted, narrow work was in some cases, where the seams were not close together and the coal without a well defined cleavage, dispensed with. Here the gangways were driven twenty feet wide, chutes twenty feet in width were started up the pitch, with pillars one hundred and fifty feet long between them, and every thirty or forty feet up the pitch breasts twenty feet wide were worked across the pitch to the inside chute. In this way oblong pillars were blocked out with their length across the pitch, one hundred and fifty feet long and thirty or forty feet wide. In all breasts across the pitch and most gangways, the road is carried on the low side and the gob and return air on the high side.

The seams worked are from five to ten feet in thickness and a row of props is carried close above the track. These props are lagged, the coal shovelled into the cars, and the refuse and rock stored above, and in most cases there is enough to completely cover the props and make a good air course.

Two seams lying rather close together gave some trouble, partly on account of the measures between thinning out locally. Before starting work on these seams, the rule was laid down that all breasts up the pitch on the lower seam should be driven by sights directly under those on the seam above, and those across the pitch directly under those above, in the direction in which a prop should be placed. It was also decided that these places should first be driven on the overlaying seam, and followed later by those on the lower one. This latter rule was not strictly lived up to, owing to the intervention of faults and the demands of the market for some few months after the commencement of this work, but no trouble was experienced for a considerable time after the pillars had been blocked. Finally the floor of the upper seam commenced heaving, and the pillars started to run, so we slowed up work on the lower seam and started pulling the pillars of the one above before they had time to run out. In a great many cases where one breast had broken through into another, we found the thickness of the measure between to be only six feet and in one case they actually run together, whereas, the thickness we had previously was fourteen to twenty feet.

From now on we intend to push the solid work of the overlying seams, and immediately follow up by pulling the pillars, and then after the removal of everything except the stumps, to mine the lower seam by a similar process

Considerable might be said as regards the waste in mining and handling the coal in these two systems, also concerning the pulling of pillars, but the writer will leave this for the discussion of members, or for future consideration.

On the Establishment of Science Classes, &c.

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By A. H. HOLDICH, Nelson, B.C.

It is right to state at the commencement of these few remarks, that the ideas therein contained are not intended to apply to large and well populated cities, where far superior arrangements can readily be made, but rather to the small and scattered towns that help to make up this vast Dominion.

The inestimable value of, amounting really to a necessity for, Technical Education will hardly be disputed, and the question now seems to be, by what means can it be best supplied. In the larger cities of the Dominion this offers no difficulty, as the various well known universities can amply supply all needs; but in the less populated districts—British Columbia perhaps especially, no city is yet powerful enough to support a properly constituted and equipped School of Mines, or College for Technical Education, nor could students be moving about from one town to another except at a prohibitive loss of time and money. But the fact remains that this special education ought to be afforded, so that all whose tastes or occupation incline them to take advantage of it should have no difficulty in so doing at the minimum of inconvenience and expense.

If, as the writer ventures to think, these statements will not be disputed, it may not be time wasted if some of it is spent in considering the matter seriously, always of course making use of experience that has been gained in other countries. In England for instance, science classes are held in every town of any pretension, and pretty well all branches of science are taught besides Technical Education in the chief industries of the district, *e.g.* dyeing, tanning, carpentery, weaving, and many other allied subjects. In many of these schools, well fitted laboratories are to be found, where the students can carry out practically what they have learnt in theory, and also make experiments in their own particular branch under the guidance of the teacher; and nothing is so productive of permanent knowledge as carefully and thoughtfully performed experiment. In some of the larger institutions there are in addition, fully equipped workshops for making engines, electrical apparatus, and such like machinery, a thorough knowledge of which will ensure a decent living to any ordinarily clever man. It is not my purpose here to refer to the still larger educational establishments such as the Royal School of Mines (London), Owen's College (Manchester) or the Liverpool University, all of which are far beyond our means, if not our wants, (and indeed it has been forcibly brought home to me that fine work is not wanted, or at least not appreciated in British Columbia—the rougher the better, usually), but merely to see what can be done with the limited means at our disposal, and it seems to me that the establishment of Science classes in all towns where there appears to be a desire for them will prove a comparatively easy task.

The beginning must of course be on a very limited scale; there is no need to build a huge structure till the enterprise is able to afford it; but most towns can find a large room furnished with all that is necessary in which lectures could be given on various scientific subjects, and possibly some practical instruction as well. A "rough outline" so to speak of a chemical laboratory can be easily and cheaply fitted up, a vast array of uniformly sized bottles with complicated glass apparatus, and any amount of paint and varnish while unquestionably pleasing to the ordinary eye, being totally unnecessary. It is not the bottles and apparatus that do the work, but the man who knows how to use them. The difficulty is that not much experimenting can be done at night—in the 3 hours usually assigned to such work—it is not at all easy to see just what you are doing, and what has actually happened as the result of your experiment, by artificial light. But lectures can easily be given at that time, and possibly a few hours of daylight can be spared during the week as well, for experimenting only. The study of minerals indeed, which is a most important branch, can only be carried on properly by daylight—unless at least some form of electric light can be introduced that is in all respects equal to daylight. However, these and many other points which are liable to crop up at any moment, must be left to be dealt with after the suggested classes are formed and in work ing order—the first thing is to have such classes organized for the benefit of those who are unable to attend the larger universities and colleges, in the more out of the way towns in this Dominion. The question naturally arises, "who is going to pay for this teaching"? And it is a question that must be answered, as it is the lot of very few of us to be out here exclusively for the benefit of our health.

How then can the expenses be met? Well, let us hope that our provincial governments will be able to see their way to assist; and let the pupils themselves pay a certain fee, more of course where laboratory practice is included, and let there be regular examinations (perhaps annually or even twice yearly) upon the results of which the teacher shall receive some grant from Government. The fees to be paid by the pupil probably might have to be varied in different localities, cost of living, &c., being an important factor in the calculation, but the Government grant should be at least equal to such fees, dependent on the condition that the pupil passes a satisfactory examination. The grant might very reasonably be graded, so much per head first class; and so much less for second class; then the teacher would have a very strong incentive to teach the subject thoroughly.

It is very much easier for one man to travel (if he must) 10 or 50 miles once a week so as to teach his particular subject at different centres, than it is for pupils to travel that distance; and it is quite possible that in every town some one man can be found who can teach at least one special subject and do it thoroughly; the same being true of more than one man and more than one subject. In any case, the matter appears to me to be well worth attention, and there are some grounds for hoping that the British Columbia Legislature will take the scheme into consideration at an early date.

Perhaps some members of the Institute will offer their own opinions and suggestions as to the feasibility of starting up even on a small scale some such classes as I have attempted to outline.

In close connection with this subject is the urgent need of some kind of association of analytical chemists and assayers, to prevent the too commonly utterly incapable man from misleading those who innocently come to him for advice. It has fallen to me more than once in British Columbia to find a man professing to do assays (and even analytical work) who was ignorant of the first principles—and often had quite unsuitable balances. While the assay for gold and silver is not very difficult (but it wants to be performed correctly), yet copper is not quite so easily estimated and requires decidedly more skill and experience, and I have met assayers out here who candidly acknowledged that they could not assay a sample for copper. Can we not join together and insist on a man proving himself capable, before allowing him to practice? or would it be "interfering with the liberty of the subject"? Some action ought to be taken, and it is my sincere hope that these rather random notes may be considered and discussed and that the hoped for good results will follow.

A Notable Canadian Deposit of Chromite.

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By J. T. DONALD, M.A., Montreal.

Chrome ore mining in Canada was begun in 1894. About 10,000 tons have been extracted up to the close of 1898. Mining has been carried on in the most primitive fashion, the only appliance in addition to hand labor being horse derricks. This is largely because the deposits thus far worked have seemed to be pockets of very limited extent, and therefore, not warranting an outlay for labor saving plant.

The object of this paper is to call attention to the most important deposit of Chrome ore yet discovered in Canada, a deposit that has already yielded about 3,000 tons, and certainly yet contains at least several times as much as has been extracted, that is to say, a single deposit that alone contains as much Chrome ore as has thus far been produced from all other sources during the five years since the inception of the industry in Canada.

This remarkable deposit of Chrome ore is the property of Mr. H Leonard, of D'Israeli, Que., and associates.

It occurs on Lot 26, Range II, Coleraine, Megantic County, which lies near Little Lake St. Francis, and about six miles eastward from Chrome Siding on the Quebec Central Railway, between Coleraine and Black Lake Stations, *i.e.*, about 160 miles from Montreal, and 86 from Quebec.

The writer examined this property twice in October, 1898, and found the ore traceable as a belt in the Serpentine for a distance of about 260 feet, in a general south-east and north-west direction and outcroppings appear at intervals over a breadth of some sixty feet.

The ore occurs on the slope of a ridge that rises gently towards the north-west The surface serpentine is much shattered and even at the greatest depth lines of cleavage are numerous, so that mining is not difficult.

Without entering into the question of the origin of Chromite, it may be said that the *appearance* of the deposit is that of a great mass which, thrust up from below and following lines of least resistance, has spread itself out through fractures and fissures in the serpentine, forming a network of pockets connected by bands of greater or less width. What seems to be the main band is from six to ten feet wide in places, and at one point reaches a width of nearly twelve feet on the surface.

A number of samples representing different portions of the deposit, have been analysed in the writer's laboratory,—the percentage of Chrome oxide ranged from 37.93 per cent. to 44.93 per cent.

The ore is in excellent repute with and is constantly being used by makers of Chrome steel, both in Canada and the United States, the larger quantity of course being used in the latter country.

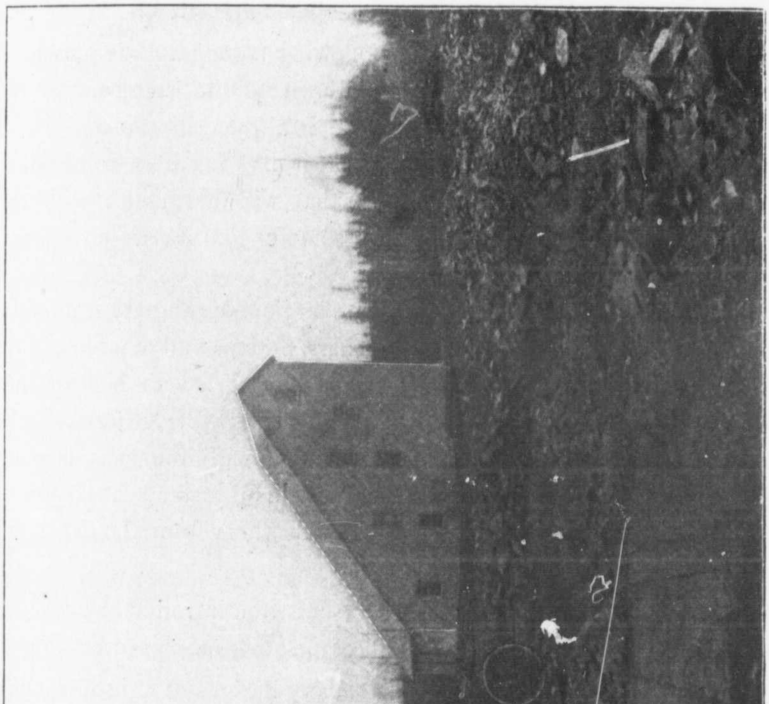
Tests have been made to learn the extent to which this ore is amenable to concentration, and with most satisfactory results.

In one case ore, assaying 39.58 per cent., was found after concentration to test 48.80 per cent. Chromic oxide.

In another case, crude ore assaying 40.50 per cent., was experimented with; the concentrates amounted to 63 per cent. of the ore, and tested 52.60 per cent. Chromic oxide

The latter test was obtained by A. R. Wilfley, of Denver, on his "Wilfley Table," whilst the first mentioned one was made by Obalski, the Provincial Government Mining Engineer, on experimental plant set up for the purpose by the E. P. Allis Co., of Milwaukee.

As a consequence of the good showing made in these tests, the Eastern Townships Chrome Iron Mining and Milling Company, Limited, have begun the erection of a concentrating plant at Chrome Siding, the shipping point for the ore from this mine, and it is probable that this Little Lake St. Francis ore will be largely mined and concentrated into high grade material in the future, since the higher prices offered for the high grade mineral would seem to allow a reasonably large margin of profit after cost of concentration is deducted.



CHROME SIDING—Piles Chrome Ore from Little Lake St. Francis.

Metallurgical Machinery.

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By A. C. McCallum, Peterborough, Ont.

The matter contained in the following monograph, is presented with the hope that it may prove of interest to the members of the "Canadian Mining Institute," provoke healthy criticism and be of more than a passing benefit; further, that it may result in some effort to specify a standard of dimensions, that will harmonize with the demands of service, and conform to some canon of style for appearance.

In the matter of the design of Metallurgical Machinery it must be admitted, with reference to Rolls, Crushers, Stamps and other machines employed in the reduction of ores, one is almost led to believe that they are not suceptible of as exact an analysis as a Bridge for example. In the following remarks it is purposed to deal with the most familiar machines employed by mining engineers, such for instance as Crushers, Rolls, Stamps, and Feeders. To deal with them from the designer's point of is my purpose.

Considering in the first place Crushers, the introductory remarks anent them are applicable to most all of the other machines mentioned.

It will readily be admitted that many designs of Crushers, show by the distribution of the material within them, that the designer neglected to take advantage of a method of analysis, commonly employed by designers of bridges, and other large structures, a system of analyzing quite applicable to mining machinery, namely by that of graphics.

The construction of a graphic diagram of stresses within any machine under design is most essential; as upon it the designer elaborates his working drawing.

The benefits to be derived from such a process of designing cannot be overestimated, it impresses upon the designer an intimate and exact knowledge of the acting forces and their distribution throughout the parts of the machine in the process of design; there may be many problems which are extremely complex and frequently unsolvable; it is necessary however, to possess definite knowledge of the resistance of the materials employed in the construction of the machine to those complex forces.

Knowledge of this kind can only be used as a guide by the designer, and in all probability he will be mainly influenced chiefly by experience and precedent, rather than altogether by calculation.

The usual resource of the merely practical man is precedent, but the true way of benefitting by the experience of others, is not by blindly following their practice, but by avoiding their errors, as well as extending and improving what time and experience have proven successful. A continual effort should be made to advance mining machinery design to that of a science, not merely executing or copying what has already been done. We must look for marked improvement, as new applications of scientific principles for the reduction of valuable ores are brought forth, bringing with them change and simplification of design in the machinery required to perform the work needed to be done.

It has been sometimes remarked that skill and good workmanship are not essential features in the make-up of mining machinery, but the idea is false, more plants built for the purpose of ore reduction, have been failures; due in large measure to the fact that the enterprise was handicapped by machinery ill adapted for the purpose.

It is to be much regretted that many engineers in the purchase of mining machinery estimate the superiority of the machines to be purchased, by the dead weight, regardless of how the material is utilized and distributed.

Discussion will not alone settle the question finally in all cases without elaborate and unprejudiced experimental work.

Most careful investigation is necessary in many instances to discriminate between real improvement and the impractical.

Logical theory is confirmed by correct intelligent practice.

"We who write at this late day are too much indebted to our predecessors, whether we know it or not, to complain of those who borrow from us," and each of us is only able to make his relay, taking up the work where others left off.

The *sine quo non* of good machine design, from a structural point of view is the presence of sufficient material of the proper kind, in the right place.

There are many types of Crushers upon the market, and there is no doubt that the majority of them were originally intended for breaking road ballast. The demand within recent years for crushing machinery in mining regions is primarily the cause of their being advanced to the front as crushing and pulverizing machines.

There is no doubt that the "Blake" type of Crusher stands preeminently for service and has been generally adjudged the most efficient and economical in use; perhaps the reasons most readily advanced for such, lies in the fact that for a given capacity the first cost is less, the cost for repairs is also less, and they are idle for repairs much less of the time.

The "Blake" type of Crusher has developed few changes from the original design. The first type of "Blake" Crushers had the crushing jaw pivoted at the bottom, as at present in general use the jaw is pivoted at the upper end. It is a matter of choice, to do a given amount of work by either of the types of machine; one with the working jaw pivoted above, the other below. For the jaw pivoted at the bottom, the plea is used that a more uniform product is obtained, and that finer crushing, when that is desirable can be secured. The concurrence of preference however if guaged by use, is in favour of the modern "Blake" design with over hung jaws, when that type of crusher is chosen. Experience upon this point from the members present would prove of interest and value to the Canadian Mining Institute.

The presentation of the graphic strain, diagram Fig. 1, discloses many interesting points to the student of Statics. The graphic method of analyzing strains recommends itself at once. It is hoped that the sketches will appeal for themselves and become easy of elucidation to the reader. I cannot hope to enter at any length into a discussion of the diagram, suffice it to say the composition of the forces may be easily calculated throughout any machine, given forces may be fully represented by straight lines, if the three following conditions are complied with .

1st. Magnitude, which can be measured by scale of equal parts.

2nd. Location. The lines representing a force being either parallel to or coinciding with the line of action of that force.

3rd. Sense, being the direction in which the force tends to move the body affected, and being indicated in some one way.

A general summary of Crushers upon the market if analyzed by the method shown, would reveal the important fact of a want of harmony amongst the various types of similar dimensions. The dimensions of the openings are not called in question, but like pieces within different makes of Crushers. So far as the openings of the jaws are concerned, those dimensions are not by any means arbitrary, but have been fixed by experience. Quartz generally breaking in sizes which can be suitably crushed by ore breakers of such standard dimensions as 10 x 7 in., 15 x 9 in., 20 x 10 in.

Mining engineers in charge of plants are well acquainted with the many faults developed in Crushers, under their care, broken frames, pitmans, jaws and other parts are known.

What then are requirements of a good Crusher?

In order that the Crusher shall run easily, cool, and prove serviceable, it is requisite that all of the journals be in correct alignment one with the other. Rigidity, strength, and sufficient weight must be found in the frame, so that the vibrations created while crushing may become absobed. This must be advanced as the reason for the failure of the many types of steel plate frames, they easily yield to the strains within the machine, thus causing the working parts to become out of proper relation one with the other, and resulting in heating, and running hard.

According to the nature of the product to be crushed, we must have a certain direction of stroke, length of stroke, and relative angle in the position of the jaws, and to procure those conditions various means are employed, which methods are well known to mining men. But it has appeared to the writer that simplicity of construction may be secured by abolishing from the type of Crusher under consideration, Fig. II, the wedge block so common, and employing other means of adjustment, for instance by means of the Toggles. Change of Toggles can be effected as readily as by means of the adjustable wedge. The movement required can then be made by rearrangement of the Toggles. The machine being provided with a set of Toggles giving the requisite maximum and minimum openings.

It is necessary that the shaft supporting the jaw should be securely fastened to the jaw, not by means of set screws, a preferable method of fastening is that of the Gib and Key. The jaw shaft is then required to move in the bearings of the machine. This overcomes the pounding and jumping due to lost motion, which readily developes when the jaw moves upon the shaft. The caps of the bearings can then be tightened whenever wear renders it necessary.

Within the pitman much trouble is often created, perhaps no other feature within the make up of the pitman creates more trouble than the adjustable devices provided to take up wear, when the eccentric shaft has worn out of round, due to the strain upon it being constantly in one direction. In the cut of Crusher, Fig. II, it will be noticed that no provision is made to take up the wear, simply an eccentric babbitted bearing within the pitman has been provided for the shaft. It requires a man of good judgment to set up the Gib usually provided, and trouble once experienced within this bearing from heating cannot be readily cured, without stopping down the machine. By the application of a first class lubricant, and employment of a high grade babbitt, the life of the bearing here should compare favourably with any other within the machine.

The use of heavy wrought iron bolts through the machine taking the entire strain when crushing is a desirable feature, but care must be exercised to so employ them within the frame, that their value as tension members, cannot be called in question as in Fig. III.

Fly wheels as commonly fastened to Crushers are at fault.

By employing them as a means to prevent serious injury to the working parts of the machine, owing to sledge hammer heads falling into the jaws, or other causes, we may so fasten the fly wheel upon the shaft that in case of accident the belt may slip and the Crusher stop while the fly wheels exhaust their motion. We may use taper keys rounded to suit the shaft, but a better method may be suggested, namely, that of splitting the hub as shown in Figure IV.

The matter of the application of Lubricants is an important one. Professor Thurston of Cornell University, says :—

"The art of economical employment of lubricants consists mainly in the determination of their adaption to specific purposes, and in the application to each machine—or to each part of a machine in which pressure on lubricated surfaces of widely differing amount is found—of precisely that quality of unguent which is best adapted to that particular place, and, above all, applying to it in the best possible way."

The employment of oil does not appear to be profitable. Grease is more economical, but a feature worth knowing in using grease is the matter of a proper kind of cup to hold the lubricant. The type of grease cup found most suitable is one in which the whole shell can be removed or unscrewed from the base, filled with the lubricant, then placed back in position. This does not necessitate the unscrewing of the entire cup from off the machine. the replacing of which is oftimes an annoying matter, where machines are placed in badly lighted places.

As to the nature of cast steel jaw plates being superior to those of chilled cast iron, I am led to decide in favour of chilled cast iron; the first cost is less; the length of life of the chilled cast iron jaw plate compares favourably with that of cast steel; they can be procured almost upon order; with cast steel plates it is often a matter of many weeks before they can be procured. Foundry men experienced in the art of making chilled castings, can produce an article that will give the utmost satisfaction, not all foundries throughout the country can do so as chilling cast iron is certainly an art.

Crushing Rolls.

The reduction or granulation of coarse particles of ore by means of Rolls, has been given much consideration during the past few years.

The variety of Crushing Rolls are many and various in type and construction.

Machines for this class of work have largely been evolved by American engineers, and proof of their superiority is to be found in the fact of their having gained admission to almost every large metallurgical work throughout the world.

Notwithstanding the many changes that have been made during past years in all the various designs known to us, no special one has met with general approval.

The most potent change has been in the adoption of steel as the material for use in the construction of the shells.

The construction of the frame in one piece, having sufficient weight and strength to absorb the vibrations set up within the machine, and closer study has been given to the matter of the strains with the structure.

Marked improvement over the older forms of Crushing Rolls has been made in the design of Journal bearings, methods of lubrication, and the facilities for dismantling the machine if required.

Considerable ingenuity has been displayed to obtain complete and satisfactory methods for keeping the lateral adjustment of the rolls correct.

The adoption of springs for that of levers and dead weights within the machine, to give crushing power to the rolls is an important improvement, affording as it does, a much more uniform product.

The adoption of some form of housing obviates the wasteful and disagreeable nuisance of dust, usually found around rolls employed in dry crushing, and length of life to the machine is ensured.

The most marked change within recent years has been along the line of increased peripheral speed, by the employment of rolls of larger diameters, and narrower faces. The results being decrease of journal friction, increase of crushing surface, and reduction of spring pressures. Those changes are undoubtedly the direction in which modern practice is tending.

Peripheral speeds of 600 to 1000 feet per minute are now found to be practicable, but this change in speed has also brought about many of the improvements already mentioned.

The aggregate spring pressure is now greater, ranging from 2 to 3 tons per inch width of face of roll shells.

Change has also been made from gears to belts, proving a much more preferable method of driving.

In the earlier form of rolls, the spring pressure was carried along the main tension bolts, making it a matter of considerable labor to adjust the rolls. The method now in use consists of enclosing the whole nest of springs between two washers, and constructing them so that each nest forms a complete washer, of an inelastic nature, until such time when the maximum pressure is reached, further compression taking place, relief is afforded to the rolls, by the deflection of the springs.

Chilled iron shells in all probability will be displaced by steel shells.

In the design of rolls presented all the above mentioned improvements have been embodied; simplicity of construction, fewness of parts, and interchange ability is to be found

The hopper underneath the rolls is constructed in such a manner that no pockets are permitted, all four sides declining towards the bottom at an angle of 45 degrees, thus affording cleanliness at all times within the machine.

The matter of sliding versus swing bearings for the removable roll, was decided in favor of swinging roll bearings. The wearing surfaces become reduced by means of their adoption. Any wear about the bearing surfaces of sliding roll bearings is an evil, which may result in damage to the frame of the machine; it is easier to maintain the alignment of the swinging bearing than in the sliding type of bearing.

In design for rolls, a feature worthy of consideration is that of the disposition of the bolts employed for the purpose of bolting the machine together, it is a desirable feature to have as few as possible, and so arranged that should they by any means become loose, they may not fall within the machine. The use of common nuts is not desirable, and recourse must be made to lock nuts or elastic nuts; this provision prevents the bolts becoming loose, and may help to preserve the machine from injury.

Mortars.

The construction of mortars will always prove interesting to mining men. It is not necessary to describe at any length the two mortars herewith presented.

The sectional mortar contains a feature new to the writer. It is usual in the construction of sectional mortars to make the ends in two pieces. In this particular mortar, to overcome making the ends in the above way, they were carefully designed (not to exceed 350 lbs. in weight) and in making the ends of cast steel the joint usually found was eliminated, and considerable strength has been thus added. The drawing shows the construction clearly. This type of mortar was designed for the Ben D'Or Mine, Bridge River, B.C.

Fig. O. shows a 3-stamp double discharge mortar. The lower guides of the battery are to be found in the upper part of the mortar, water supply is carried to and around to each of the heads. The pulp from back screen running through a channel cored in base of mortar and joining to that of the channel from front screen is then carried by a pipe and distributed over the amalgam table. This type of mortar was designed for the Oro Fino Mill of Fairview district, B.C. Fig. O. delineates the battery framing for above mortar.

Amongst designers of mining machinery the ore feeder has been taken in hand, and it doubtless has been observed in recent designs presented for public favor that of the suspended type, shows many marks of improvement in design, utility and simplicity of construction. Fig. O. shows a type of ore feeder recently constructed, and calculated to handle the heaviest class of ores. By its use considerable room is now afforded around the back of mortar, and it can be readily placed away from mortar when desirable. The action is similar to that of the well known " Challenge " type.

The marked changes in this feeder are to be seen in the abolition of the adjustable mechanism to the feed lever, the lever adjustment being made by means of a collar on the stamp stem, or by the bumping rod. Gears are not employed at all, thus resulting in quiet running.

One could, perhaps, make extended remarks with regard to other machines in process of design and manufacture.

I feel I have not done justice to the subject ; it is much too wide for a single paper. Papers on metallurgical machines to be of real benefit to the Institute should be divided into sections, treating of the design and dynamics of each machine in separate papers. Should it be the pleasure of the Institute I would willingly contribute my small quota. Publication of data thus collected may not be considered of much moment by the busy outer world, but it clarifies the writers' ideas, and brings into compact form and small bulk, a large amount of knowledge otherwise unattainable. This information adds much to the making of the routine work of profession more productive and pleasuteable. The figures or cuts mentioned in the paper will be presented upon the screen affording better opportunity for examination of details.

Swedish Iron Metallurgy and its Application to Canada.

By James Douglas, New York.

Iron, its production and its manufacture, is even more essential to the industrial progress of a nation than sulphuric acid. The former is the bone and sinew of the mechanical arts, the latter of the chemical. The vitality of the nations of the world may be guaged by the amount of iron and sulphuric acid they can absorb and assimilate. Tried by this standard, Canada is certainly not conspicuous for energy. Many reasons, some valid and some futile, can be educed as arguments to account for her backwardness. The most cogent apology for the inferior postion she occupies in the list of iron producers, is found in the absence of coal in Quebec and Ontario. But as these sections are supposed to contain iron ore of exceptional purity, to be covered with almost boundless forests, and to possess sulphur ores rich enough for export, a comparison is irresistibly suggested with Sweden, where exactly similar conditions exist and which is nevertheless one of the most notable iron producing and manufacturing centres of the world. Climatalogically, and in many of its geological and physical features, Sweden not only resembles, but is identical with Canada.

The iron deposits of Sweden exist in two groups. The largest, rivalling in size, though not in purity of ore, those of Michigan or Minnesota, are in the extreme north, at Gellivare, Luossavaara, Swappavaara and Kiirunavaara. These ores, abundant in quantity, rich in iron, but highly phosphoretted, lie within the Arctic circle, where till lately there have been no means of transportation and no open ports in winter, where population is scanty, and where no mineral fuel is available for their reduction. But a railroad, from the Galliware mines to Lulea on the Baltic, now gives egress to the ores of this mine. At that port some of the ores, richest in phosphorus and poorer in iron, are subjected to concentration, with the view not only of securing a product higher in iron, but a valuable bye-product in the separated apatite. But these mines will rise into still greater prominence when the railroad projected across the Scandinavian Peninsula, to a winter port on the German ocean, has been built. The port on the German Ocean will be Victoriahamn on the Ofoten fjord, and the railway will be 113 miles long from the port to the Kiirunavaara mines, and 178 miles to the Gellivare mines. At that point iron furnaces will be erected to be fed with English coke, and thence ore will be shipped at all seasons to foreign markets. Already over one million tons are shipped from these Norrbotten mines, which even in 1876, were treated by Akerman in his report "On the State of the Iron Manufactures in Sweden," as worthy of only passing notice, for, as he says, "These iron ores in consequence of the difficulty of transportation, and the extreme sparseness of the population in these regions, have been utilized to a very inconsiderable extent, or not at all." Yet within twenty years they have become one of the most important factors in Swedish industrial progress. Their enormous reserves may be estimated by the size of four only of these deposits, which reach the horizontal area at surface of 1,275,000 sq. yards. Lundbohm in his official report on the iron ore fields of the Nordbotten Province, estimates the ore area in the Kiirunavaara district alone at 449,700 sq. yards, and the quantity of ore above the level of Lake Luossajarvi at 265 millions of tons. As distances are being obiterated by ever cheapening appliances for carriage. Such ore deposits on one side of the German Ocean are as available for use in Britain as though they existed within the bounds of the little island itself.

By all accounts Canada has large deposits of manganiferous iron ores on Hudson's Bay, and still larger deposits of higher grade ore on Ungava Bay. The Newfoundland iron ore beds are notable for size and accessability. If these ores from the hyperborean forests of Sweden can be profitably procured to feed the furnaces of Europe, why not yours? For to the modern sailor the Atlantic is no wider than the Baltic or the German Ocean.

It is not to these iron ores which Sweden exports, but to these she treats at home, and to the methods she employs for overcoming her metallurgical deficiencies, that I want to draw your attention.

Through Central Sweden, with a general trend of southwest and northeast, is a band of Azoic rocks, the equivalent of our Huronian, about 100 miles in width and 200 in length. Forest covers most of this tract Within it are the mines which, during the 17th and 18th centuries, produced the ore that made Sweden one of the most important factors in the iron and copper markets of the world. When cheap coal and coke became the fuels of the iron and steel makers, Sweden's prominence waned. For a time after Bessemer's great invention was introduced, Sweden's pure manganiferous pig iron was almost the only material to which it could be successfully applied. But improvements in the process and subsequently the adoption of basic converter lining, deprived Sweden of the advantage which in this respect her pure ores afforded her. Yet nothing daunted Swedish industry and metallurgical skill prevailed, and to-day she has resumed, not her former commanding position as one of the largest producers of iron and steel, but her former importance as the manufacturers on a large scale of the purest grades of those metals in the world.

The intelligence and the flexibility with which Swedish iron masters have adjusted themselves to new conditions and new requirements, is one of the most interesting phenomena of modern industrial life, and one well worth studying by Canadian metallurgists. Again and again Sweden has led the way in certain directions, and been diverted from that path by the invasion of her markets by more favorably situated competitors, and yet she has as often found a new outlet for her energies and her wonderful products. To-day more than ever, quality, not quantity, is the aim of her iron masters.

The ore in the central zone of Sweden is not all of exceptional purity, or equally low in sulphur and phosphorous and high in iron. Moreover the mines which yield the present ores, are not the largest. Therefore as the exceptional excellence of the product is secured, not only through the purity of the raw material, but also by dint of infinite care in the manufacture, the mining and metallurgical operations of even the large manufacturing concerns are conducted on what would be regarded on this side of the Atlantic as an insignificant scale. The total output of Sweden in 1879 was in metric tons :

Pig iron..	533,800 metric tons
Charcoal iron blooms.................................	189,000 "
Bessemer steel ingots	107,500 "
Siemen-Martin ingots.................................	160,800 "

The furnaces and plants generally are on as comparatively diminutive a scale. The furnaces in blast in 1897 were:

Blast furnaces..	111
Charcoal hearths..	292
Bessemer converters..	27
*Siemen-Martin steel furnaces......................................	38

The charcoal furnaces are small, the height being from 11 to 18 meters, or 36 to 59 feet. The average annual prodnct of each blast furnace is 4,800 tons, or only 13.1 tons a day, and that of the largest at (Domnarfert) 40 to 45 tons daily. (Akerman Swedish Mineral Industry, Iron and Steel Institute, Aug., '98.) Akerman gives the production of wrought and ingot iron and steel as follows by decades from 1833 to 1887, from which I extract the extremes:

Date.	Quantity produced in metric tons.	Exported.	Percentage of export to production.
1887	463,147	209,756	45.29
1833	67,795	60,039	88.56

It speaks well for the steady growth in production of the country that similar figures for every decade since 1830 show not only a gain in production, but a reduction in exports, and therefore a healthy development of its internal resources.

All the furnaces in Sweden make yearly only as much pig iron as one of Carnegie's great Duquesne stacks pours forth weekly. And yet so intimately interwoven is the iron trade of Sweden with other of her staple industries, that the wealth of that thrifty little land, with a population (4,824,150 in Dec. 31st, '93) rather less than that of Canada, depends in no small measure upon it.

Sweden's present prosperity is in great measure due to the association of three great branches of industry under common management,

*Journal of Soc. of Arts, Feb. 18th, 1898.

namely: I. Iron and steel making; II. Lumbering, and III. Wood pulp manufacturing. Dissimilar as these three pursuits seem they are in reality closely allied. The high character which the product of the furnace possesses, is attributable to the use of wood fuel alone. Not a breath of sulphur gas is allowed to taint the iron and steel during its reduction or subsequent manufacture. The iron companies which treat the purest ores find it more profitable to make a moderate output of extraordinary quality with wood as fuel, than to treat large quantities with mineral fuel. But in order to secure wood good enough for metallurgical purposes at a permissible cost, the iron companies own large forest reserves and convert the better grade and larger sizes of timber into dimension lnmber and wood pulp. As an example: The largest works in Sweden are those of the Kopparberg Co. (the Stora Kopperbergs Bergslags Aktiebolag) whose property is situated in the Province of Dalecarlia. The company produces about $\frac{1}{10}$ of the total output in iron and steel of Sweden. Its forests cover an area of 736,000 acres. Its sawmills are on the Baltic at Skutskär. There the highest grade of lumber goes to the pulp mills, the second quality to the lumber mills, and only inferior and small lumber to the charcoal kilns for use in the blast furnaces, while mill refuse and sawdust are converted into gas for other metallurgical purposes. In 1896 the company's mills turned out 57,369 St. Petersburg standard= 113,590,620 ft. broad measure and 5,500 tons of pulp. The pulp is made by both the sulphite and mechanical processes, the latter being possible through the possession of water power of 15,000 h p. capacity. The sulphurous acid for the sulphite process, comes from the old Falun copper mines, from whose ores, in addition to the sulphurous acid for the pulp mills, over 2,000 tons of sulphuric acid are made annually.*

But the lumber trade of the company's activities is insignificant compared with its iron and steel operations. These are best described

* These Falun copper mines, which have been worked for 700 years continuously, have yielded since opened 500,000 tons of copper; and were in the 17th century probably the largest producers of copper in the world. They now yield only 400 tons of copper annually, with a large list of bye products.

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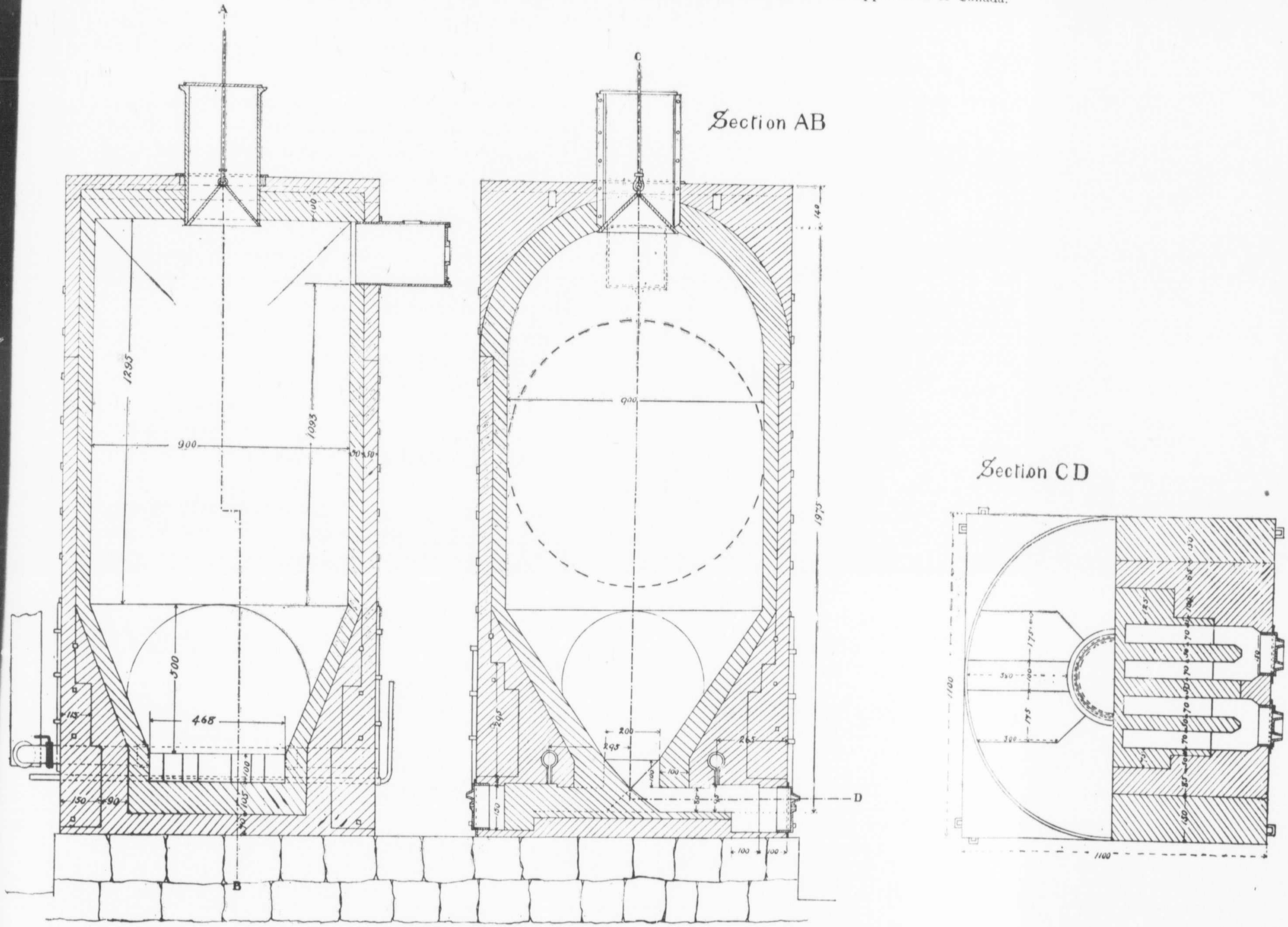
Plate illustrating Dr. Douglas' paper on "Swedish Iron Metallurgy in its Application to Canada."



Generator for Gasifying Wood and Sawdust used at Munkfors, Sweden.

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in the company's own circular, prepared for the Stockholm Ex, in 1897:

"In the year 1733 the company built their first iron works, Svartnäs, based on the then discovered iron mines at Vintjärn; one iron work after the other was later on added, each intended for its own particular specialty so that the company has manufactured iron at some 20 places in all.

So many difficulties met, however, in economically carrying on the manufacture at so many places on accouut of the expensive communications existing, that it was decided about 1870 to concentrate the iron manufacture and for that purpose build new works for which place was selected at one of the big waterfalls of Dala River. This new works is Domnarfvet, which is the largest iron works in Scandinavia and the largest in the world based on charcoal as fuel. To it belong 160 iron mines and a number of waterfalls together capable of developing about 50,000 horse-power, of which however only a small part at present is utilized. The works consist of the following departments:

Charcoal making plant with 8 large kilns.

Blast furnace plant with 5 blast furnaces, 6 Westmans roasting furnaces, regenerative blast heating stoves, etc.

Bessemer Works with 5 converters, etc.

Siemens-Martin works with 4 furnaces of 15 tons each, etc.

Rolling mill plant for sheet iron and plate, wire rods, rails, beams, channels, angles and all kinds of merchant iron.

Forge for hammering tool steel and miscellaneous tools.

Plate pressing works for boiler heads and similar articles.

Horse shoe nail factory, etc., etc.

The whole iron and steel manufacture is, as before said, exclusively based on charcoal by the aid of which is produced from the purest ores:

The highest grade of steel for cutting and other tools, for springs, coining dies, etc.

The principal manufactures at Domnarfvet are:

Pig iron, extra pure.

Ingots, blooms, billets and slabs of Bessemer and Siemens-Martin steel.

Billets specially made for seamless cold drawn tubes.

Projectile steel in large quantities for the English and other armies and navies.

Bars in various shapes and nail rods, wire rods, rivet rods, of Bessemer and Siemen-Martin steel and Swedish Lancashire iron.

Hammered bars of Swedish Lancashire iron.

Rails.

Boiler and ship plates.

Sheet iron, corrugated and smooth.

Pressed and flanged work of plate.

Machine straightened shafting.

Hammered steel (miners drill steel, tool steel, shear steel, spring steel, file steel, pin steel, machine steel, file blanks, etc.)

Stone cutting tools, hammers, anvils, etc.

Horse shoe nails, etc.

The products from Domnarfvet are to a large extent exported to the great countries of Europe, to America, to Australia, the East Indies, China and Japan.

The company furthermore owns two other works, Korsä and Äg, where especially soft Swedish charcoal wrought iron is made. The annual production of iron and steel is:

55,000	tons of	pig iron.
35,000	tons of	Bessemer ingots.
26,000	"	Siemens-Martin ingots.
4,000	"	charcoal iron blooms
47,000	"	rolled and hammered iron and steel of all kinds.
1,000	"	horse shoe nails, bolts and nuts, spikes, etc.

For the works are yearly used 450,000 cubic metres of charcoal (of these are 150,000 cubic meters made in the kilns at Domnarfvet and Skutskär."

Although rails are enumerated as one of the many articles into which their crude material is manufactured, comparatively few are made. Swedish steel is too precious to be turned to such vulgar use, and therefore in the very yards of the steel works themselves one generally sees English or Welsh rails.

It is by thus combining these reciprocally related interests that it is possible to make all three remunerative. Yet even thus, the life of all would be short, in fact that of the iron trade would have been extinguished long ago, but for the practice of strict economy in the consumption of the vegetable fuel, and the application of the rules of scientific forestry.

Only about 13 per cent. of the total area of Sweden is under cultivation and yet she exports to Britain $8,000,000 worth of dairy produce. In travelling through the country the farms are so scarce and so hidden away in the valleys of the vast forest clad ranges, that one wonders where even the 50,000 kilometers of agricultural land are, and still more, how what there is can be made to yield such a balance of agricultural exports, considering how large a proportion of the population is engaged in mining and manufacturing pursuits, and is therefore a home consumer. By far the most extensive forests are in the north, and are not available for the fuel supply of the great metallurgical establishments of the middle zone. The forests within reach of the furnaces have therefore, been replanted and recut many times over during the centuries of mining and metallurgical activity. It is found that the most economical life of the coniferous trees is 40 years, within which period they attain a diameter of from 8 to 10 inches. You seldom or never see a larger tree in Sweden or Norway. Calculating from the statistics above, to make 55,000 tons of pig iron and charcoal blooms at the Kopparberg furnaces, there are consumed 450,000 cubic meters of charcoal, or approximately 9 cubic meters to the ton of ore, or nearly 1 ton of charcoal to the ton of iron of both grades. One cubic foot of pine charcoal weighs 5 lbs. to 7 lbs., say 6 lbs., therefore, 1 cubic meter weighs 210 lbs., and if 55,000 tons of pig iron and 4,000 tons of blooms are made at the Domnarfert works with 450,000 cubic meters of charcoal, each ton of pig iron consumes rather less than 8.2 cubic meters of charcoal, or 1,722 lbs. One cubic foot of

NOTE.—The area of Sweden is	445,080	kilometers.
Of this there is covered by water.......	37,380	"
And by forest.............	300,000	"

pine weighs 18.9 lbs., and therefore, a cubic foot of charcoal weighs approximately 33 p.c. of the weight of 1 cubic foot of the same wood, but taking the reduction of bulk into account, the charcoal from 1 cubic foot of wood weighs only from 20 to 25 p.c. of the weight of the original wood, or 5.04 lbs. Akerman (In Swedish Mining Industry Iron and Steel Institute, 1898) gives the consumption of charcoal per ton of pig iron at from 4.8 to 8.2 cubic meters, a very large margin of difference for different ores, different charcoals, and different establishments. This therefore, rather conforms to above calculations of 8.2 cubic meters per ton of pig and charcoal blooms, at the works of the Kopparberg Co.

American practice agrees with these figures. J. A. Church (T. of A. I. of M. E., Vol. IV, 119-1875) gives:

1,922 lbs. of charcoal as consumed to the ton of pig in the Bay Farm Furnace, Michigan.

1,911 lbs. of charcoal as consumed to the ton of pig on the Morgan Farm, Michigan.

2,456 lbs. of charcoal as consumed to the ton of pig on the Deer Lake, Michigan.

1,760 lbs., or 80 bushels of 22 lbs. each, made 1 ton of iron at the Hinkle Furnace.

But the weight per bushel in the last instance would indicate coal of exceptional quality (Potter T. of A. I. of Mining E. Vol. XXIII, 371). The weight and not the bushel measure is the only reliable standard; for according to Wetherbee, (Eggleston T. of A. I. of M. E., VIII, 384) the weight of the bushel of charcoal from different woods is as follows:—

White pine	9.8	White ash	16.3
Spruce	11.2	Beach	17.3
Poplar	12.2	Yellow birch	18.7
Hemlock	12.8	Maple	18.9

T. Sterry Hunt, in the Geological Survey of Canada Report for 1869, p. 247, quotes the experiments of François in the Pyrenees, who gave as the mean for hardwood charcoal 21.9 lbs., and for softwood charcoal 16.4 lbs. per bushel of 2,150.42 cubic inches; also the result of Marcus Bull's investigation on American woods, which gave per bushel of:—

Red cedar	12.52	Ash or birch	19.25
White pine	15.42	Maple or oak	21.23
Yellow pine	17.52		

The wide discrepancies indicate the extent to which variations in manufacture influence results.

Similar incongruities of statement meet us as to the yield of wood and charcoal per acre. Sir Lothian Bell (Iron Steel Inst. in America in 1890) states on the authority of Chevandier, that the forests of the Vosges yield 72 cwt. of dry wood per hectare = 2,471 acres, or 29.2 cwt. per acre. Assuming even this high figure to be correct, Sir Lothian demonstrates easily the impracticability of running a large furnace that would consume 40,000 tons of fuel yearly on charcoal, 217 square miles would have to be cut over annually, and yet, if using coke, 1.33 square miles of a 3 foot seam would feed the furnace for half a century.

Birkinbine in T. of A. I. of M. E., VII, 149, tries to reduce the consumption of charcoal to the standard of cord wood and arrives at the conclusion that 4 cords of soft wood will make 1 ton of pig iron. If therefore, only 1 cord of wood, as he states, is the yield from an acre of replanted timber land, and 4 cords are considered as making 1 ton of pig, to make the output of 515,000 tons of pig which was the output of U. S. in 1873, 2,000,000 acres must be cut over annually. In fact, however, when a large quantity of charcoal iron was made in the U. S. the forest lands around the furnaces were stripped and yielded about 30 cords to the acre. Forest conservation and careful cutting and replanting were not practiced.

Akerman in his report for the Philadelphia Exhibition on the Swedish Iron Industry, gives still lower figures for the yield of Swedish forests. He states that 2.8 hectares, or 6.92 acres must be cut over annually to yield a ton of pig iron. Since the Centeninal year Swedish methods of both forestry and metallurgy have improved. Of course, on their system of cutting, the forest is perennial, unless destroyed by fire or wind. Moreover, in the above estimates, the assumption is that only the large wood is consumed, whereas with modern kilns good charcoal is made of inferior material, and in the producer, saw-dust, and large twigs and anything that will burn is turned into gas, and thus made into as valuable a fuel as the best of wood. Nevertheless, only in very favorably situated districts, can large quantities of iron be made with charcoal. Such a district would seem to be the original seat of the iron smelting industry of the *old regime* on the St. Maurice, Province of Quebec, whose waters are said to drain 200,000 square miles of forest land, and at the same time literally breed bog ore, so that the mineral and the fuel to reduce it grow simultaneously side by side. (Griffen T. of A. I. of M. E., XXI, 974.)

Yet if there be pure iron ore accessible to a territory covered by good timber, and intersected by water ways and provided with abundant water power, the establishment of such combination of enterprises would confer a national benefit and should be profitable :—for the value of such iron and steel is not to be measured by the price of common pig or ordinary steel. Of late the price of most Bessemer pig in the U. S., has been about $10 at the furnaces, whereas Swedish charcoal pig iron is worth £5 cif., Swedish malleable iron bars are quoted at £9.5 cif., and hollow steel ingots, such as are used for bicycle tube making, are quoted at $120, duty paid into the U. S. But such complicated enterprises as those of Sweden, can no where be carried out profitably unless the same economical methods are adopted which Sweden applies. If they can be duplicated anywhere it is surely in Canada. For Canada like Sweden possesses boundless forests, intricate water ways, immense water power, pure iron ores, and sulphur mines.

But should the fuel or iron ore not be available for work on such a scale as the operations of the Kopparberg Co., there are ores accessible to the Ottawa in treating which the saw-dust and waste lumber of that river, might be used. Whether the iron ores of Ontario and Quebec within easy reach of the Ottawa are as abundant as some claim I cannot of course decide, but the analyses published certainly represent ores of such remarkable purity, that they compare favorably, not with the best, but with the average of Sweden's Bessemer ores. In the following table 1, 2, 3, are examples of the purest Domnarfert Bessemer ores; 4, 5, 6, 7 of good Swedish ores of second grade, and 8 to 16 are examples of Canadian ores from Quebec and Ontario.

No.	Name of Mine.	Sesqueoxide of iron.	Peroxide of iron.	Protoxide of iron.	Protoxide of manganese.	Magnesia.	Lime.	Alumina.	Silicic acid.	Sulphur.	Carbonic acid.	Iron.	Phosphorus.
1	Johannisbergs grufvan	68.57	....	5.34	5.96	4.68	2.20	0.44	0.60	.....	12.10	53.80	0.003
	" "	64.42	....	6.13	6.88	4.72	1.62	trace	1.30	0.036	13.60	51.42	0.002
2	Bispbergs Stor grufva I	89.64	4.48	....	0.14	0.78	0.60	0.32	4.46	.....	......	68.05	0.003
3	II	73.75	6.57	.....	0.13	0.94	0.60	1.60	16.20	0.013	.....	58.00	0.008
4	Norbergs parish D : o Lilla Bads tugrufvan	......	79.25	.....	0.05	0 15	0.50	1.00	18.80	0.009	.....	......	0.021
5	Norbergs faltet new Skacelbergs grufvan	......	8.51	......	trace	0.11	1 30	0.18	13.00	0.076	......	......	0 011
6	Risbergs faltet Allmannig	......	69.05	......	0.05	0.30	1.65	0.60	28.25	0.021	.....	......	0.034
7	11 Old Stora By grufvan	......	71.58	......	0.15	1.49	2.07	2.01	22.08	0.006	......	....	0.032
	Hunts Iron & iron ores, Geological Survey Report 1866-1869.												
8	Hull Bed ore	......	66.20	17.78	.....	0.45	3.42	.....	10.46	.280	......	58.78	0.015
9	" Black ore	......	73.90	....	......	1.88	.....	.61	20.27	.085	......	.....	0.027
10	North Crosby	......	90.14	.....	.....	.84	.82	1.33	5.25	.120	.....	64.90	0.007
11	Belmont	.....	72.80	.....	......	6.46	2.75	...	14.73	.....	.....	52.41	0.035
12	Madoc	......	89.22	.....	.....	...	.....	......	10.42	.073	.....	.....	0.012
13	McNab	......	84.42	......	......	1.04	5.40	......	7.16	.065	.....	......	0.030
	Harrington Geological Sur. Rep. 1873-74—												
14	Bristol	......	65.44	14.50	....	......	......	.....	11.45	1.40	.....	58.37	trace
	A. I. of M.E. Vol. XXII, pages 201 and 204.												
15	Levant	......	63.73	......	...	......	......	......	4.466	0.032	......	......	0.028
16	Glendower	......	62.32	... ..	......	......	.. ..	......	10 67	0.39	.....	......	0.01

Analyses are given of other Ontario ores by T. D. Ledyard on some Ontario Magnetite, Vol. XIX, page 31, T. A. I. of M. E. They indicate ores even lower in phosphorus. The amount of pyrites in these ores seems to be well within the limit of Swedish practices, where owing to the methods of firing in charcoal hearths, the percentage of S. must nevertheless be small. This is attained by roasting. The gas calcining furnace of Westman is largely used.

The Canadian ores represented by above analysis come nearly up to the standard of Swedish ores from the Norbergs District Vestmanlands län, and are purer than much which is sold as Bessemer ore from Lake Superior, taking the following as examples :—

	Fe.	Ph.
Mountain iron	64	.045
Holmer	64	.055
Tubal	62	.065

It is estimated that 700 to 800 tons of vegetable matter goes to waste daily at the mills on the Ottawa, or say 450 tons of dry wood. If half of this, or say 200 tons could be converted into charcoal in the Ljungberg kiln it would yield 55 tons of charcoal and make over 60 tons of pig, while the saw-dust would make gas enough to convert the pig into steel and to manufacture the steel into specialized forms. This amount of iron may seem insignificant, yet it is more than one-tenth of Sweden's output.

At present disposing of this valuable vegetable matter on the Ottawa as waste involves expense, yet in Sweden every grain of saw-dust, all the bark, and whatever will smoulder is carefully collected and turned into gas. Fish are there abundant in rivers which turn half a hundred saw-mills. Even if the law permitted of the pollution of the rivers, self-interest would forbid. Attempts have already been made in the United States to utilize saw-mill waste in iron making. The Plattsburg or Norton Furnace was built in 1877 as an auxiliary to Norton's saw-mills for the treatment of Chateaugay ore, (T. of A. I. of M. E., IX, 77), but without much success. The appliances and metallurgical experience were however, at that date vastly inferior to those now accessible. The Kopparberg Company for instance, now uses the Ljungberg continuous kiln, in which refuse wood is burnt into charcoal, at 33 per cent. less cost than in heaps, and with 22 per cent. higher yield. The company reports that the yearly output per kiln is 200,000 hectoliters (=550,000 bushels) of charcoal. The kiln is charged by means of hoisting and conveying machinery. The coal is mechanically discharged into pockets, whence it is conveyed by rope transportation to the top of the blast furnace. The company exhibited at Stockholm, tar, acetate of lime, methelated alcohol, and other bye products of the charcoal kiln.

Waste such as saw-dust, shavings, bark, etc., too small or unfit for conversion into charcoal, is grasified in producers of peculiar construction. If the charge be sufficiently open to allow the free passage of air, the charge in the producer is 12 feet deep, if compact, as for instance, when saw-dust is being burnt, 6 feet in depth. In the latter case, forced blast is introduced, on a level with the solid hearth, for no grates are necessary, there being no clinkers and very little ash. Formerly it was considered necessary to condense the moisture and the tar, before the gas was burnt; but now the ligneous fuel is dried before being thrown into the producer, and the gas, if the producer be no further than 50 feet from the furnace, is burnt as it is made. The introduction of the wood gas producer enables charcoal iron to be made into open hearth steel, and permits this to be manufactured into articles which require high or accurately controlled heat, and the gas is made out of material whose disposal elsewhere entails cost and serious inconvenience to the lumberers.

If the circumstances in Canada be as supposed, the methods pursued in Sweden are certainly well worthy of study by Canadian lumber men and iron miners. To the combination of the two great industries of lumbering and iron smelting is largely due the prosperous condition of both in Scandinavia. To practice conservative forestry is what every enlightened economist and lumbermen on both sides the line preaches, and what no one practices on a large scale, nor I fear will

NOTE.—According to Mathews (T. of A. I. of M. E. XI, 84) one cord of wood charred in a retort yields 70 bushels charcoal of 2,561 cubic inches; 225 gallons of pyroligneous acid, ½ gallon of wood alcohol, 25-30 gallons of tar. But for furnace use retorted charcoal is not considered economical, and the Kopparberg kilns do not show so high a yield of bye products.

any one practice it, until obliged by law to do so. It requires no argument to prove, that a perennial blessing is better than an annual one; but before the full benefit of scientific forestry can be achieved a large immediate sacrifice must be made, and afterwards the lumberman would I suppose have to be satisfied with a lower average scale of profits. But to associate pulp making with saw-milling is doing no violence to either industry, though it would certainly strain the versatility of our most enterprising lumber merchants, were they to undertake as an adjunct the delicate task of iron smelting, steel making and tool manufacturing. Such complex industries must be the product of growth. But the first step towards the realisation of such a system of exhaustive and economical utilization of nature's resources might be the establishment, if necessary under independent management, of iron and steel works, conveniently situated to the saw-mills of the Ottawa, and under contract with the saw-mill owners to supply mill waste. The failure of such old enterprises as the Hull furnace, need not deter the promoters of such an enterprise, if they are satisfied of an abundant supply of pure ore; for a revolution in iron and steel making has taken place within the last 25 years. Moreover charcoal, iron and steel are even rarer products than they were then; for in 1875 the U.S. produced 515,700 tons of charcoal pig, whereas the output fell to 255,211 tons in 1897. The production is never therefore likely to be in excess of the demand.

Such iron furnaces and mills need not be on the immense scale of the great coke and coal iron and steel plants. The famous Sandvik works of Sweden which supply the United States with the finer bicycle steel for tubing, turn out only 20,000 tons of finished product annually. Another company which exhibited its products in a separate pavilion at Stockholm, the Finspong, makes only 6,000 tons of open hearth steel ingots, 6,000 tons of open hearth steel castings, 600 tons of wrought iron blooms, and 2,500 tons of manufactured articles.

Compared with the enormous production of the United States for example, whose blast furnaces made in 1898 11,900,000 tons of pig

NOTE.—There have been great oscillations in production between these dates. The production rose to 628,140 tons in 1890, but for years past the production has not notably exceeded that of 1897.

the largest stacks touching 700 tons per day, Sweden's output if measured by quantity is almost inappreciable. Nevertheless by adhering to the principle of never sacrificing quality to quantity, her comparatively small contribution of iron and steel to the world's total, owing to its unique excellence, and its wonderful properties, maintains Sweden in a prominent position among the metallurgical powers. Her enviable position and bright example are therefore worthy of being taken to heart by Canadian miners, metallurgists and lumbermen.

An Improved Method of Introducing Feedwater to the Stamp Mill Mortar.

—

By BERNARD MACDONALD, M.E., Montreal.

The vertical cross-section and plan of the mortar shown in Figs. 1 and 2 illustrates the method used by the writer in feeding the water supply to the mortars of the stamp mill batteries at the Dufferin Mine in Nova Scotia. This method has proved so satisfactory and effective that it is thought a detailed description of it would be found interesting to the members of the Institute.

The points of superiority of this over the customary methods may be seen best when viewed in contrast with the latter, a brief description of which will be given first.

In considering this question it should be understood that a continuous and uniform stream of water is required in the mortars of the stamp mill to mix with and form a *thin pulp* of the ore as it becomes pulverized beneath the blows of the falling stamps and in this condition (thin pulp) to carry it in suspension until discharged through the screen meshes.

It is customary to introduce the water requirred for this purpose over the top of the mortar in iron pipes or rubber hose. Thus introduced the water falls about three feet before it reaches the top level of the pulp mass in the mortar where it is still about seven inches above the crushing surfaces of the shoes and dies. On reaching this position it will be seen that a large portion of it must of necessity be discharged from the mortar before it can be mixed with the ore as it is pulverized. Therefore such portion fails to effect the purpose for which it was introduced. But perhaps the greatest defect in this system is the fact that the feedwater falling on the pulp mass has a tendency to settle the fine sands and slimes below the discharge level which not only lessens the discharging capacity of the mortar, but subjects the fine sands to further pulverization after having reached the proper degree of fineness to pass through the screens, thus producing loss by sliming the pulp and unnecessary abrasion of the free gold particles.

The points of superiority claimed for the "improved" method are that the water being introduced below or on a level with the crushing surfaces of the shoes and dies under a static head sweeps off at once from the dies and between them such portion of the ore as has been reduced to a sufficient degree of fineness and carries it upward into the pulp mass, where it is immediately presented with the most favorable opportunity of being "splashed" through the battery screens. This removes to a very considerable degree the cause of sliming the pulp for which the stamp mill has been noted, and, as will readily be seen, increases the discharging capacity of the mortar and hence its crushing capacity. In thus washing away the fine sands and slimes from around the dies leaving only the coarser particles of ore to occupy these spaces a favorable receptacle is provided into which the coarse gold may settle and be protected from unnecessary abrasion. Were the water introduced in the customary way the spaces around the dies would be packed with an impenetrable mass of silt which would offer no hiding place for the coarse gold which would be lashed hither and thither through the mortar losing by abrasion with every contact between the stamps and dies or with the sharp quartz. Summed up the points of advantage in this method are:

(1) Increase of crushing capacity.

(2) Decrease of sliming.

(3) Preparation of the bottom of the mortar to retain and protect the coarse gold from abrasion.

Details of fixtures for the Method Shown in Figs. Nos. 1 and 2.— (*a*) The main feed water pipe 3″ in diameter fitted on end with a blow-off plug as shown, and connected with B.

(*b*) The 1½″ connecting pipe fitted with globe valve to admit or shut off the feedwater. This valve would reduce pressure of feedwater entering the mortar, if required. Between it and A is a ¾″ pipe connection to which is attached the hose for washing the plates.

(*c*) The 3″ distributing pipe to which is connected by tapping the six ¾″ feed pipes. This pipe is fitted, as shown, with a blow-off plug on end.

(*d*) The six ¾″ feed pipes connected to holes tapped on mortar, as shown, and each fitted with a globe valve to regulate the amount of feedwater and also with a piece of hose to prevent the vibrations of the mortar from being communicated to the piping.

(*e*) The holes tapped in mortar feed steel liner to admit the feed-water.

(*f*) The top level of the pulp mass at rest.

(*g*) Level of discharge from mortar.

(*h*) Shortest line from entry of feedwater to discharge of pulp.

(*i*) Shortest line from entry of feedwater to discharge of pulp if introduced over top of mortar.

It was feared at first that the holes for admitting the feedwater to the mortar might become choked up with pulp inside the mortar, but one month's continued operations without any symptoms of trouble from this source, has proved these fears groundless.

The blow-off plugs in pipes A and C provide facilities for cleaning out grass, leaves or mud that might be deposited from the feedwater.

The six regulating valves on pipe when once opened to admit a sufficiency of water are never touched afterwards, the feedwater being admitted and shut off by the 1½″ valve on B, which is turned wide open or shut off as desired, whether shut off or otherwise the water for washing the plates coming from between this valve and A is not interrupted.

The head under which the water flowed to the mortars in the case under consideration was 30 feet.

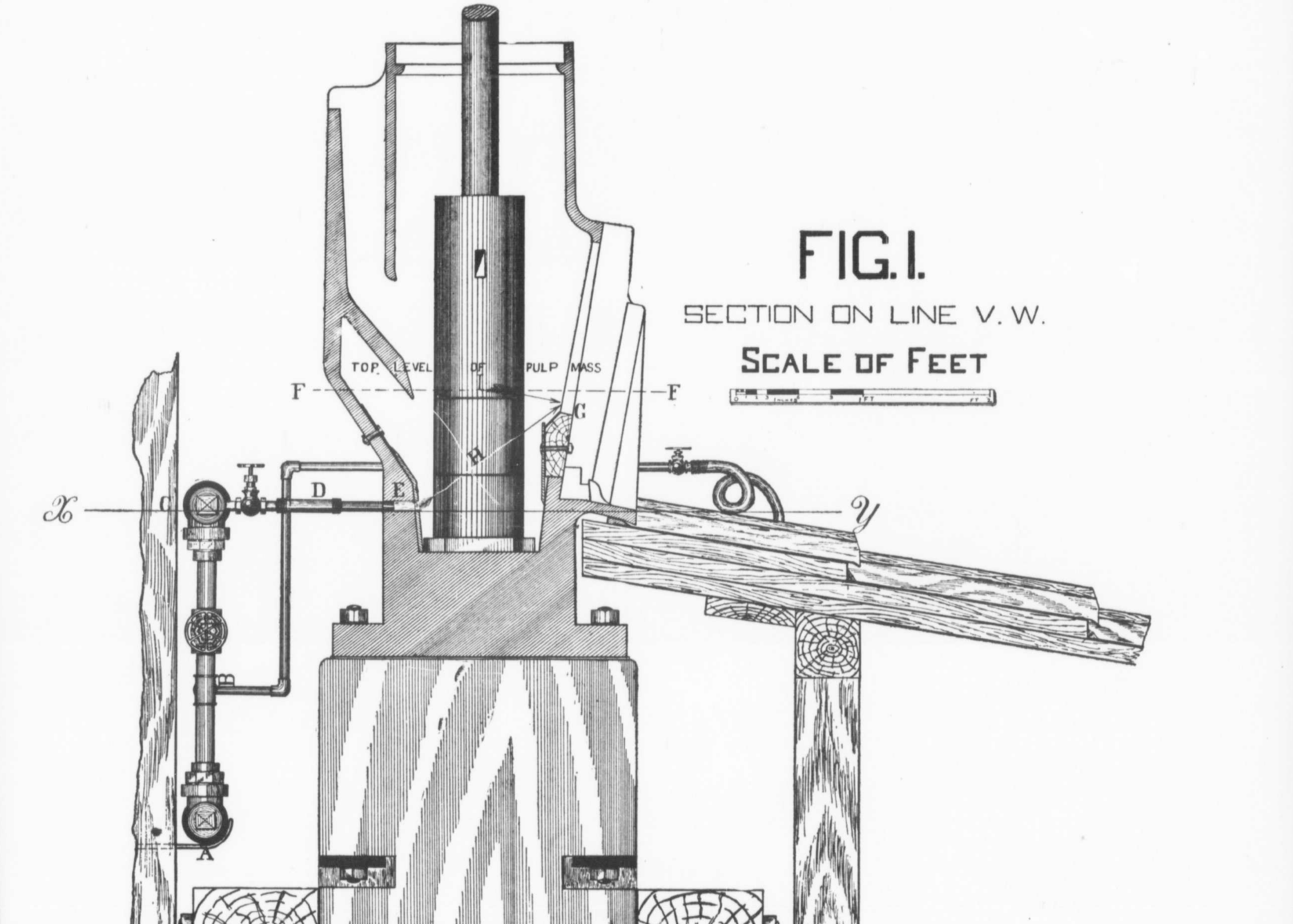

FIG. I.

SECTION ON LINE V. W.

SCALE OF FEET

An Improved Method of Feeding Water to the Stamp Mill Mortar.

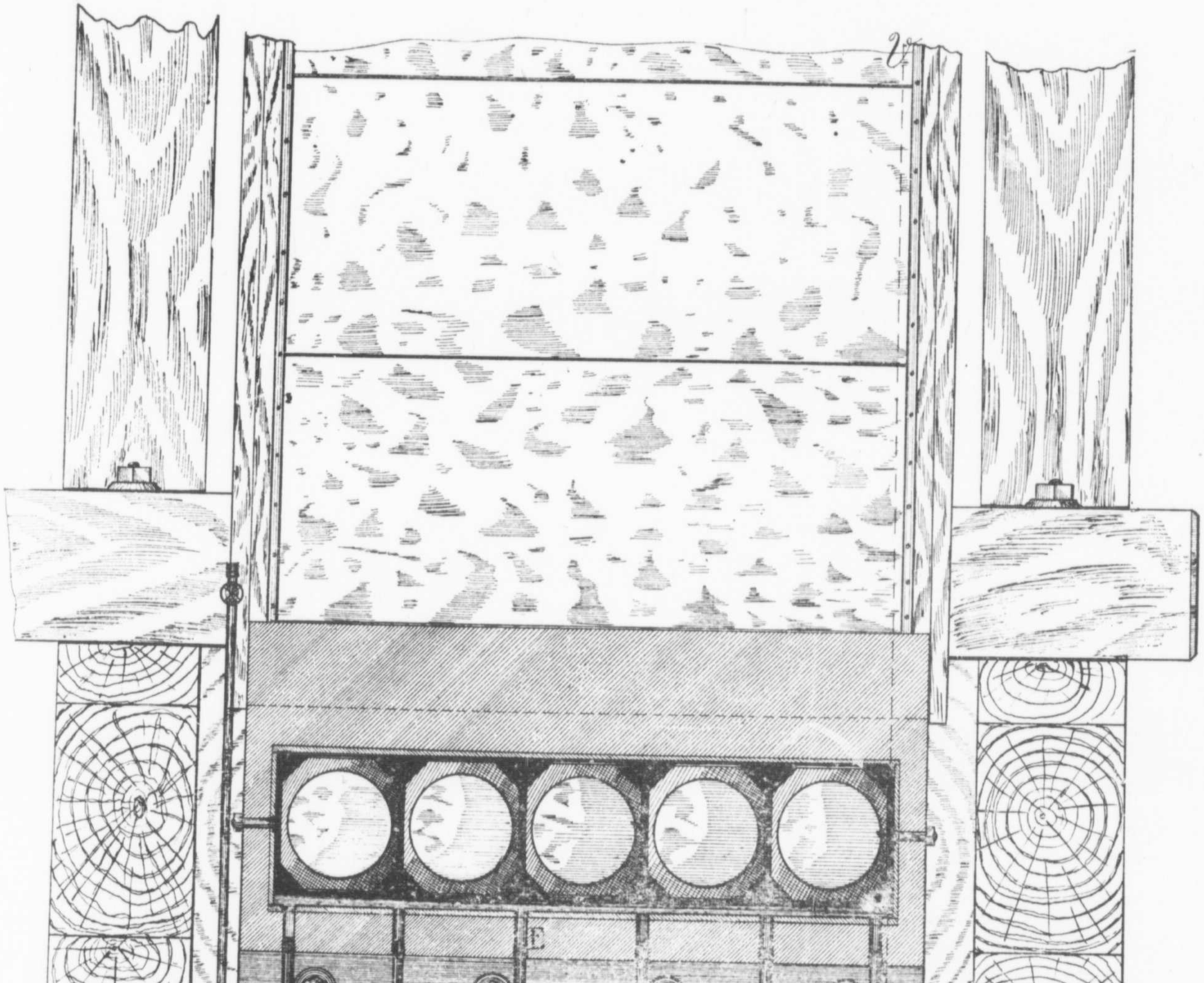

FIG. 2.

PLAN ON LINE X. Y

SCALE OF FEET

An Improved Method of Feeding Water to the Stamp Mill Mortar.

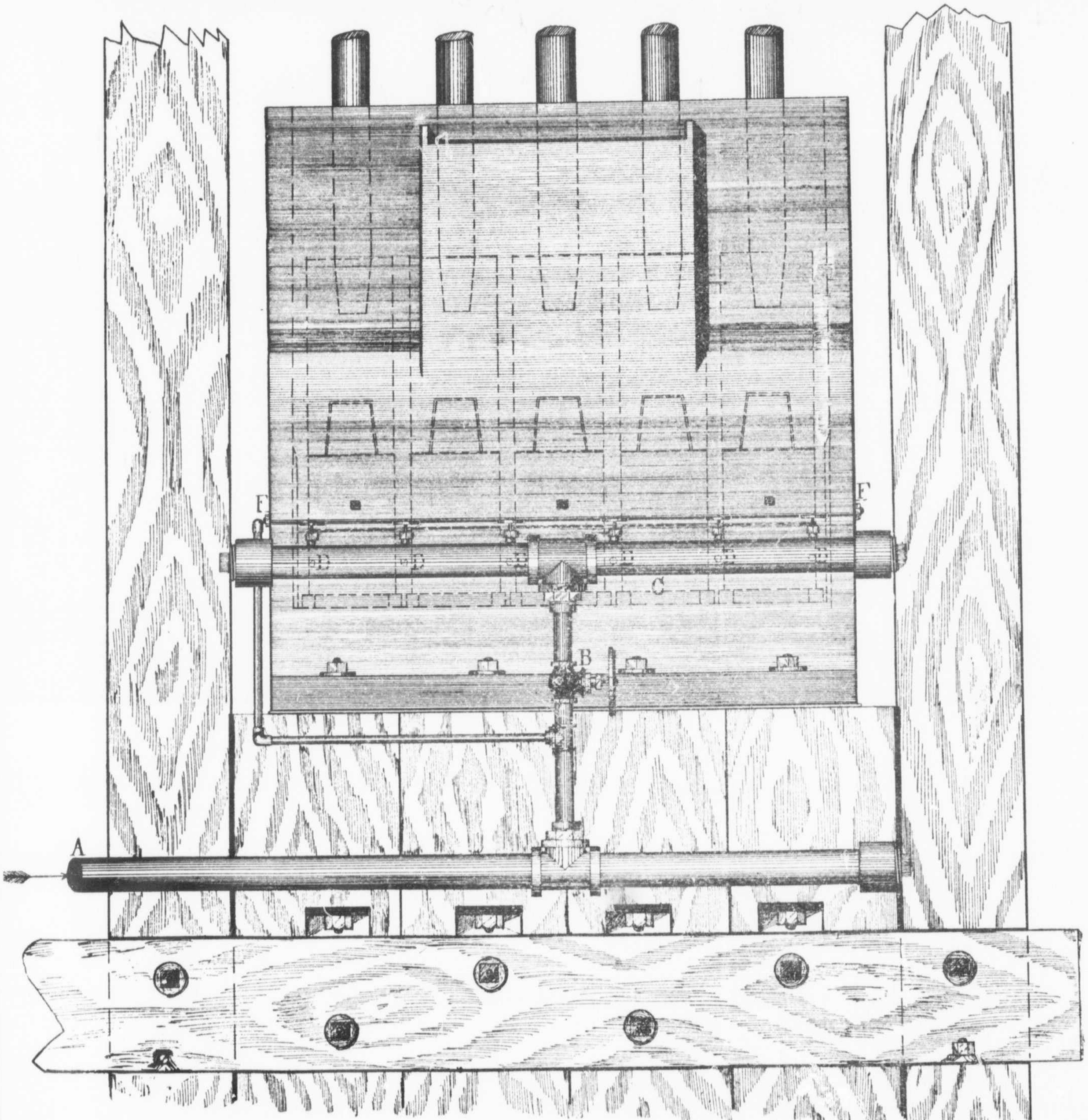

FIG. 3.

REAR ELEVATION

SCALE OF FEET

An Improved Method of Feeding Water to the Stamp Mill Mortar.

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The Iron Industry in 1898.

By George E. Drummond, Montreal.

The past year has been a record one in the principal iron producing countries of the world, and, as far as Canada is concerned, 1898 may be considered as marking a new era in the native iron industry, the beginning of a modern expansion in the manufacture of pig iron within the borders of Canada that will in due time give us a respectable position among the great iron producing countries.

Following the usual course and reviewing briefly the iron markets of the world, we have first the United States, showing a most remarkable record for 1898 as far as production is concerned, and a wonderful rate of consumption that already in February, 1899, indicates almost a famine in iron and products of iron. Figures for 1898 show that the United States produced 11,773,934 tons of pig iron, and this enormous production goes on at an increasing ratio, using up the available ore supplies at such a rate that the greatest difficulty may be experienced before the close of the present year in keeping the furnaces supplied with raw material.

The present great revival of trade in the United States, brought about by two successive years of splendid crops and consequent increase in railway earnings, which enabled the railway companies to undertake vast expenditures for new rolling stock, is the cause, no doubt, of a great deal of the revival, but everywhere most satisfactory expansion is marked in all lines of manufacture of which iron is the the basis. The lessons of the war with Spain will probably result in a great expenditure being made by the American Government in perfecting their coast defences, and all this is in the direction of an increased utilization of iron.

The export trade in the United States in 1898, in all kinds of metals, reached the enormous sum of $120,000,000. In the item of pig iron alone they exported 250,000 tons. With the scarcity of iron for home requirements at the present moment, it is not likely that they will press the export trade unduly in 1899, and the iron producers of other countries (and not least of all Canada) will have a chance to gain strength to meet future competition in the United States.

Great Britain.—The British iron masters hold second place as the iron producers of the world to-day. The total records of iron produced in Great Britain in 1898 are not yet to hand, but it is pretty safe to estimate an output aggregating 9,500,000 tons as against a production in 1897 (revised figures) of 8,796,465 tons. The use of British iron has almost ceased in Canada, and while that does not mean that Britain is not holding her own in other markets, still the situation is a somewhat grave one for British iron producers inasmuch as their ore supply is growing more precarious every day. The life of the Spanish iron mines, upon which Britain draws heavily for supplies, is already well understood to be but short. The product of the home mines grows steadily less, and it will be well for Great Britain to look to her Colonies, such as Canada and Newfoundland, for her future source of ore supply The indications are that this alone will enable her to hold the position that she has held for so many years. The British home trade in iron has been very prosperous in 1898, exceeding that of any previous year. In ship yard and railway work, and in all branches of the iron trade, manufacturers have been exceedingly busy, and with more or less freedom from strike difficulties. Great Britain emerges at the close of the year with a splendid record, but Canadians regret to note how very much "out of touch" they are to-day with the British iron masters, who formerly supplied this country, and who have been replaced to a very great extent during the past few years by the iron producers of the United States.

Germany and Luxenburg.—Enormous strides have been made by the Germans during the last three or four years in their iron industry, and the figures of production for 1898 (Germany and Luxenburg) 7,402,717 metric tons, come so close to the records of the British iron masters that there is grave cause to fear that unless most vigorous measures, political and economic, be taken by Great Britain, her rank as an iron producing nation will be displaced by Germany, as it has been by the United States.

Canada.—The output of the Canadian furnaces for 1898 exceeds that of 1897. Advices received from Hamilton, Ont., New Glasgow, N.S., and Radnor Forges, Que., report a combined gross tonnage produced of 75,920 net tons of pig iron, 23,541 tons of steel, and 2,276 tons of forgings. The combined tonnage of pig iron in 1897 was 57,904 net tons.

The works at Londonderry, N.S., were closed down throughout the year, the company being in liquidation, but this not because the market could not absorb its full output had the works been running. Everywhere the product of these Canadian furnaces has given entire satisfaction, so far as the quality of metal produced is concerned. The work of developing the Canadian mines has been carried on quietly, but steadily, by those interested, and the new year opens with splendid prospects for a very much larger production of Canadian metal in 1899.

The new charcoal furnace constructed at Deseronto during 1898, has just been put into blast, with an average output of 30 tons of charcoal metal per day, practically doubling the daily production of charcoal iron in Canada.

A new charcoal furnace is projected for Midland, Ont., by the Canada Iron Furnace Co., Limited, of Montreal and Radnor Forges, this being a branch of their business at the latter point, but the intention being to manufacture at Midland an iron similar in quality to Lake Superior charcoal, and which is required for mixture with the special charcoal metal now made at Radnor from the bog and lake iron ores of the district of Three Rivers. The new Midland furnace will have a daily capacity of from 60 to 80 tons of charcoal iron.

A four furnace coke iron plant, of large capacity, is projected by American and Canadian capitalists at Sydney, C.B., where the ores of Newfoundland will be smelted with Canadian coal.

Other furnaces are talked of, but those already mentioned will turn out sufficient iron in the near future to care for all the immediate wants of Canadian iron founders, and doubtless a considerable quantity of the metal produced will be exported to Europe, especially perhaps from the proposed Cape Breton plant. The time is rapidly approaching when the product of the Canadian furnaces will have to be carried (on a larger scale than at present) to the finished stage of of iron and steel of all descriptions, there being an ample and increasing home market for such products.

The following are the records of the furnaces at Hamilton, Ont., New Glasgow, N.S., and Radnor Forges, Que., for 1898 :

THE HAMILTON BLAST FURNACE CO., LTD., HAMILTON, ONT.

Ore smelted (tons of 2000 lbs.)	77,023
Scrap and mill cinder	8,614
Limestone	13,799
Coke	50,407
Pig iron product	48,253
Average number of workmen	130
Wages paid for labor	$ 61,476
Value of pig iron at furnaces	530,789

THE NOVA SCOTIA STEEL CO., LTD., NEW GLASGOW, N.S.

Pig iron made	21,627	net tons.
Steel made	23,541	"
Forgings made	2,276	"

The material used being as follows :—

Coal	107,000	net tons.
Canadian ore	19,000	"
Newfoundland ore	15,000	"
Spanish or Cuban ore	6,000	"
Coke	32,000	"
Limestone	18,000	"
Average number of men employed	750	
Wages paid about	$280,000	

N. B.—These figures do not take into account the men employed in mining coal, nor does it include the various parties employed professionally and otherwise and not paid directly by the company.

In addition to the operations carried on by this company they have during the year been working their Newfoundland iron ore property more extensively than ever before, having shipped to Germany and Scotland about 75,000 gross tons, besides bringing over 30,000 tons to their own works at Ferrona.

THE CANADA IRON FURNACE CO., LTD., MONTREAL AND RADNOR FORGES.

Owing to the plant being overhauled and improved during the year, the campaign was only of about eight months' duration. The production during that time was :—

Special charcoal pig iron............	6,040—420/2000 tons.
Charcoal made...............	580,100 bushels.
Ore made	14,400 net tons
Limestone flux made.................	1,432 "
Average number of men employed.	600

As usual, the labor in connection with this furnace was principally drawn from the farming class, and the field work is therefore of a more or less intermittent character, being performed at seasons of the year when the farmer is not engaged in his usual agriculture pursuits. A very large number of horses are also employed in teaming the ore and wood necessary for the supply of the furnace.

The product at Radnor Forges continues to attract most favorable consideration from engineers abroad as well as at home. During the year shipments of "C.I.F.," special charcoal metal were made from the furnaces to leading establishments in Great Britain, France, Germany and the United States and the demand for this special iron is an increasing one.

While the figures for 1898 do not show a very large increase over those of 1897 (this being largely accounted for by the liquidation of the Londonderry Co's affairs) yet the furnaces in blast show a healthy strong business growth, and the projected furnaces (all in strong hands) now coming into the field, is good evidence of the fact that we are on the eve of a very considerable expansion of the native iron industry. A great factor in bringing this about is the settled condition with regard to the governmental policy of encouragement. If that policy is steadily maintained for a few years to come, Canada will have an industry that she may well be proud of, and that will strengthen and build up every other kindred industry in the Dominion, an industry that will be useful too in an Imperial sense, making for the independence of the Empire in so important a commodity as iron.

Mining in Quebec Province in 1898.

By J. Obalski, M.E., Quebec.

The following remarks and statistics will give a fair idea of the progress made by the Mining Industry in this Province during the past year:

Bog Iron ore operations have been carried on as usual, the ore being raised in many different localities and transported to the Drummondville and Radnor furnaces. These latter were operated for about eight months of the year, utilizing 13,363 gross tons of ore and producing a total of 5,762 gross tons of charcoal pig iron.

No other iron ores have been worked, but inquiries have been received concerning the Magnetic sand found on the north shore of Gulf of St. Lawrence, and possibly something may be done in this line before long.

The Ochre producing plants have done a fair season's work in the Three Rivers district, the product finding a market abroad as well as in the Dominion.

Chromite operations have been steadily continued in the Coleraine district, and improvements in the system of extracting the mineral were remarked. Special attention was given to the idea of concentrating the ore, in order to produce a 50 per cent. grade, the standard n demand. In this connection, two mills have been erected, and will probably be ready for work during the coming summer.

Our *Low Grade Copper Ores* of the Eastern Townships have been worked with the usual success by the two Capelton companies, and some important prospecting work has been done by other parties. At the Harvey Hill Mine, the present owner is deepening the Whitburn shaft; and in view of the rise which has taken place in Copper, we should see this year a notable increase and activity in this industry.

Up to a recent date, *Nickel and Cobalt* had not been found in this Province in any appreciable quantity, the only instance reported being in the Township of Orford. Last summer Mr. E. P. Cowan while prospecting in the south part of Calumet Island, in the County of Pontiac, located a remarkable deposit of this mineral. This district, as established by the Geological Survey, is overlain by a band, unquestionably Huronian, and in connection with the Diorite, it contains, several varieties of minerals have been found. The work performed by Mr. Cowan consists of a shaft 20 feet deep sunk on a small band of Diorite, 12 feet in width, carrying in a disseminated state, numerous grains of nickeliferous pyrrhotite, and which at one point concentrate in a small vein 8 inches wide. A specimen of the ore tested gave: Nickel, 3.33 per cent.; cobalt, 0.35 per cent. Besides the above, a small vein of yellow mineral, established by the Geological Survey to be "Niccolite," or arsenical nickel, presents itself in one place two inches wide, and probably patches of same are disseminated through the whole mass of Diorite, which latter lies in a N.N.W. direction with a dip 20 deg. E. The claim is situated on lot 12 or 13 in the XI. Range. Although numerous indications of pyrrhotite are found in the vicinity, I have not seen any other than those above mentioned, containing nickel in commercial quantity.

Molybdenite attracted attention last year on account of its new uses for metallurgical purposes, but up to the present time, no deposit has been worked, and as a matter of fact, we have no idea of the actual form of the deposits. This mineral has been found at several points in the Gatineau Valley, in the Counties of Ottawa and Pontiac, and also on the north shore of the St. Lawrence. We hope that some of those deposits will be worked in 1899.

Operations on *Galena* have been carried on to some extent at Lake Temiscamingue and Calumet Island; at the latter place, the ore is mixed with a large proportion of zinc blende. The development work here may lead, in the near future, to some important discovery.

Alluvial Gold mining in the Beauce district has been continued, and some good prospecting work was done on the Gilbert River; no doubt there is a fair profit to be obtained here by intelligent action and we may expect to see a marked increase in development,

Some prospecting work was done in other parts of the Chaudiere Valley which promises well. Altogether, there should be a much larger output of gold in 1899 than during the last few years.

The production of *Asbestos* is now a firmly established industry, and large quantities of fibre were extracted in the Thetford and Danville districts. Danville was also a large producer of Asbestic. A certain amount of work was done at Broughton and Black Lake, and to a lesser extent in the Ottawa District.

Graphite (in the vicinity of Buckingham) was but little worked in 1898, notwithstanding the fact that there was a fair demand for the prepared article. In 1899, we hope to see activity, as it is reported that a company is being organized to operate on a large scale.

Phosphate mining was practically neglected, and only a few hundred tons were produced in the Ottawa district, being taken out in the process of mining for mica.

The Mica mining industry showed a somewhat increased activity compared with the last couple of years, e. g. there were 250 men employed last year, as compared to 50 to 100 in 1897, prospecting and working. Mica is now shipped chiefly in the "thumb trimmed" condition, firstly because it is more easily handled, and secondly because the duty on the mineral in this shape is less. The demand for Canadian mica is strong, and the prospects of this industry for the future may, with safety, be said to be bright.

Feldspar has been taken out in fairly large quantity at Templeton and shipped principally to the United States market.

The building material industry has been maintained in about equal volume to former years.

Prospecting for other minerals has been done, and in this connection, I should specially make mention of the work done in the Gaspe Peninsula in boring for petroleum. The results met with were encouraging. In the north shore of the St. Lawrence, some prospecting in the Magnetic sands was also done.

In the following statement, I show the quantities and values of the raw material at the mine, of the various minerals produced in the Province during the year, but not including the building material, and mineral waters, as complete returns of same could not be procured.

The value of the raw material at the mine, *i.e.*, the quantity shipped or used in 1898 is $1,700,000, approximately.

The mining industry generally employed about 4,000 hands at various points in the province.

	Quantity shipped from the mine, or used.	Value of raw m terial at the mine.
Charcoal pig iron (gross tons	5,762	$116,154
Bog ore "	13,363	37,927
Magnetic ore "	22	66
Ochre (tons of 2,000 lbs.)	1,260	12,600
Chrome iron (gross tons)	1,805	25,000
Low grade copper ore "	35,686	143,884
Zinc, blend and galena "	1,300	21,900
Gold (ounces)	370	6,500
Asbestos (tons of 2,000 lbs.)	15,893	496,340
Asbestic " "	7,122	14,916
Plumbago (prepared) " "	85	8,500
Phosphate " "	870	5,975
Mica (thumb trimmed) " "	275	81,000
Feldspar " "	2,000	5,000
Sulphate of Baryte " "	55	275
Slate " "	3,432	37,374
Flag stone " "	946	3,580
Cement (barrels)	20,000	32,000
Lime (bushels)	1,000,000	140,000
Bricks	120,000,000	600,000
Total		$1,672,837

Prospecting for Iron Ore in Newfoundland and Cape Breton.

By C. A. MEISSNER, Londonderry, N.S.

The subject of this paper may perhaps have some special interest at this time owing to the general activity displayed in iron ore and pig iron brought about by the remarkable revival of the general iron trade, especially in the United States, and by the increased demand for ore, and even pig, in Great Britain and the Continent. The Spanish sources of ore supply are not as available as in former years, owing partly to measurable exhaustion in certain districts, and partly to the increased developments of Spanish iron works, which have a tendency to cause the Spanish Government to take measures that will prevent too rapid an exhaustion of this very profitable resource of their country.

This increasing European demand for ore and pig is really the key note to all the activity displayed in iron ore developments in the sections that I am now describing, and these matters have been well understood among those interested in Canadian iron developments. The time for taking action, however, had been unpropitious until last year, and since then developments have been rapid.

The success of the Spanish-American war gave the necessary impetus to this revival in iron, as well as in many other industrial lines, and as a result an almost feverish activity has taken place in some sections of the countries referred to by these notes.

In Newfoundland the movement towards active development has been going on for some time, stimulated particularly by the remarkable deposit of ore discovered on Belle Island, and which was brought to the first stage of its full development last year. The fact that so large and uniform a deposit was found naturally gave reason for supposing that there were others equally as good, and it seemed unreasonable to suppose that this should be the only one of this nature in a country which showed signs of ores in many localities, and whose whole geology was in many respects so nearly akin to that of the famous

Lake Superior regions; in many cases the fact was undoubtedly lost sight of that this Belle Island formation was entirely unconformable, and had no apparent direct relation to any of the surrounding geological formations. Nevertheless, the general public interested in iron naturally jumped to the above conclusion, of where this was there must be more, and English capital has been heavily interested already in many localities, while the prospects are that next spring and summer will see a remarkable activity in prospecting and developing this colony, with, it is to be hoped, good results.

There is no need of my describing the Belle Island deposits, as this has been done most thoroughly by Mr. R. E. Chambers, at the March meeting, '96, of the Mining Society of Nova Scotia, and Mr. J. P. Howley, of St. Johns, Newfoundland, has made a close study of the geological formation.

I will only add that what strikes one as being peculiarly interesting is the remarkable fact of this ore being in regular stratified formation, so that it enables the miner to make definite calculations as to quantities contained in the areas, which is so great a departure from the usual run of ores throughout this whole country that it deserves special mention, and should be kept in view, so as not to mislead one in prospecting the rest of the country.

Its real value lies not so much in its richness of iron (it averaging about 55 p.c., which a Lake Superior man would call low grade), but in its extreme uniformity, both of quality and size of vein, and its proximity to the most available iron smelting point on this side of the water for English consumption.

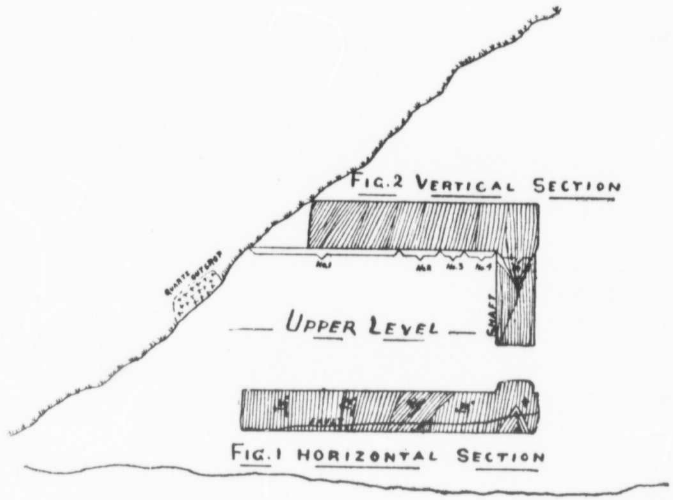
A feature of the districts I examined in Newfoundland, outside of Belle Island, was the rather striking geological similarity to those of some of the Lake Superior districts; in fact this general similarity is noticeable all through the northern iron bearing districts, including Nova Scotia and Cape Breton, and a study of the monograph by Henry Lloyd Smith, on the Marquette iron bearing district of Michigan and other U.S. geological reports emphasizes this in very many points. These ores occur almost invariably in the older formations and are irregular in lenses or basins, sometimes only in small seams, frequently pinched out by rock. The slates here were underlying the volcanic granulites, and penetrating through these latter were found the thin seams of ore, following apparently cracks in the granulites, and constantly varying in thickness. The great question apparently will be whether these crevices widen out into hollows and basins filled with ore, or whether they are merely the remnants of the large ore-bearing formations which appeared to have centered their deposits in the Lake Superior regions. The theory of ore solutions penetrating and filling these volcanic formations wherever cracked or hollowed out, in blow holes or otherwise, seems to be pretty well accepted, and is, perhaps, the most reasonable one. The prospecting of these deposits, therefore, is one of extreme uncertainty, and it appears that the diamond drill is the most suitable method to employ; driving shafts in the hard granulites is expensive work, and the ease with which the drill can be changed, and the large territory that can be covered with it from one point, makes it the most available and economic factor in determining the presence of ore in these sections.

In Cape Breton we have somewhat similar conditions to deal with; various ore properties have been partially exploited and abandoned because of their irregularity, yet I think some very fair deposits can still be found. The irresponsibility and unreliability of many prospectors, coupled with ignorance in many cases, is a serious drawback in all these countries, and I would utter an earnest word of caution on this subject, as it is bound to react on the whole country if persistent mis-statement and exaggeration are laid before the public, especially before English investors. I can speak feelingly on this subject, as I have lately had experience in these matters, where, in various cases, there was no foundation for reports that claimed large quantities of ore, and where it was evident that no more than mere superficial examinations had been made. I will not impute worse.

We are entering a new era where especially English capital is looking this way, and only fair and honest treatment in such matters can bring and hold it here. It is easily made timid, and any one large deal based on fraud or ignorance would turn away dozens of others that might have merit. I trust that some of my speculative friends in

Date 1899	Distance Bored per Day	Total Depth Feet	Bore Hole No. 2	Description of Stratum: Thickness in Feet	Remarks
Jan 17	3				
18	6'	9		9	Quartz No Solid Core
19	5'				
20	5'	19			Water
24	6'	25		16	2 Gal. Per Minute Quartzyte
25	1'				
26	10'				Water Increasing
27	4'	40		15	Slate
Feb 8	3'				
9	8'				
10	6'				
11	8'	65		25	Quartzyte
13	7'				
14	3'				
15	3'	80		15	Very Hard Slate
17	6'				
18	7'	93		13	Quartzyte
21	5'	99		6	Water 12 Gal. Per Minute Quartz

Date 1898	Distance Bored per Day	Total Depth Feet	Bore Hole No. 1	Description of Stratum: Thickness in Feet	Remarks
Dec 28	6'				No Solid Core
29	5'	11		11	Quartz
30	1'				
1899 Jan 3	2'				
6	12'	26		15	Quartzyte
7	6'				
9	5'	37		11	Mixture Slate and Quartz
10	6'				
11	5'				
12	6'	54		17	Quartz with Occasional Thin Layer or Parting of Slate
13	5'	59		5	Quartzyte



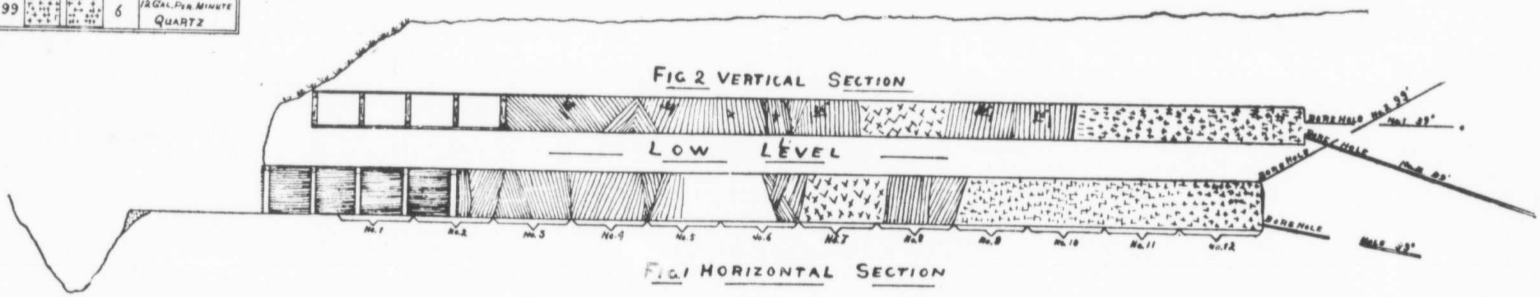


Plate illustrating Mr. C. A. Meissner's paper "Prospecting for Iron Ore in Newfoundland and Cape Breton."

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this country will take these words to heart and remember, that after all, as an ordinary business policy, honesty pays best.

I will speak of one deposit in Cape Breton which shows some of the difficulties to be contended with in all prospecting—this is at Whycocomagh; the vein was discovered some 150 feet up the side of the mountain, and a tunnel put across it. This struck some 15 feet of ore and rock; the ore being part magnetite and part hematite. Then we cut a vein of ore some 9 feet thick, which was a 56 to 58 per cent. part hematite, part specular ore, mixed with a little magnetite. I append some analyses, and also a sketch showing the work done in endeavouring to determine how this deposit ran. On the surface all indications pointed to an almost vertical dip with a well defined hanging wall; yet subsequent developments by tunnel and Diamond Drill plainly showed that while the apparent dip of strata continued for a space there was no sign of ore below, and the drill has not yet definitely determined which way it is running. This sort of experience I have met with at other places here, and the only safe way is to arrange for the cost of a sinking and pumping plant and follow the ore. Nature here will not allow you to take anything for granted.

You have just got to put up your cash and patiently follow her wherever she leads.

In connection with this account of the difficulties of prospecting in Cape Breton; I would like to bring to your notice a proposition that has occurred to me on reading an article on the subject of bounties recently; in this article it was proposed that a bounty should be paid on iron ore so as to encourage the prospecting and developing of the ore and iron industry down here. That some Government aid for this purpose could and should be given is undeniable. The objections to a bounty however, are that it is purely individual and you cannot draw the line; every other mineral operator has as much right to ask for bounty as the iron miner, and you would have endless complications. In place of that I would recommend that the Geological Survey of Canada be empowered by the federal and local Governments to take certain areas under certain conditions and make detailed stratigraphical maps of them; this would be of lasting benefit to the whole country, extend the value and practical influence of the Survey and be of more specific value to the intelligent prospector than any bounty would. No one could raise objections to this, as it is not an individual, but a general matter of interest. In taking up an area the Survey would necessarily have to make it large enough to get a clear idea of formations, follow any faults, foldings, etc., and thus get up a map that would be available for any and all metals that that section might contain. After a few years there would be a series of such detailed maps, which when studied carefully would undoubtedly show the co-relation of these sections and give very clear ideas of the intermediate and undetermined sections.

A Geological Survey to be of real value should of course be economic as well as purely scientific, and that this is fully realized here is plain by the very interesting and encouraging correspondence that I have had with the various members of the Survey, from the Director down.

In the United States the practice now is to put the Survey into any section which is likely to show economic value—make a careful study of it and thus enable the prospecting and development of these sections that is at times surprising; while here we still have to grope in the dark, try to do our own work largely with many disappointments and imperfect and unsound data to go by.

The investigations of the Springhill coal fields are perhaps an example of the very great economic value of the Canadian Survey when so applied. We certainly have the very best material in the Survey to do this work.

Just how the Survey should be called in is a question that would have to be decided upon; they naturally could not come at the beck and call of every speculator who thought he had millions in sight, but it would be an easy matter for the Director to satisfy himself that there was sufficient ground for undertaking the work, arrangements would have to be perfected that would insure intelligent co operation between the Survey and the prospector. I think such an understanding would tend to encourage development companies who would go into the matter with sufficient capital to meet if necessary some disappointments, and who could thus do the work much more intelligently and of more lasting benefit than the small prospector whose few hundred dollars come to an end, cause the abandonment at what may be a critical stage of his prospect.

In making these remarks and suggestions I am well aware that this is a subject that has been discussed and urged by some of the ablest and most far seeing mining men in Canada, and that apparently it has not met with that encouragement which its scope and encouragement should receive. It is a proposition that cannot be carried out in a day or even a year, but requires constant and patient work on the part of all those interested in the economic development of Canada, particularly the legislative powers.

West Kootenay Ore Bodies.

By R. W. BROCK, Ottawa.

Within the limits of the present paper it is of course impossible to do more than take a brief and very general survey of a field as extensive and varied as West Kootenay. It is proposed merely to review briefly some of the observed facts relating to its geology so far as it is connected with the ore deposits, and to the ore deposits themselves, and to indicate to some extent their practical bearing. Some of these observations may have been already recorded, others have been suggested as being probable and now stand confirmed in the light of further study. If any apology is needed for such a re-statement let it be that such observations have a direct economic importance, for anything that contributes to a more exact and definite conception of the nature and mode of formation of a group of ore deposits has a commercial value, since it makes possible more intelligent exploitations of the particular members of the group, and more accurate forecasts, beyond present workings, of their probable form and extent. In discussing the ore deposits, while it is possible to separate them into a number of different classes, it is here proposed to touch upon merely some general features. The progress, prosperity and possibilities of the district are now so well known, and can be so eloquently supported by statistics, that it is quite unnecessary to go into such matters.

Geologically the district is a complex consisting of several series of crystalline schists and stratified rocks, dyked, metamorphosed by, and caught up in multifarious eruptives, which in turn treat each other in like manner. The crystalline and stratified rocks, while limited in distribution, include a considerable variety of rocks.

There is a series of grey gneisses, mica schists, quartzites, crystalline limestones and dolomites with old intercalated crushed igneous rocks. These rocks have been referred to the Shuswap series of probable Archean age. They occur typically developed on Kootenay lake north of Crawford bay, and the West Arm. They are also found on the north end of Slocan lake, on Slocan river, at the head of Snow creek, and on Upper Arrow lake. Numerous small inclusions of gneiss in the eruptives in various portions of the district may probably be also referred to the Shuswap.

A series of slates occurs, more or less altered to mica, staurolite and andalusite schists, with bands of greenish schists, quartzites and dolomites. This series has been classed with the Nisconlith series of the Cambrian. It is most largely developed in the southern portion of the district where a band several miles in width, interrupted once or twice by granite intrusions, extends from a point just south of the West Arm of Kootenay lake, a little east of Nelson to the international boundary. Along the boundary it has considerable, width, extending from four miles east of the Pend d'Oreille crossing to within a few miles of its mouth at Waneta. It is also found in a narrow band north of Kaslo, parallel to Kootenay lake a short distance inland. Rocks which may also be referred to this series occur near Deer Park, on Cariboo creek near Burton City, and on Upper Arrow lake.

This series is overlain by a great thickness of rocks that have been classed with the Selkirk series. They consist of various schists, quartzites, conglomerates, dolomites and green eruptive rocks. They are found east of the Salmon river on the divide between the Salmon river and Kootenay lake at the head of Wild Horse, Sheep and Lost creeks and down Summit creek for half its length. They are also found east of Kootenay lake from about Lockhart creek to near Gray's creek. They also occur in a band west of Upper Kootenay lake, succeeding in a westerly direction the Shuswap and Nisconlith rocks. This band, north of Kaslo, has some width but gradually tapers as it continues southward till it runs out near the West Arm.

On Summit creek they are apparently overlain by a great volumn of quartz and mica schists which extend eastward to Kootenay lake. These are classed as Upper Selkirk.

Another important group of stratified rocks is that known as the Slocan series. They consist of a group of dark and banded rocks composed of tuffs and ash rocks with some impure slates and limestones. They occur all around the north end of Slocan lake, southward, cut by one or two granite bosses, as far as Four-Mile creek, and eastward to the forks of Kaslo creek. From here a band extends south to the West Arm between the band of Selkirk rocks and a great granite mass. Similar rocks also occur on Cariboo creek.

Varied as are the schists and stratified rocks, the eruptives show still greater complexity. Among the oldest and most important economically is the Columbia group of volcanics. This group includes porphyrites of various kinds, monzonites, diabases, gabbros, breccias, tuffs, agglomerates and dark fine-grained slaty ash rocks. The monzonites are interesting rocks, both on account of their petrographical peculiarities and also as being the country rock in the War Eagle, Le Roy and other famous Rossland mines. It is a peculiar type of rock referred to the syenite family. It exhibits wonderful differentiation ranging according to relative proportions of feldspar and colored constituents through syenitic, dioritic and gabbroitic types. Along the border of a mass it may present even a more basic facies.

The Columbia volcanics cover a considerable area. They are largely developed in the Rossland district and also east of the Columbia, where they extend eastward to the Salmon river and northward to the west arm of Kootenay lake and Kootenay river. Around Nelson and along the Columbia river they are cut off by granite, a large mass of which extends as a peninsula from the Columbia eastward into the volcanics. Porphyrites and associated rocks, which are probably to be referred to this group, occur on Arrow lake in the neighborhood of Deer park, and up Cariboo and Snow creeks behind Burton City.

Younger than, and cutting all the rocks so far mentioned, is the grey granite, the commonest rock of the district It is a biotite hornblend granite, usually, but not always, grey in color. It varies considerably in texture and composition, being in places syenitic or dioritic, but apparently having a prevailing granitic habit. The feldspars are often large and porphyritic, in which case it is very striking and easily recognizable rock. When crushed, as it sometimes is, this porphyritic facies makes a beautiful augen gneiss It occurs in large and small areas throughout the entire district, and is intruded through all the older rocks. A typical development of this rock may be

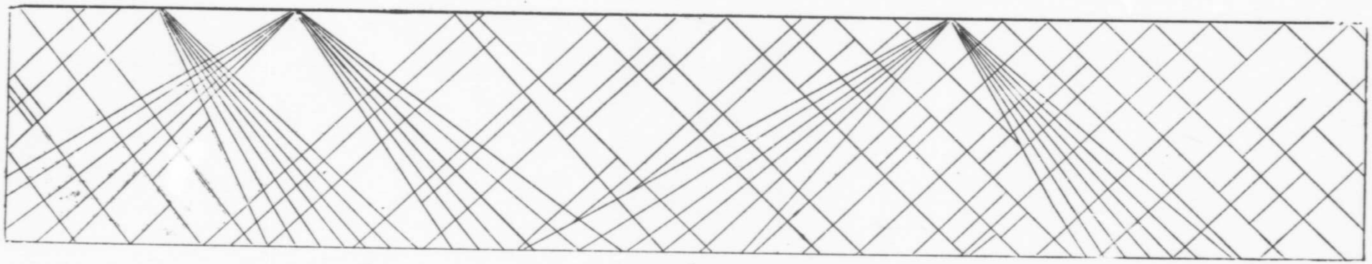


Plate illustrating paper by Mr. R. W Brock on "West Kootenay Ore Bodies."

seen at Nelson. Another granite, younger than the grey, is the older red granite, a very feldspathic rock found on Lower Arrow lake near Deer Park, and elsewhere along the Columbia valley.

Under the head of younger eruptives may be grouped a series of rocks which shew a wide range of structure and composition, ranging from plutonic to volcanic types, from granitic to at least dioritic. They are sometimes developed in quantity, as the younger red granite along Lower Arrow lake and also near Trail creek, and north-west of Rossland. As dykes they occur in almost every part of the district, cutting all the older rocks.

The most important of these dykes are the "white dykes" or white porphyries. These are usually white compact dykes varying in size from broad masses to little stringers, which cut sharply through the country rock. So far as is yet known, in structure and composition they appear to range from rhyolites to diorite porphyries, including felsites, granophyres, granite porphyries, and syenite porphyries. The acid, however, appear to be the prevailing types, at least in the northern part of the district and along the Salmon. Though varying in character these dykes may usually be recognized by their light color and their sharply defined contacts with the country rock. Near Rossland and in some other portions of the district, darker types are, however, to be met with. This system of dykes seems to have immediately preceded the formation of the ore deposits.

Younger than this system of dykes and the ore bodies, and consequently cutting these, are the "black dykes," a group of lamprophyric and basaltic dykes.

The above constitute the main groups of rocks of the district so far as connected with the ore bodies. They present many facies, which have not been here noted. Other rocks occur, as comparatively fresh andesites, diabases and such volcanics, but as these have not been observed to be connected in any way with the ore deposits, we need not stop to consider them.

The economic minerals which may be found in the ores are also various, as the following list shews:—Native GOLD, *silver*, copper and arsenic; stibnite, bismuthinite, tetradymite, molybdanite, ARGENTITE, GALENA, altaite, hessite, chalcocite, stromeyerite, *sphalerite*, cinnabar, greenockite, PYRRHOTITE, bornite, CHALCOPYRITE, *pyrite*, gersdorffite, marcasite, *arsenopyrite*, danaite, jamesonite, *pyrargyrite*, *proustite*, TETRAHEDRITE, tennantite.* The gangue is principally country rock, quartz, siderite, calcite, sphalerite. Oxydation products of the metallic minerals, such as the oxides, carbonates, sulphates, are found in the weathered zones.

The above list could probably be enlarged, but it will serve to shew the variety and general character of the economic minerals.

The character of the ore varies more or less with the district, thus in the Rossland ores the auriferous iron and copper sulphides predominate, in the Slocan the lead and silver minerals with argentiferous tetrahedrite are characteristic, while the Nelson district mineralogically as geographically lies between the two. But while in the different portions of the district there is considerable variation in the relative proportions and mineralogical combinations of the principal elements, the elements themselves remain practically the same throughout. But why in one plaee the ores should be *mostly* silver-lead minerals, and in another *mostly* auriferous iron and copper ones, or why in one place there should be large bodies of metallic sulphides and little gangue, and in another the value should be in a small quantity of sulphides and much gangue, or why the silver and gold tenors should vary so, these are points which cannot yet be very well explained.

It may be remarked, however, that the production of the quartz veins appears to have been about the last stage in mineralization; also that in places it appears that the country rocks exerted some chemical influence, causing the deposition of the iron and copper sulphides in the massive rocks and the silver-lead in the fragmental, but this has not always been the case.

As to the age of these deposits nothing definite can be asserted, except that while all the evidence tends to show that they are comparatively recent, they are certainly pre-pliocene. To go into this

*The minerals printed in capitals are the most important economically. Those in italics rank next, while the others have so far been found only in small quantities.

evidence would take too long, but it may be said to to be derived from the relationship of the deposits to the dykes, from the differences in the character of the country rock and deposits at high and low elevations and Tertiary erosion.

On account of their comparatively recent formation and the fact that the factors which determined the deposition were physical rather than chemical, they may be looked for in all the rocks except the latest dykes (and probably the younger eruptives) wherever the physicial conditions are favorable.

As to manner of formation, the evidence afforded is conclusive that they were formed by mineralizing solutions, which followed lines of fracture, dissolving away the country rock and replacing it with mineral matter in return. In a large ore body, or where the country rock is a homogeneous one, such as some of the Slocan rocks, this history cannot be so clearly read as when the deposit is small and the country rock is a heterogeneous one, such as granite. Here it is sometimes possible to trace the alteration from the unaltered granite to the solid sulphides; first the more easily decomposable constituents show signs of alteration, then one constituent is removed and replaced, then another, until of the original rock only a skeleton of quartz remains, and finally this is almost completely or wholly replaced. But even if the process had not been exposed as in the example above, the evidence would still be complete. For in many of the large deposits cores of the unaltered country rock still remain; the country rock near the deposit has often been silicified, producing "capel" like bands. This silicification has proceeded in places till it almost amounts to complete replacement. Calcification in places has also been extensive. The country rock has often been more or less mineralized, and if it contained feldspars, bisilicates, and such alterable minerals, these often have been attacked in such a way as to indicate the action of hot mineralizers. In one case on Pine Ridge in the granite adjoining a small deposit, the feldspars have been altered, pyrite probably represents what once were bisilicates, and a violet-colored secondary fluorspar has been disseminated through the rock. A violet-colored quartz present is probably of the same origin as the fluorite.

Very little work has been done on the chemistry of these deposits and consequently few chemical data are available, but what there are afford additional evidence. In a paper by Gwillim and Johnson on "Some Ores and Rocks of Southern Slocan" * the following analyses are published :—

	(*a*)	(*b*)
SiO_2	60.09	70.70
Al_2O_3	17.20	18.25
Fe_2O_3	6.73	3.18
MgO	0.47	2.12
CuO	8.24	3.36
Na_2O	2.45	not estimated
K_2O	6.23	" "
H_2O	not estimated	" "
	101.41	98.61

(*a*) is an analysis of the country rock, a facies of the "grey granite"; (*b*) is an analysis of a horse of this rock in an ore deposit.

As the localities of the two specimens are not given, an exact comparison between the analyses cannot be fairly made, but still (*a*) may be taken as expressing in a general way the chemical nature of the country rock to which (*b*) belongs. The water in an altered rock like (*b*) would probably be sufficient, if estimated, to raise the analysis to 100, so that the alkalies are here practically absent. In the unaltered "grey granite" their percentage is high. So that in the horse the large percentage of alkalies has been practically removed, together with the greater part of the lime and a large part of the iron, while there has been a corresponding raise in the percentage of magnesia, alumina and silica. This is just the alteration to be expected in a rock subjected to thermal waters containing such reagents as carbonic acid and sulphuretted hydrogen.

* Canadian Record of Science, Vol. VII., No. 5, pp. 295 and 298.

Natural processes are rarely simple, and the slow process of vein formation is no exception. While replacement of the country rock seems to have been the chief mode, it is highly improbable that there has not been to a certain extent deposition in open spaces—in fact there is evidence to indicate that this did occur, to a limited degree. In certain parts of some deposits there is a distinct crustification. Now, while it is true that a banding may be and is produced by slight alterations in the conditions during the progress of slow metasomatic change, it may be doubted if a deposit in clear-cut, distinct crusts is ever so produced. So that it is probable that such portions of a deposit have been formed in cavities. Dissolution sometimes may have proceeded in advance of deposition, and thus the space would be produced. But in some cases the ore is found between slickensided walls, sometimes with selvage. This indicates that movement has taken place. As the deposit itself shows no signs of it, it must have preceded the vein formation. It may be that the slickensided walls do not belong to the same fissure, but to two parallel ones, and that the intervening rock has been replaced. But still, any movement of the walls of an irregular fissure, such as these are, would open up spaces—which might, of course, be partially filled with triturated rock. It is thus altogether probable that some open spaces along the fractures did exist, to be filled by the mineralizing solutions. But in the formation of these ore deposits the process of space-filling seems to be entirely subordinate to the replacement of the country rock.

From the nature of the minerals formed and from the composition of known thermal springs, one is justified in assuming that the mineralizing solutions contained hydrogen sulphide, carbonic acid, and sometimes, perhaps, sulphates, in addition to their metallic contents. These reagents would account for all the chemical changes involved in the replacement of the country rock and the deposition of the minerals and ores.

The mineralizing solutions, following lines of easiest penetration and substitution, used, to a large extent the lines of fracture and crushed zones of the country rock as highways, and as starting points in the formation of the deposit.

Coming from a region of higher temperature and pressure, and charged with the metallic sulphides and active chemical reagents, the solutions would readily attack the crushed and triturated material in these fractures. With chemical activity thus set up, and the nucleus of a deposit thus formed, with a constantly renewed supply of material and reagents from the circulation of the mineralizing solutions, metasomatic action could rapidly proceed.

There should be no prejudice against deposits formed in this way. There is no reason why they should not be as extensive, as valuable, and as permanent as bodies formed in large open fault-fissures. Indeed—the history of mining has shown that these great fissures are not as a rule the great producers To any who may have misgivings about this class of deposit, it may be comforting to know that many of the best deposits, especially in western United States, are quite similar in mode of formation to these of West Kootenay.

Thus there is no reason why the ore bodies of West Kootenay should not display permanence in depth. The developments in the Whitewater Deep, Payne and Le Roi have shown that the ore chutes here have a considerable vertical dimension. The valleys appear to have been largely sculped after the formation of the ore bodies. Now extensive ore bodies have been found in the deep valleys, thousands of feet below the highest mines, as well as at high altitudes. The surface which existed at the time of formation would be still higher. So that ore was deposited in quantity at great depths below that surface and below most of the present mines. That more mines have not been opened up in the deep valleys is easily accounted for by the difficulty of prospecting owing to the covering of drift and vegetation.

The best ore and largest ore bodies in any particular district are found in the rocks which are most fractured, as the greater facilities offered by crushed and fractured zones more than compensated for any chemical advantage a rock might possess. As before stated this might take place in any kind of country rock where the physical conditions were favorable.

Owing to the mode of formation, by replacement following lines of fissuring and crushed zones, the forms of the bodies may be very numerous and irregular. In general they may be said to possess a degree of irregularity corresponding to the degree of complexity of the preceding dynamical effects. To begin with, minor fissures or fractures are usually very irregular. They are usually numerous and co ordinated. They may be reticulating; they may be parallel so that the country rock is sheeted, with or without connecting cross fractures, and perhaps groups of these may be separated by bands of unbroken country rock. But the ore deposition may have been even more irregular. The ore bearing solution may have followed one fracture for some distance and then have crossed to another and so on, or it may have followed several parallel ones and the resulting deposits may or may not be connected with stringers forming what the Germans call *stöcke.* The ore itself may be found only in certain places in the form of chutes. To further complicate matters the replacement of the rock along the fractures and crushed zones may not have been uniform. Sometimes when three or more fissures intersect, the enclosed rock only may be replaced forming a chimney deposit. Examples of all the foregoing might be given from the Kootenay ore bodies, and if time permitted various other possibilities might be considered. But enough has probably been stated to suggest some practical considerations. It must be evident that no weight can be attached to either the presence or absence of walls. The absence of one or both walls is to be accounted for by the manner in which the rock has been replaced. The presence of apparently well defined walls may seriously mislead if they are considered as proof that the ore deposition has been confined within their limits, since however well defined they may appear to be a crosscut may reveal an adjoining parallel ore body. As an example, reference might be made to an important West Kootenay mine, where the mine captain took great pride in his walls. I tried to show the possibility of there being ore beyond, and the wisdom of judicious cross-cutting and received unexpected support. A shot near one of the walls where it was best defined did greater execution than had been intended, bringing out a large fragment of the wall. This revealed a large parallel ore body apparently equal to or better than the original.

So that in the development of the ore bodies all the attention should not be bestowed on sinking and drifting, judicious cross-cutting may sometimes be advisable. At Butte and in many other mining districts in Western United States, where similarly formed deposits occur, this principle of cross-cutting even where there are apparently good walls is practised often with great success.

Further, should a good ore body apparently discontinue in depth, it may be that a little exploiting might reveal its downward continuance along another plane. Another point which is apparent is the advisability of *following* ore. In a *highly* mineralized locality even little stringers may lead to bonanzas.

In addition to the dynamic activity prior to the vein formation, which resulted in the complex fracturing of the country rock and which prepared the ground for the mineralizing solutions, there have been subsequent movements which have caused minor displacements, both normal and reversed.

Since the ore bodies show great complexity but are dependent more or less upon the fracturing of the country, and since matters are further complicated by subsequent faulting, it is evident how important it is that the mining engineer should make a careful study of the structural geology of his district, for by this means alone can a correct notion be obtained of the mode of fracturing of the country which prevails, of the ore body, and of the character and extent of the faulting. In the study of the latter he will find the dykes of great assistance, as they are numerous, clean cut and easily recognized and as many are as old as the deposits, these must have undergone the same displacements. He will also find that the smaller veinlets will often afford the key to the solution of problems which his larger, intricate ore body will not disclose.

On a *prospect* where the trend of an ore body is not definitely proved, it is obviously dangerous, instead of following the lead, to spend money on work which will be of value only if the ore body happens to follow a particular direction. To point to the number of shafts and tunnels on prospects in the Kootenay which have eaten up the prospector's capital, while proving absolutely nothing regarding the deposits, is all the comment that is needed on this point.

The light "porphyry" dykes to which attention was called while speaking of the rocks appear to be closely related to the ore deposits. They are abundant in richly mineralized portions of the district, and are conspicuously absent in such portions of the district as on parts of Midge, Cultus and Summit Creeks, where no deposits of value have as yet been found. That the dykes and ore bodies should be so associated appears to be more than a mere coincidence.

In the portion of the district in which I was working last summer between Slocan and Arrow Lakes, I found that almost without a single exception, wherever a deposit of mineral was observed, it was in the immediate vicinity of a dyke, frequently along the contact, or if not, in fractured country rock close by. Later on in the season, when on the North Fork of the Salmon, near the head of Burnt Creek it was found that the claims ranged along a dyke. The prospectors inquired about the influence about the white dykes, stating that wherever mineral was found in that portion of the district, it was in the neighborhood of the dykes.

I had not time to verify this statement except at the one point. Before the season closed a visit was paid to the mines around Sandon.

Here, as elsewhere, the same relationship between the dykes and ore bodies appeared to exist. A habit was formed of asking for the white dykes on a claim, as naturally as for the lead. I think in every mine visited not only were dykes seen in the vicinity, but one or more could be found in the workings themselves. Most of the observant managers considered the white dykes to "form part of the deposit." One or two claimed that proximity to the dykes influenced the tenor of the ore. Even if the dykes could not be observed in or near every mine, this would not necessarily disprove the relationship, as they might be close at hand, yet not be exposed at the surface or in the workings.

It is quite probable that the volcanic activity which resulted in the injection of the white dykes may have been the cause of much of the fracturing or fissuring of the country rock, and thus of the production of the highways for the mineralizers. The white dykes themselves do not show this shattering. It is now generally accepted that eruptive rocks, especially acid eruptives, thermal springs and ore deposits, are intimately related in their origin. It is an observed fact that the closing stages of a period of volcanic activity are marked by solfataric action, the emission of thermal mineral-bearing waters. Now, as before stated, the West Kootenay deposits were formed by the direct agency of such hot mineral-bearing solutions. It is not improbable, therefore, that these were connected with some eruptive. If this were the case it would be with the porphyries, as these mark the last period of volcanic activity which preceded the formation of the deposits. Moreover, the dykes themselves show evidence of solfataric action in the alteration they have often undergone. The feldspars are altered and calcified, so that it is sometimes difficult to make out the structure of the rock. Pyrite has been formed—often probably at the expense of what colored constituents the rock possessed. An interesting point with regard to these dykes is that they are to some extent auriferous. Profs. Nicol and Miller, of the School of Mining, kindly assayed three samples. They were small samples *selected as rock specimens*, one from a dyke in the Last Chance mine, Sandon, one from the North Fork of the Salmon, and one collected by Mr. McConnell from the Antelope claim. The last proved barren, but the Last Chance and North Fork rocks yielded distinct colors of gold. Considering the small quantity taken for assay (two assay tons), the result is very interesting.

From the evidence so far available I am inclined to favor the view that the solutions mark the solfataric stage in the period of vulcanism, during which were erupted the white dykes. On the other hand it might be held that the solutions came from depth and merely used as highways lines of weakness often occupied by the dykes; or mineralization might be considered by some to be due merely to the increase in physical and chemical activity in the existing circulating currents, caused by the heat of the eruptive.

But such speculations as to the precise way in which the dykes and ore bodies may have been related, while extremely interesting, are not of direct economic importance, and need not be here further discussed. The point of practical value to be established is that the relationship does obtain. If this can be done the value of such well-defined and striking bodies as these dykes as guides in prospecting and developing would be inestimable. While the observations made last summer, particularly in the mines, were not sufficiently extensive to warrant one in definitely asserting that such a relationship obtains throughout the entire district, yet they covered a comparatively wide field, and in mauy cases were of so positive a nature as to justify the conclusion that, in those particular instances at least, the dykes and the ore bodies were related. But the strongest evidence probably is the fact to which attention has already been called, that *the districts rich in dykes and rich in ore bodies, and those barren of dykes appear to be barren of ore.*

The attention of mining engineers is called to the matter in hope that they will test the point in various parts of the field, for it is only when supported by observations in the mines and prospects of the entire district that it can be considered definitely established for the West Kootenay district.

In a great many mining districts throughout the world such a connection between dykes and ore deposits has been observed. At Pontgibaud, in Auvergne, silver lead occurs in gneiss and mica schist dyked by porphyry; the lodes generally follow the dykes and are productive only when so associated. *In the silver lead deposits of Eureka, Nev., the ore-bearing solutions were almost entirely due to solfataric action arising from the eruption of rhyolite, which dykes all the formations. The rhyolite dykes show every evidence of solfataric decomposition. †Hague, in speaking of the same district, states that after a careful study he is forced to the conclusion that there exists the closest relationship between the rhyolite and the formation of the ore deposits.

§In speaking of the relationship between the deposits and the eruptives in the Mercur district, S. F. Emmons says that In searching for gold in that district the first thing to do is to learn to recognize in the field the porphyry in its many forms of alteration, and then gives

*J. S. Curtis, Mon. VII, U.S. Geol. Surv., p. 188.

†Monograph XX, p. 294.

§XVI Annual Report, Part II, p. 369, Geol. Survey.

rules to be observed in prospecting, based upon the relationship which exists between the ore bodies and the eruptive.

‡Blow, in a paper on Iron Hill, Leadville, states that as a guide to future developments on Iron Hill, it may be well noted that wherever a dyke (of porphyry) of considerable size has been heretofore disclosed, an ore body of proportionate size has been encountered following it.

It will be seen that the West Kootenay ore bodies bear a strong resemblance to many in Western U.S.

Thanks are due to Mr. McConnell for information regarding portions of the district not visited personally and for other assistance. The notes on the rocks and their distribution are based on Mr. McConnell's work to a large extent.*

‡Trans. Amer. Inst. Mining Engineers, XVII, '89-'90, p. 156.

*Summary Reports of the Geological Survey Department for the years 1894, '95, '96 and '97.

Description of the Sultana Quartz Lode, and the Sinking of the Burley Shaft in Bald Indian Bay, Lake of the Woods.

By J. Burley Smith, C. & M. E., Winnipeg.

The Sultana lode is situated on the eastern shore of Bald Indian Bay, and about seven miles south of the town of Rat Portage. It has become famous chiefly on account of the well-known Sultana mine, which unquestionably owes its success to the indefatigable perseverance and enterprise of Mr. John F. Caldwell, of Winnipeg, the owner. Perhaps not a little of its more recent fame is owing to the prolonged dispute and consequent litigation as to the ownership of the continuation of the lode beyond the Sultana location to the south-west on the land under water of Bald Indian Bay. The Sultana lode was discovered about the year 1882. At that time it was remarkable chiefly on account of its magnificent proportions and great length as visible on the surface, cropping up as it did here and there for a distance south-west of the Sultana location of more than 3,000 feet. The quartz at that time was not at first sight thought to be auriferous. The first official account recorded of this deposit occurs in the able report of Mr. Eugene Coste, M.E., to the director of the Geological Survey of Canada, dated January 16th, 1884.

He says: "This vein, called the Sultana Lead, is about 30 feet "wide. Its strike is 70°, and its dip south at an angle of 72°; the "quartz is yellowish, hard and void of minerals—I do not think it is "auriferous. It reappears 500 or 600 feet to the east on another bay "of Indian Bay; and also a quarter of a mile to the west on the "island directly west of Quarry Island."

The doubt expressed as to the auriferous quality of the quartz is not to be wondered at, as there are several outcrops of quartz visible on the surface at various points along the outcrop of this lode to-day, having clearly defined walls and every appearance of veins, which, however, seldom carry more than the merest trace of gold.

Several diamond boring tests made on these locally termed "blowouts," show that they do not continue down to any great depth—perhaps 50 or 60 feet at the most—giving place then to the huge lenses of auriferous quartz which are characteristic of this remarkable lode.

The Sultana mine of to-day, with its depth of 400 feet, its well-equipped mill of 30 stamps and its regular yield of gold bricks for the last six or seven years, is the best testimony which can be offered as to the auriferous character of the deposit generally.

The lode itself, where it has actually been worked for a number of years by the owner of the Sultana mine, has been exhaustively described by many eminent authorities in the annual reports issued by the Bureau of Mines of Ontario, notably those of 1893-4-5-8.

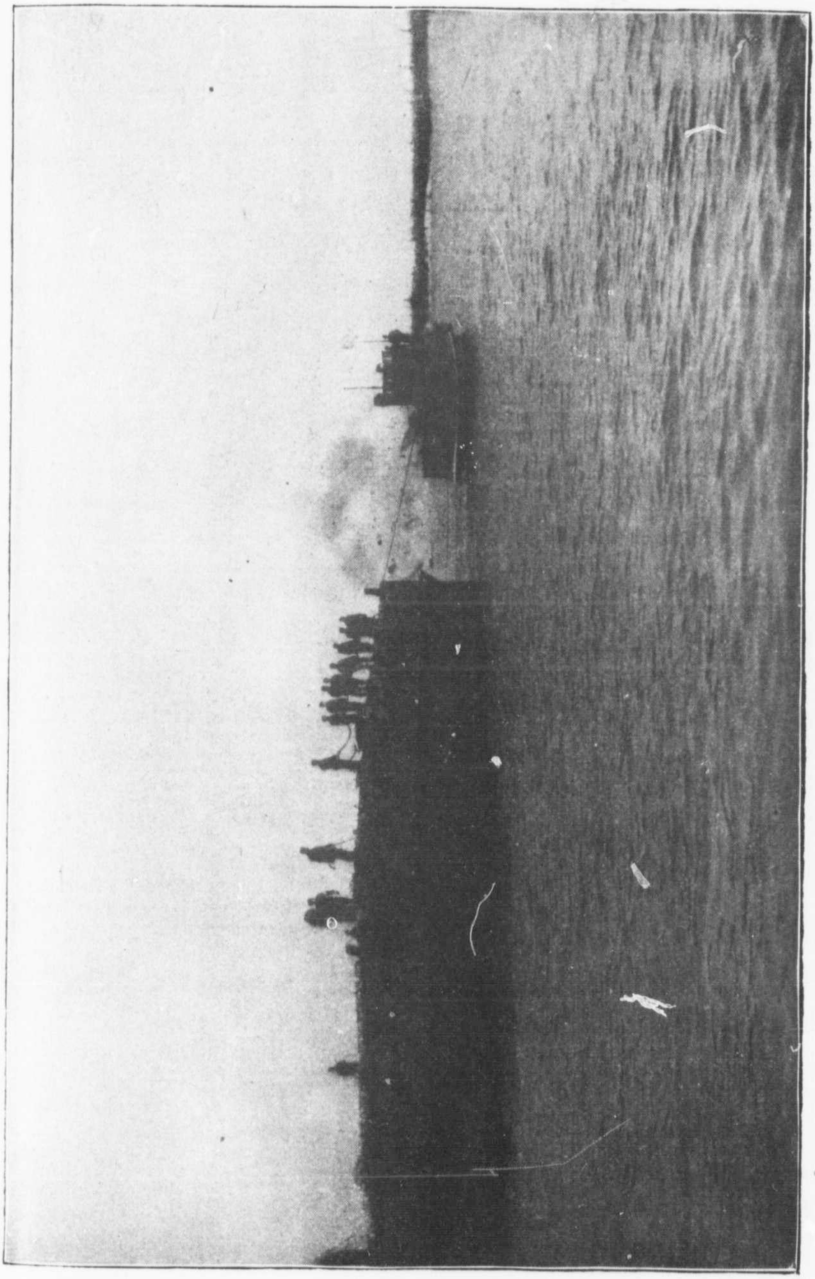
It will not, therefore, be necessary for me to supplement these by more than a general description of the deposit, showing where it strikes under the lake after leaving the Sultana mine location, X 42, on to location D 193 (the property of the Burley Gold Mining Company, of Ottawa, Limited), as shown on accompanying map, marked A.

The latter being one of land under water entirely, without any dry land save that of a very small island, shown on map as Reef 271 P, necessitated the sinking of a shaft through the water to reach the lode, proved by boring tests to exist in the rocks below, and to continue in a south westerly direction across the bay as far as Quarry Island and beyond to the Chien d'or Island, location 389 P, and the Queen Bee Island still further to the south-west (See map A.)

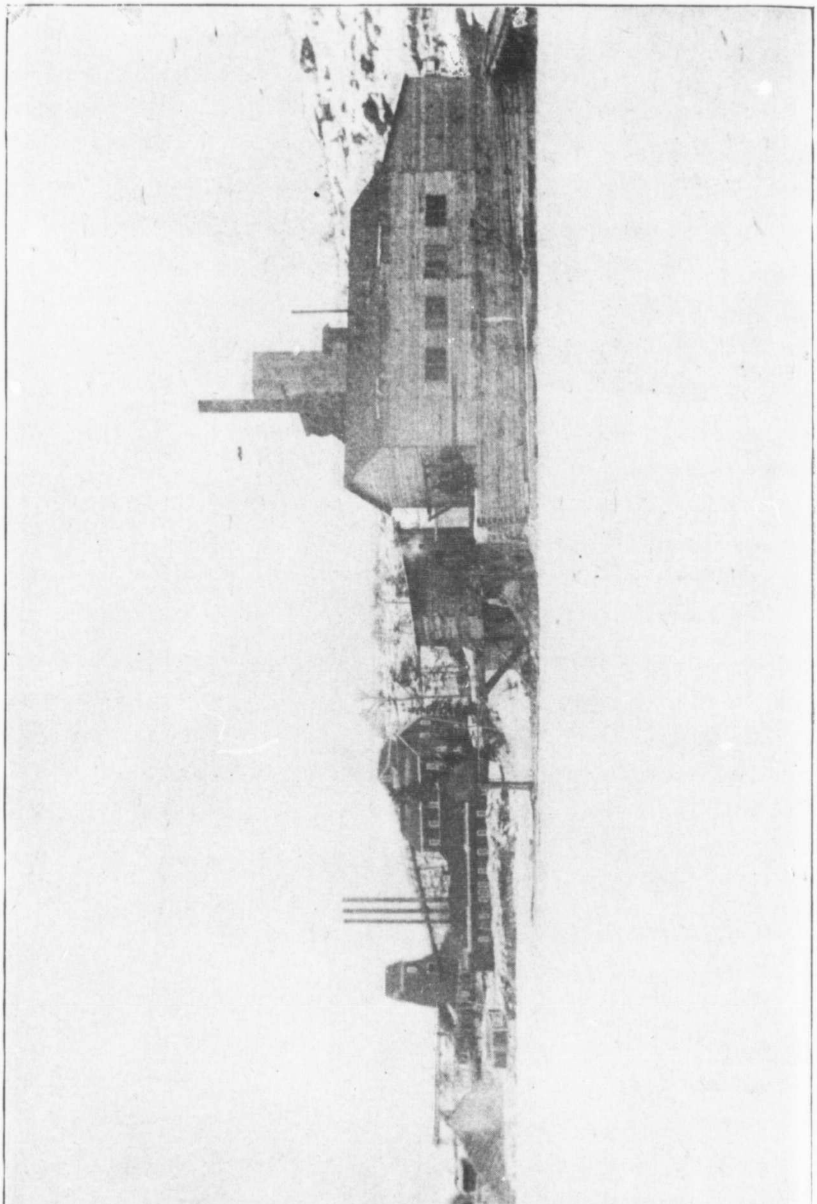
The Sultana deposit or lode, if it can properly be so called, may be briefly described as composed of huge masses of auriferous quartz, of lenticular shape, interbedded in the Keewatin schists (Huronian), at or near their contact with the granitoid gneiss (Laurentian).

Sometimes extending for a considerable distance as one enormous lense, again of a number of smaller lenses lying near together and separated only by a few feet of schist.

There are no walls to define the width of the zone or belt enclosing these lenses of quartz, and it is probable that this has not yet been accurately ascertained.

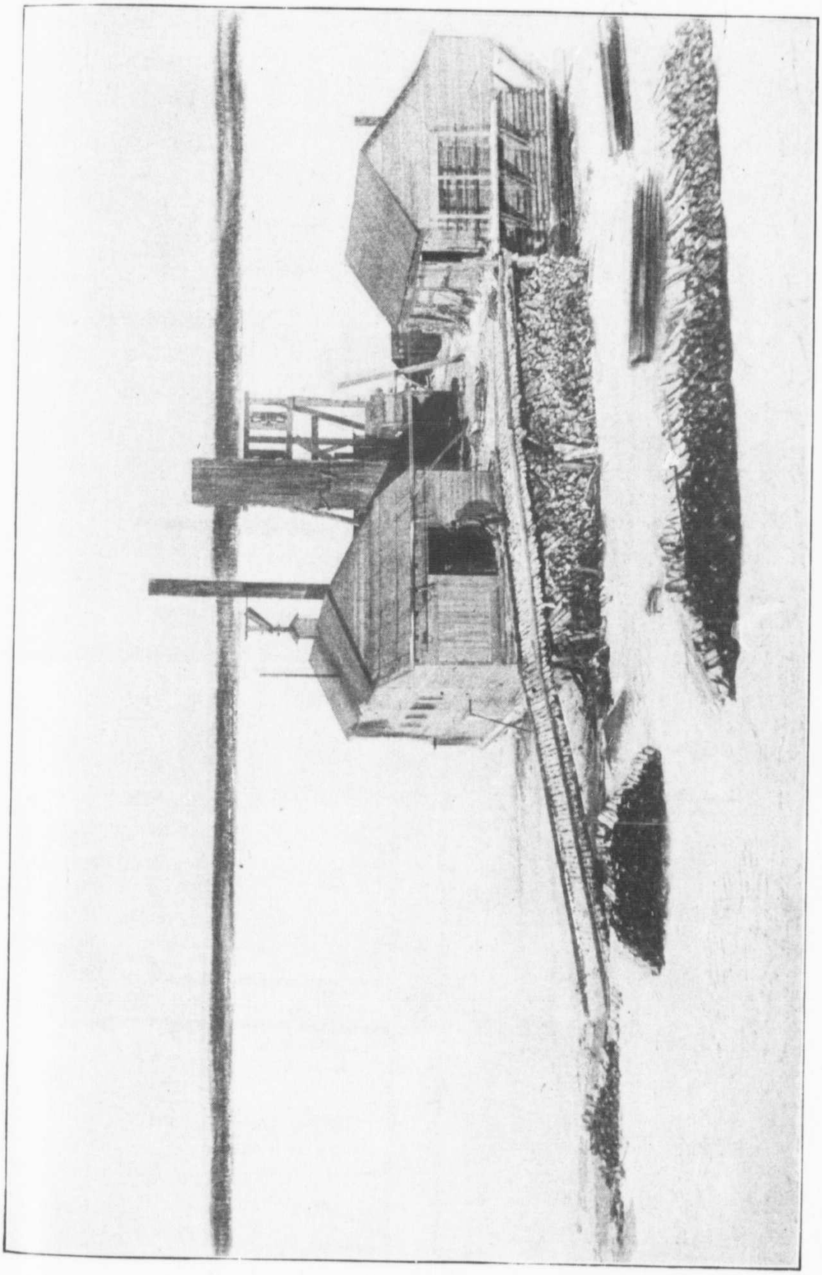


Towing Caisson into position.—Bald Indian Bay.

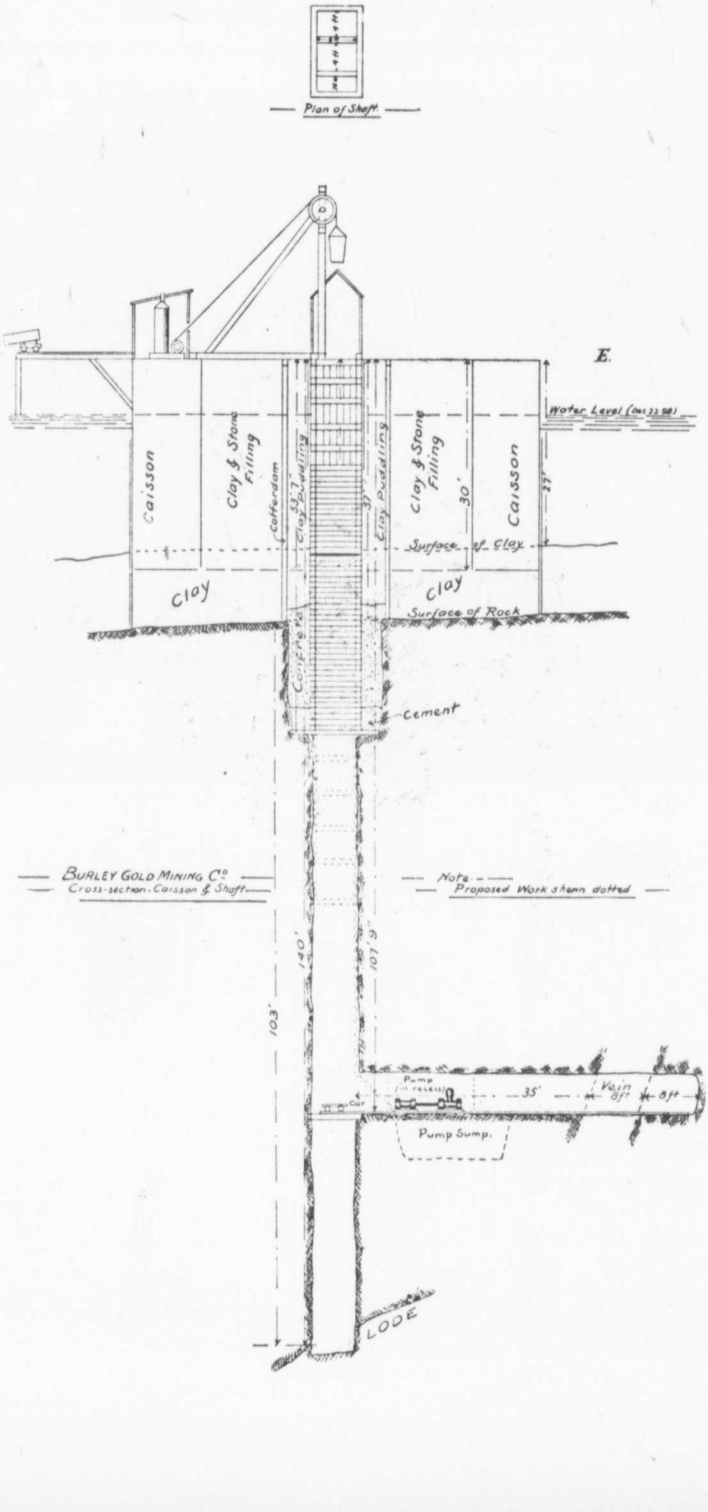


Sultana Gold Mine.

Shaft House. 40-Stamp Battery. Burley Caisson.



Surface Works of the Burley Gold Mining Co., Bald Indian Bay, Lake of the Woods, Ont.


Plan of Shaft
E.
Water Level (Oct 22 98)
Caisson
Clay & Stone Filling
Cofferdam
53'7"
Clay Puddling
37'
Clay Puddling
Clay & Stone Filling
30'
Caisson
27'
Surface of Clay
Clay
Clay
Surface of Rock
Concrete
Cement
Burley Gold Mining Co
Cross-section Caisson & Shaft
Note.
Proposed Work shown dotted
140'
107'9"
103'
Pump (in recess)
Car
35'
Vein 8ft
8ft
Pump Sump
LODE

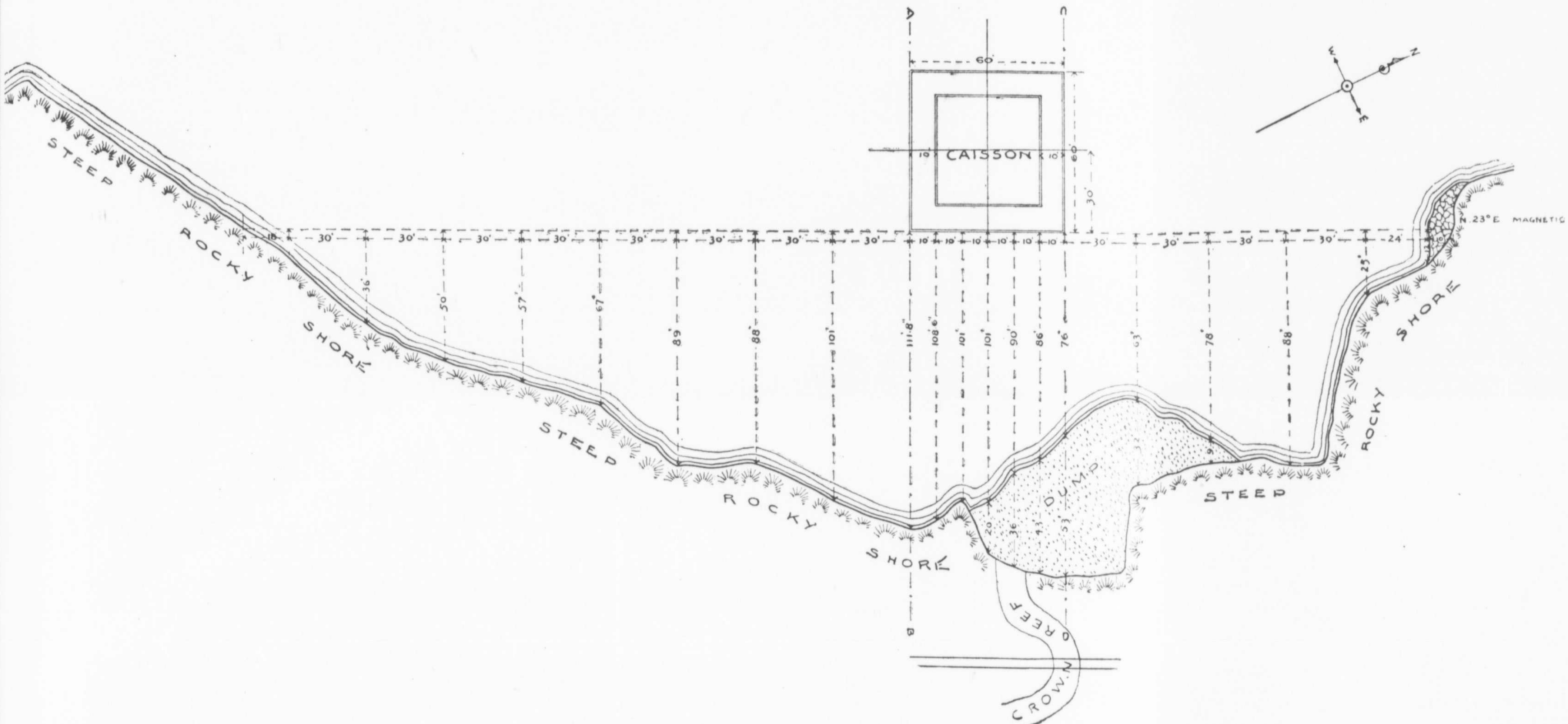


Plate showing Position of Caisson—Burley Gold Mining Co., Lake of the Woods.

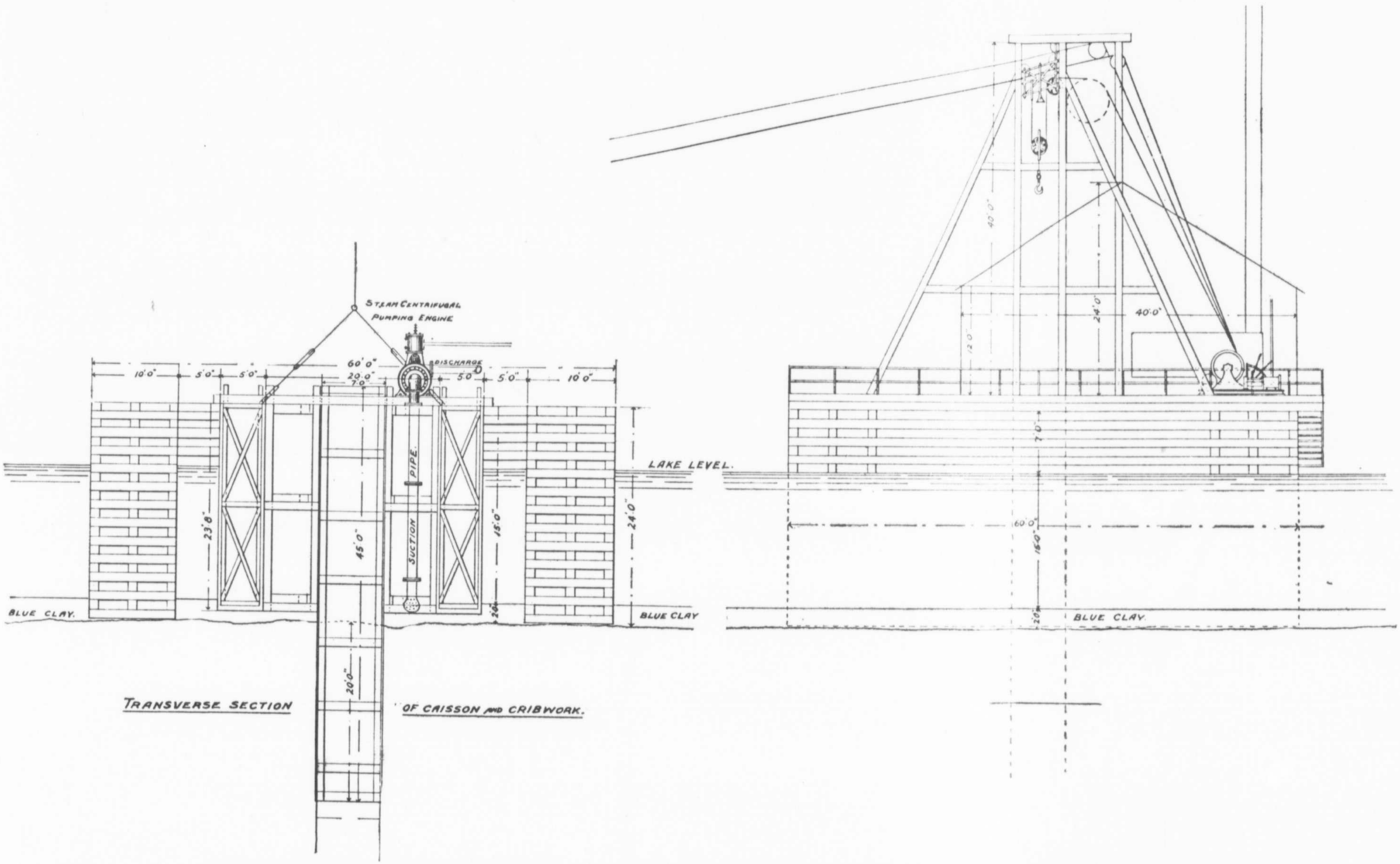
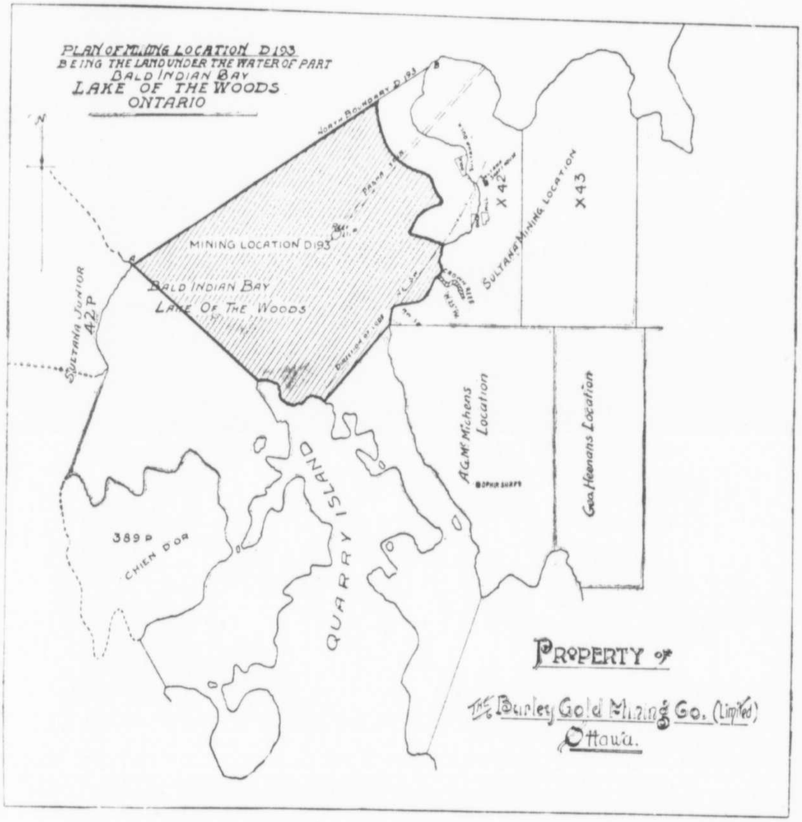
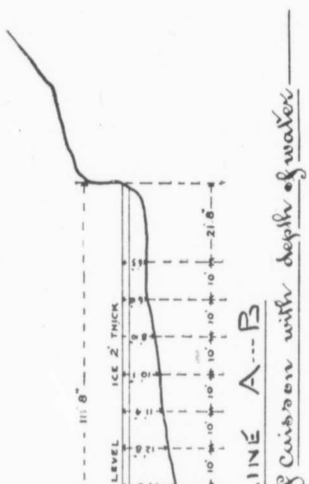
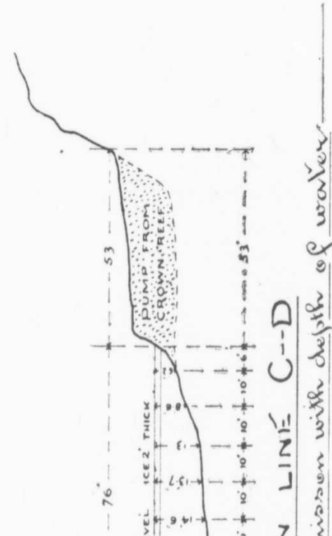
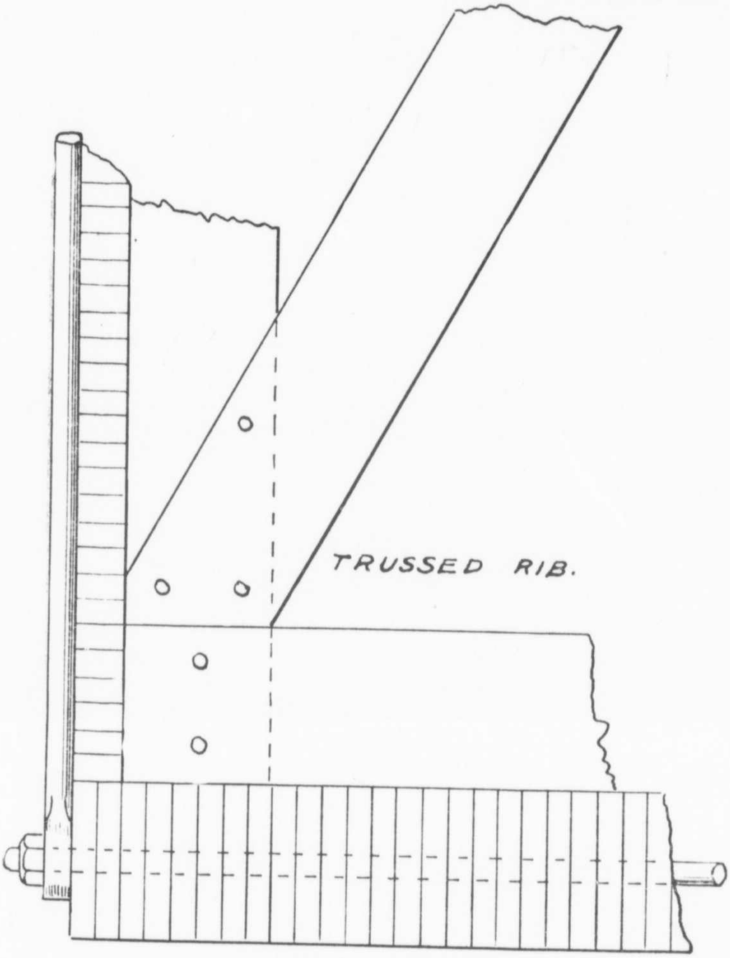


Plate showing Caisson Cribwork and Hoisting Conveying Apparatus—Burley Gold Mining Co., Lake of the Woods, Ont.

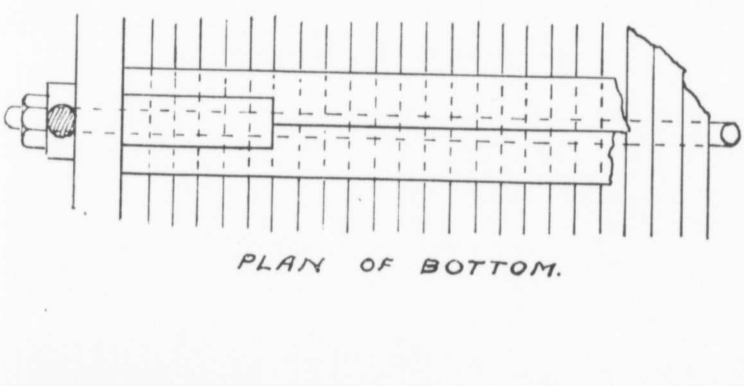

PLAN OF MINING LOCATION D193
BEING THE LAND UNDER THE WATER OF PART
BALD INDIAN BAY
LAKE OF THE WOODS
ONTARIO
N
NORTH BOUNDARY D 193
MINING LOCATION D193
BALD INDIAN BAY
LAKE OF THE WOODS
SULTANA JUNIOR
42P
X 42
X 43
SULTANA MINING LOCATION
A.G.McMichens Location
OPHIR SHAFT
Geo. Heenans Location
389 P
CHIEN D'OR
QUARRY ISLAND
PROPERTY of
The Burley Gold Mining Co. (Limited)
Ottawa.


PROFILE ON LINE A--B
showing proposed position of Caisson with depth of water
CAISSON
60'
24'
ICE LEVEL
ICE 2' THICK
111' 8"
21.8'
20'

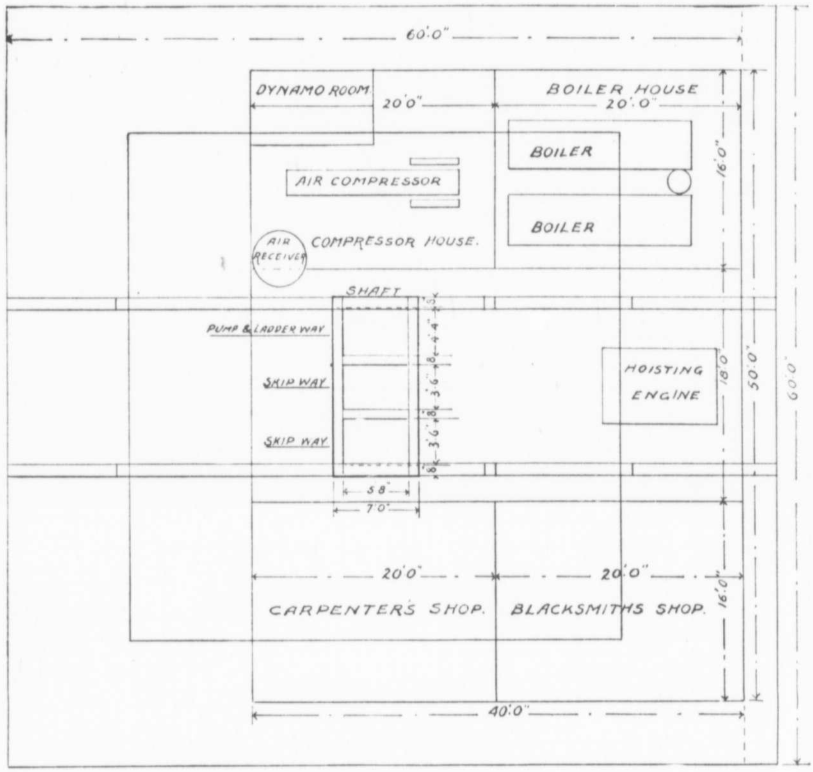

PROFILE ON LINE C--D
showing proposed position of Caisson with depth of water
CAISSON
60'
24'
ICE LEVEL
ICE 2' THICK
DUMP FROM CROWN REEF
53
76'
53'
20'



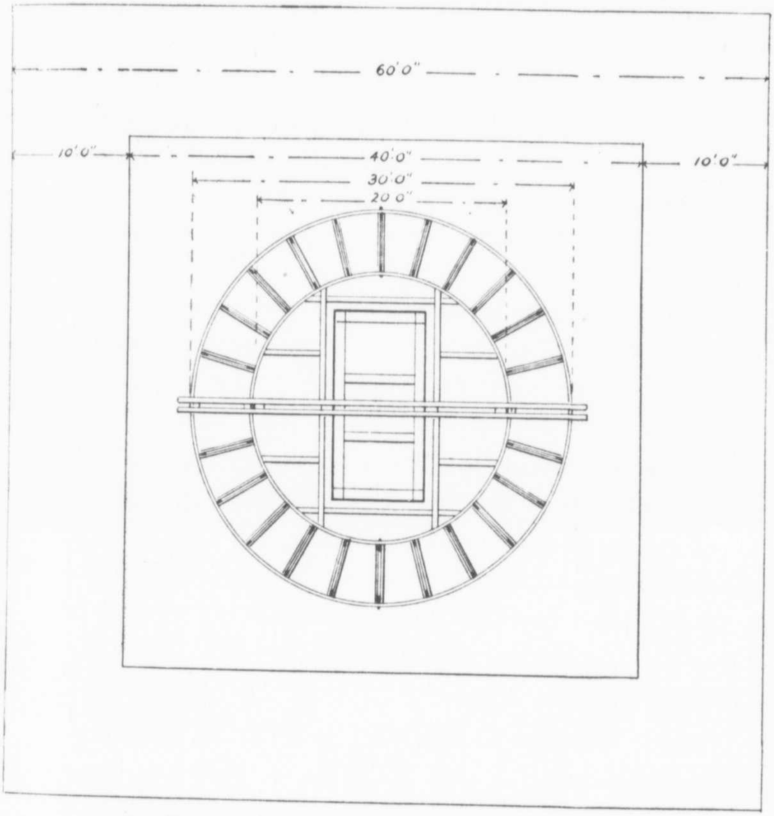
TRANSVERSE SECTION



PLAN OF BOTTOM.



PLAN SHOWING ARRANGEMENT OF BUILDINGS AND MACHINERY



PLAN OF CRIB. SHOWING SECTION OF CAISSON

The walls that have hitherto been observed are, I am inclined to think, those enclosing individual lenses of quartz.

It is noteworthy that the schists separating the lenses of quartz is often to be found in the auriferous.

It is also well known that the lenses of quartz lying nearest to the contact with the gneiss are richer than those farther away, and appear to be much larger in size.

On what is known as Sultana Island, where the mine of that name is situated, there is an immense boss of granitoid gneiss, bare and rugged looking, and having almost the appearance of a mountain compared with the low lying hills of schist and altered traps in its vicinity.

This bold ridge may be noticed some miles to the north-east of the Sultana Island, breaking through the Huronian schists, and it is at this contact on both sides of the gneiss in which most of the gold discoveries in the immediate district have hitherto been made.

The general strike of the granitic boss is N.E. to S.W. The Sultana mine is situated on the N.W. slope of this hlll.

This granitoid mass declines abruptly as it approaches Quarry Island, which it crosses, finally disappearing under the waters of the lake near the south-west extremity of Queen Bee Island. (See plan A.)

The lode, as might be expected, follows the general trend of the granite, its strike being N.E.—S.W.

It has been proved by means of a great number of diamond borings, to continue along the belt of schist, at its contact with the gneiss, from the Sultana mine to the point before referred to at the S.W. of Queen Bee Island.

A shaft sunk on this island within the last few weeks to a depth of 25 feet, shows a width of 24 feet of quartz in which there is much visible gold.

The general strike of the lode is shown on map A by a red dotted line crossing part of Bald Indian Bay, Quarry Island and Chien d'or Island, the Queen Bee not being shown on this map, and is N.E.—S.W. (Refer to map A.)

The north-east boundary of the Burley Gold Mining Company's location is about 700 feet from the Sultana shaft.

At a distance of 165 feet S.W. of this boundary, or 865 feet S.W. of the Sultana shaft, a cross section was obtained of the deposit by three diamond drill borings, to locate the position of the proposed shaft on the Burley water location.

A drawing of this section is shown on plan A, which speaks for itself, and will not require further explanation.

There being, however, insufficient clay covering the rock-bed of the lake at this point to insure a perfectly water-tight seal, a diver was employed to carefully examine the bottom, and finally a location was found having a covering of from ten to fifteen feet of fine plastic blue clay over the rock, 56 feet to the south-west of the point where the borings were put down.

It was at first intended to sink a crib 60 feet square on the outside and 40 feet on the inside, using an inner caisson for a water-tight compartment in which to commence sinking the shaft and to then carry a steel lining from a depth of 20 feet in the rock up to the deck of same, and afterwards to build a wall of concrete masonry round the shaft which would be carried up to the same level The space between this wall and the inner walls of crib to be braced strongly together with timbers and filled with rock. (Refer to drawing B.)

Owing, however, to unexpected delays, the lateness of the fall season and the stormy weather to be expected at that time, and the fact that we were at the last moment unable to secure any land in the immediate neighborhood on which to frame the crib, our plans had to be changed.

It was then decided to build a water-tight caisson on the Queen Bee Island, about one mile away from the proposed site of shaft.

A good sloping beach of sand was selected in a sheltered bay, ways were laid down and the work of building the caisson commenced.

Its dimensions are 60 feet square on the outside, 40 feet on the inside (leaving a box space all round about 10 feet wide for the rock ballast to be used to sink it), and 24 feet high.

It was strongly ribbed and braced and sheeted throughout with eight inch square timbers, the whole bolted and spiked together in the strongest possible manner.

The heavy eight inch sheeting being caulked and pitched right up to deck.

Valves were provided inside the caisson to admit water, as it was known that the structure could not contain sufficient weight of rock to sink it without this addition.

The time occupied in building the caisson was something under two months.

At the end of November 1897, it was safely launched and towed by steam tugs to the proposed site of shaft, and a few days later it was frozen hard and fast in position by the ice. Shortly after this the caisson was filled with rock and sunk to the bed of lake.

To make doubly sure an inner coffer-dam was constructed inside the hollow square of the caisson.

The water was then pumped out with a powerful contrifugal pump and the clay inside the inner coffer-dam was excavated down to bed-rock.

The shaft was then excavated the full size of the inner coffer-dam, 12 feet into the solid rock.

A strong water-tight shaft-casing formed of timbers eight inches square was carried up to the deck platform of caission, which had previously been raised six feet higher to be safely above flood water mark of the lake.

Behind this casing and under its foot, careful sealing with the rock was made by caulking with oakum and filling in with hydraulic cement ; the remainder of this space was then filled in with concrete up to some feet above the surface of the rock-bed of lake.

From this point upward to platform the space between shaft-casing and coffer-dam was filled in with puddled clay. (Refer to drawing C.)

The space still left between the inner coffer-dam and inside walls of caisson was filled in with clay and rock, after being securely framed and braced with timbers.

The platform on top was decked in the usual way, and on this platform are erected the temporary buildings containing the machinery and plant of the mine, and a temporary pit-head framing. (See drawing C.)

The sinking plant and machinery consist of one Ingersoll-Sergeant air compressor and three rock drills; one 80 h. p. boiler, one Ingersoll eight inch x 10 inch duplex double drum steam hoist; one portable steam derrick hoist; one direct-acting steam centrifugal pump, and some ordinary sinking pumps.

The shaft is six feet x 12 feet in the inside, and is now down to a depth of 153 feet.

At a depth of 107 feet down a cross cut level was driven S.E. towards the shore as a test, and as expected crossed a lense of auriferous quartz eight feet wide, 35 feet from the shaft. (See cross section—drawing C.)

The shaft was continued down to a depth of 140 feet when quartz was again struck, showing visible gold in places.

Our manager reports in his last letter that the shaft is now down to a depth of 153 feet and is not yet through the quartz. (See cross section—drawing C.)

The lode dips to the N.W. The shaft is perpendicular and was expected to strike the deposit at a depth of about 150 feet, which, however, was reached at 140 feet or thereabouts.

Very little water has found its way into the shaft through seams or fissures, and we have every prospect of having a dry mine.

An Improved Method of Introducing Feed Water to the Stamp Mill Mortar.

[Supplementary to paper on page 54.]

By BERNARD MACDONALD, M.E., Montreal.

The details of this method are shown in the accompanying figures, cross-section (fig. 1), sectional plan (fig. 2) and back view (fig. 3) of the stamp mill mortar as installed by the writer at the Dufferin mine in Nova Scotia.

The method has proved so effective and satisfactory that it is thought a detailed description of it would be interesting to the members of the Institute. In considering this proposition in its various phases it will be assumed that the purpose and utility of a continuous feed of clear water to the stamp mill mortar while in the operation of crushing ore is understood, which being so, very few words are necessary to properly present the proposition.

The points of superiority of this method may be best seen if reviewed in contrast with the defects of the customary method, and for this purpose a brief description of this latter will be given first.

The customary way of feeding water to the stamp mill mortar is through iron pipes or rubber hose discharging over the top. In this way the water streams down the falling stamps till it reaches the top of the pulp mass. (See position as indicated in fig. 1.) From this position it will be seen that the feed water, conditions being equal, is more likely to traverse the straight and shorter line I G than to follow the triangular and longer line I H G to the point of discharge, G. But the purpose of the feed water is to mix with and form a pulp of the ore as it is pulverized at the crushing surfaces of the shoes and dies at H, and to carry it in suspension to the point of discharge. Therefore it will be seen that a considerable portion of the feed water coming over the top of the mortar will be discharged before it can perform the duty for which it was introduced. But the greatest defect in this system is the fact that the clear water thus falling on the top of the pulp mass has a tendency to settle the sulphurets and fine slimes around and on the dies, in which latter position they are subjected to still further pulverization, which produces the sliming of the sulphurets and the unnecessary abrasion of the free gold particles that may settle on the bottom. These facts account for a very large part of the loss that occurs in stamp milling.

The "Improved Method."--The mechanical details of this method as shown in figs. 1, 2 and 3, already referred to, will, if studied, make manifest its points of superiority over the method already described. It figs 1 and 2 it will be seen that the water is fed into the mortar through six ¾" pipes entering the back of the mortar at level of 3" below the crushing face of the shoe when new, and would be on a level with the surface of the shoe when worn out on the 2" false bottom liners. It will be seen that the water thus admitted enters the mortar at the most advantageous point to sweep away from around the dies such portion of the ore as has already obtained a sufficient degree of fineness, and carries this portion upwards through the pulp mass to the level of discharge, where the fine material is held in suspension until it issues from the mortar.

Fig. 2 shows that the inflowing water is directed straight for the spaces between the dies, from which it washes away all the fine material, leaving in these spaces only the coarser grains of ore, say somewhat smaller than pea size, which form a kind of coarse sieve into which the coarse gold liberated from the quartz drops and remains undisturbed till clean-up day. The advantage of providing such a receptacle, where the coarse gold may be free from abrasion, is very material, for no inconsiderable loss occurs from the abrasion of coarse gold when mixed with quartz grains in the mortar under the repeated blows of the falling stamps

Further details of this method and its advantages may be seen by a study of fig. 3. This figure shows the rear elevation of the mortar in the background, made transparent to show within the position of the shoes and dies, the top level of the pulp mass and the points at which the water enters from without.

Details of Piping. - In fig. 3 may be seen in longitudinal elevation the piping details in scale. The main feed pipe A is furnished with a

T, having 3" run and 1½" outlet, opposite middle of mortar. The main feed pipe is continued beyond this T and stopped on the end by a plug, which may be removed to clean out deposits of mud, or grass, or leaves, or to extend the water supply beyond. From the outlet of the T rises a 1½" connecting pipe. This pipe is furnished with a valve, B, which shuts off the flow of water into the mortar but allows it to flow through the branch underneath, to which the hose for washing the plates is permanently attached. This valve would also reduce the pressure when that would be required by throttling the flow of water into the mortars. Above this, as shown in the figures, is the distributing pipe, C. Both ends of this pipe are stopped by plugs, which may be removed to facilitate cleaning. A gauge may be attached to this pipe to show the pressure under which the water enters the mortar. The pressure may be controlled by the valve on the connecting pipe, B. and otherwise as desired.

The distributing pipe, C, is tapped for the six ¾" feed pipes, which deliver the water into the mortar through holes E. These feed pipes are fixed with valves which adjust the amount of feed water, and with a piece of rubber hose in the middle to prevent the vibrations of the mortar from being communicated to the piping system which is attached to the foundation, and therefore entirely free from the jar of the battery.

Advantages of the Method.—Summed up, the points of advantage believed by the writer to be possessed by this system are :

(1) Increase of crushing capacity.

(2) Decrease of sliming and consequent losses.

(3) Preparation of the material around the dies to receive and protect the coarse gold from abrasion.

It is very probable that the mechanical devices of this process could be used to great advantage for the introduction of compressed air into mortars of dry crushing mills. An exhaust fan would be a necessary adjunct if used in this way, and if so used the crushing capacity of dry crnshing mills would probably be very considerably increased, and the pulp would be of a more uniform classification.

The Gold Bearing Sands of the Vermillion River

—

By Mr. J. W. Evans, C. & M. E., Sudbury, Ont.

The alluvial deposits of gold bearing sand found along the banks of the Vermillion River, in the District of Nipissing, created considerable local excitement last spring and summer, but owing to the character of the gold the results obtained from a few primitive tests were far from satisfactory. In this paper I wish to draw attention to a few points which came under my observation.

In the majority of the deposits the gold is found in the first ten or twelve inches of soil, a reddish sand composed of quartz, granite and greenstone, containing garnet and magnetic iron with a quantity of coarse gravel, covered in patches with hardened clay Samples of this sand from the east bank of the river, in Hanmer township, within 20 miles of Sudbury, averaged from six samples, 60 cents per ton gold, and yielded, with very careful panning, from 100 to 200 colors to a 10 lb. pan.

The colors vary greatly in size, the larger ones being flat and much indented are very liable to float off in panning or washing, owing to minute air bubbles adhering to the indentations. I have frequently lost these larger colors when panning from one pan into another, even when exercising the greatest care.

A few panning results from samples taken to the depth of from two to three feet I have mounted upon slides for the microscope in order to show the variations in size and character of the colors. The average fire assay result on this lot was about 15 cents per ton, the number of colors varying from 40 to 80 per 10 lb. pan. As an example of the loss in treating the sand with a rocker I found on selected material assaying $1.15 per ton, that the washed coarse gravel which had been thrown out of the screen, yielded upon panning and breaking up the hardened clay sticking to it, 20 colors, which had remained attached to the clay, and assayed 45 cents per ton of gravel or about 25 cents per ton of sand taken. The tailings which were being washed into the river assayed 40 cents per ton of tailings, or about 15 cents per ton of sand taken, and the concentrates from the rocker 80 cents per ton of concentrates or about 10 cents per ton of sand. The sand taken was from about 10 inches from the surface. The fire assay result being $1.15 per ton leaves 65 cents unaccounted for, but as the sand contains galena, copper pyrites and some gold bearing quartz, a higher result in the fire assay is to be expected.

The fire assay results, without previous concentration, however, I find very variable on this work, for instance, taking 100 colors to a 10 lb. pan, there will be only 3 colors, on an average in a 5 A. T. charge, assuming the sampling perfect, and as there is a great difference in the size of the colors the results are bound to vary greatly. In a 5 A. T. charge an error in weight of gold will be multiplied 6,400 times in calculating to a ton, while in a 10 lb. lot will be multiplied only 200 times, this will in a great measure offset the loss in panning.

The loss in ordinary panning on this sand I put down as about 50 per cent., but with proper care about 75 per cent. of the gold can be saved.

I found in every case where I passed the gravel through the crusher, and assayed the pulp the results were higher than when the coarse gravel was screened out, proper allowance of course being made for the percentage of gravel. In one shaft which had been sunk to a depth of 60 feet, about 200 feet from the river bank, no gold was found after leaving the surface layer until within about ten feet from the bottom but from trouble with water the shaft was not sunk any further, and in no instance, to my knowledge, has bed rock been reached. Owing to the slight fall and thickly wooded nature of the country, sluicing on a large scale would be difficult if not impossible.

Gold has been discovered in many places further up the river, and in almost every case the gold gets coarser as one goes north.

On one slide I have mounted a fac-simile of the largest color yet found on the river, it comes from some distance to the north. The gold found so far is not much worn and the microscope shows pieces of quartz attached to many of the colors.

The sand on the hill side several hundred feet from the river bank gives almost the same result as that nearer the river, and as the course of the present stream is very sinuous it suggests the existence there of a much larger river at some time in the past. I think it very probable that some valuable deposits containing coarse gold will be found upon this river in the near future, and that many of those already found could be worked at a profit on a large scale, in some manner similar to the dredge work done on low grade placer deposits in California.

I am indebted to Mr. A. H. Robinson for help in the laboratory both in panning and fire assay work.

The Sampling of Argentiferous and Auriferous Copper.

By ALBERT R. LEDOUX, Ph.D., New York,

The practice of sampling of ores and furnace materials which can be crushed, has been reduced to a science. The methods and operations have been demonstrated to be correct, not only by their practical results, but by mathematical formulae. It has been proved that "time samplers" are to be relied upon to extract from a given mass of crushed material a portion sufficiently small for assay, that will accurately represent the lot. On this side of the Atlantic, machines are employed wherever possible, while hand sampling of ores is still the rule in Great Britain and on the continent of Europe. It is only within comparatively recent years that the demand has been made upon the sampler for a method which will produce an accurate sample of argentiferous and auriferous copper bars.

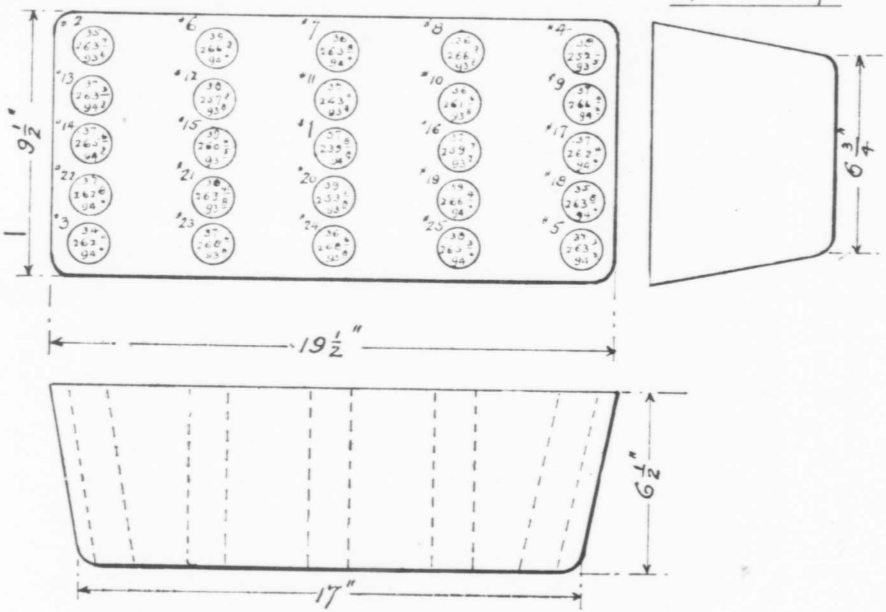
The sampling of lead bullion has a longer history, and methods have crystallized around a few precautions to be observed. Years ago, careful study was made of the distribution of precious metals in pig lead, and there is little or no trouble in obtaining fair samples of such material.

In copper, for a long time, the gold and silver contents were not important Lake Superior and Chili coppers were the chief products coming into the American and European markets, and they, like those produced on the Continent of Europe, carried small values in gold and silver. It was not difficult to obtain an average sample of such bars. In fact, the London Metal Exchange under its Contract "J," decreed what method should be employed, and simply specified that one bar in ten should be bored half way through on opposite sides and ends. This was sufficiently accurate for all material, which, however the copper might vary and the impurities be distributed, only carried low gold and silver values. To-day, Chili bars are selected with a view to their content of precious metals; for the electrolytic process can

FIG. A.

One Sample Bar of Blister Copper drilled at .... Works.

March 1897.



General Average

Au	Ag.	Cu.
.37	261÷	93⁹

— Bar drilled through with ¾" drill. Weight of sample about 12 Ounces. —

— No pains spared in drilling to avoid mixing with dirt or other samples. —

— Each sample ground in mill & well mixed before assaying. —

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separate these so economically, that when the silver is as low as eight to ten ounces and the gold as low as 50 cents in value, to the ton, these values go perhaps one-third of the way toward paying the cost of electrolytic refining.

Argentiferous copper bars are sampled to-day in one of three ways:

By boring.

By taking dip samples.

By sawing.

It is to these three methods that I address myself to-day, and report for the benefit of my fellow engineers and assayers, and for furnace managers, what is the "State of the Art" at the end of this century.

It was soon found that, by the ordinary method of boring, prescribed by the London Metal Exchange, the results could not possibly be uniform. For in the ordinary pig of copper there was a segregation of the precious metals. It was sometimes found that the middle line, longitudinally, would generally contain some 25 per cent. more silver than would a line drawn, say two or three inches from, and parallel to, the edge of the pig. Dr. Keller in his admirable researches into the distribution of impurities in copper material, has shown that the distribution of precious metals bears some relation to the distribution of impurities. This has been my own experience. It was at first my belief that the precious metals were invariably concentrated near the centre of the pig. This belief was first shaken by a request which was made of my firm, by parties who were selling argentiferous pig copper quite rich in gold, on our assay, that we would not bore the pigs along the centre line, but would make the holes half way between the sides and centre, and at diagonally opposite corners. On making some experiments, I found that the gold and silver, in the copper pigs in question, were more concentrated nearer the edges than in the centre, although in other material of the same general assay, so far as copper was concerned, and of the same general content of silver and gold, the segregation of precious metals was usually near the centre. I found that the material in question contained between two and three per cent. of arsenic, and whatever may be the chemical or metallurgical reason, I am convinced that the presence of arsenic prevents the segregation of the precious metals along the centre line, to greater or less degree. As proof of that, I have been furnished with the results of some interesting experiments in this direction made by a Western smelter whose product generally contained from one to three per cent. of arsenic The following diagram (Fig. A) will show the results :

Briefly stated, this experiment consisted in boring 25 holes through the pig, the holes going all the way through from top to bottom, on parallel lines. The assays of silver vary from 239 ozs. per ton, in the hole nearest to centre, to 268 ozs in two holes nearest the edge. The assays of silver in a quadrilateral embracing 9 holes nearest the centre were as follows : Centre line, 243, 239, 253. Line at left of centre, 257, 260, 263. Line at right of centre, 261, 259, 266. The samples at the edge, with one exception, all ran over 262 ozs. of silver, several running up to 268. In fact, the sellers of this particular blister copper were frank enough to admit, that a sample taken by boring holes through the middle, or on the centre line, would be too high, and suggested that the holes be bored not nearer than three inches from the side, which give an average, in their experience.

The great variation in the distribution of precious metals, in the blister copper upon the European market, has been shown by careful experiments, made public, by some of the sampling works in England and in Wales. There, as here, the air has resounded with the outcries of buyers who were sure that they had lost heavily. Unfortunately for the benefit of science, when a refiner receives more gold or silver than he pays for, he seldom makes a complaint, and, his ability to keep quiet is equalled only by that of the works manager, who has reason to doubt the accuracy of the assays, because his works are charged by the mine, with less gold than he can produce. But nearly all producers, of my personal acquaintance, are only anxious to get at the facts, and to buy, and sell again, on safe and accurate assays.

The following diagram shows the variation in certain argentiferous bars, as determined in England.

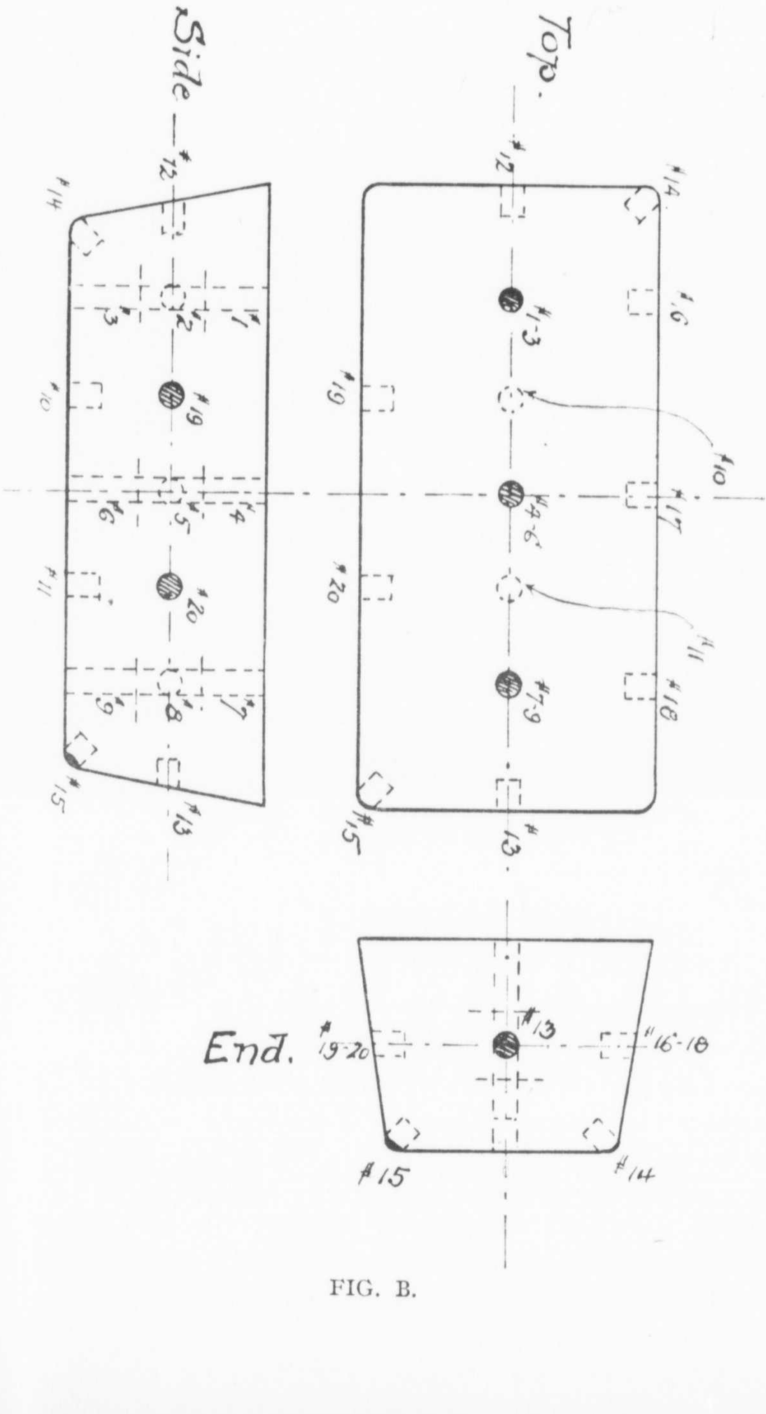


FIG. B.

This diagram shows that holes were bored on all sides of a pig of copper, traversing about one-third of the block in each direction. The following table shows the assays of 20 samples taken at the points indicated.

	OZS. PER TON.			OZS. PER TON.	
	Silver.	Gold.		Silver.	Gold.
No. 1	133.1	6.01	No. 11	68.8	4.32
2	101.6	5.14	12	61.49	4.16
3	77.2	4.40	13	65.7	4.19
4	135.7	6.00	14	76.5	4.49
5	90.8	4.88	15	101.59	4.57
6	66.6	4.22	16	64.17	4.10
7	137.8	5.93	17	68.10	4.41
8	101.6	5.18	18	68 43	4.41
9	66.7	4.16	19	69.41	4.41
10	73.5	4.24	20	71.14	4.31

It will be seen from this that in accordance with the point where the sample was taken the silver varied from 66.7 ozs. per ton to 133.1 ozs.; the gold from 4¼ ozs. to over 6 ozs. The average of all the samples, from 1 to 20, assay:

Silver.................... 81.99 ozs. per ton
Gold .... 4.67 " "

While the parcel was sold on the basis of:

Silver.................... 97.5 ozs per ton
Gold .... 4.99 " "

Was not this enough to frighten both buyer and seller!

Another series of experiments on Australian and American copper, side by side, is illustrated in the following diagrams:

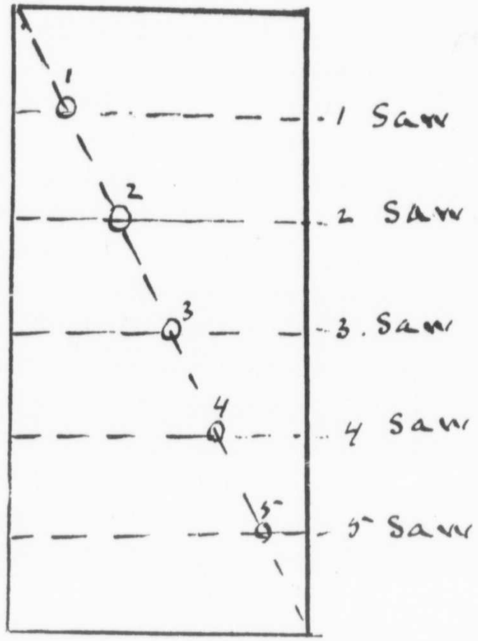


FIG. C.

In this case holes were bored all the way through the pigs on diagonal lines, hole No. 3 being in the centre. The bars were then sawed across as indicated. The following are the results of the assays ;

	LOT L.				LOT B.			
	DRILLED.		SAWN.		DRILLED.		SAWN.	
	Ag.	Au.	Ag.	Au.	Ag.	Au.	Ag.	Au.
	Ozs.		Ozs.		Ozs.		Ozs.	
No. 1	108.6	5.68	107.0	6.01	38.3	.16	32.7	.18
2	124.4	6.20	116.3	6.33	48.8	.19	45.7	.22
3	137.1	6.53	117.2	6.30	52.0	.16	44.1	.22
4	126.2	6.33	122.3	6.14	44.2	.16	49.0	.19
5	115.3	6.14	110.4	5.97	39.0	.16	32.7	.18
Averages	122.3	6.17	114.7	6.15	64.5	.165	40.8	.198

It will be observed how in each case the drillings in Lot L. increase in richness ; 108 ounces of silver at hole No. 1 to 137 ounces at hole No. 3 ; and in Lot B. from 38 ounces at point 1 to 52 ounces at point 3. In this case there was a segregation of the silver and the gold from the sides towards the centre. This material is comparatively free from arsenic.

8

It is unnecessary to multiply examples of this kind. I could duplicate the above general conclusions by the score. The above is simply to show what may be expected in any material, and it can be taken for granted without further demonstration, (1) *that all gold and silver bearing copper varies in richness at different points.* (2) *That while there is no absolute rule, each product being a law unto itself, yet in general, highly refined material free from arsenic has a concentration of the precious metals along the centre line, the maximum being at the middle point of the bar.* It can thus be seen that the old method of sampling described in contract "J" long ago had to be abandoned.

Five Bar Method. The first attempt at arriving at a method of sampling that would be fair to all parties, was by varying the position of the hole, and here began logically the development of the system of sampling which I shall recommend. In order to vary the hole location, the first change was adopting the custom which had been employed for some years by the samplers of argentiferous lead. Three or five bars were placed side by side. A diagonal line was drawn across them, and the point at which this line crossed the centre line or axis of the pig was marked. At these points drill samples were taken by boring all the way through. This will be shown by the following diagram:

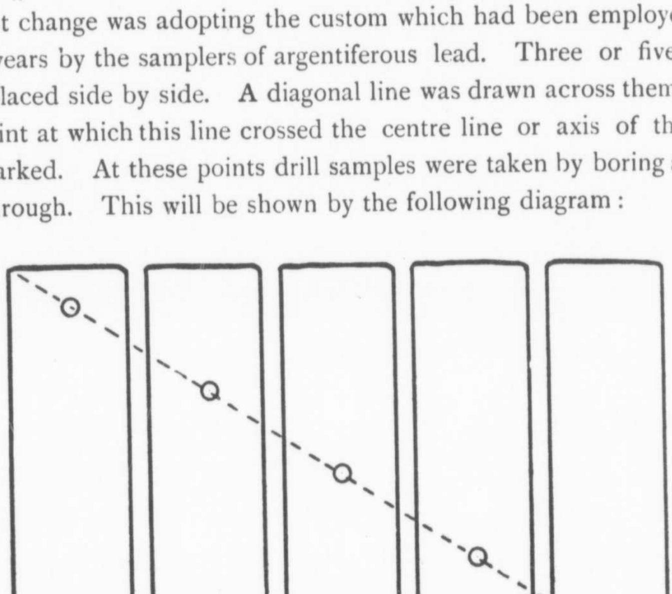


Fig C.

The difficulty with this is that while it takes account of the variation between the ends and middle of the pig, the holes are still bored along the centre line, and are likely to be richer or poorer than the average.

Just here it may be stated that our experience for years in our sampling works, has shown what Dr. Keller has recently published, that anodes cast from pigs, no matter how variable the latter were originally, will be quite uniform in composition, no matter where you bore them. Therefore, some smelters are already sending their copper to market in the form of slabs not over three inches thick, instead of in the form of pigs. These slabs cool so quickly and so uniformly that the precious metals do not seem to have a chance to segregate. I strongly recommend this system of casting, although it is more expensive and disagreeable—from spattering and other causes. It removes from the sampling the element of gambling on results, which is considerable, unless the precautions which I shall enumerate later are uniformly adopted.

Eighteen Hole Method. When we find that the three bar or five bar diagonal sample also fails to give uniform results, we have adopted in many cases, after careful testing of the particular material in question what is becoming to be known as the "eighteen hole" system of sampling. This will be made plain by the following diagram :

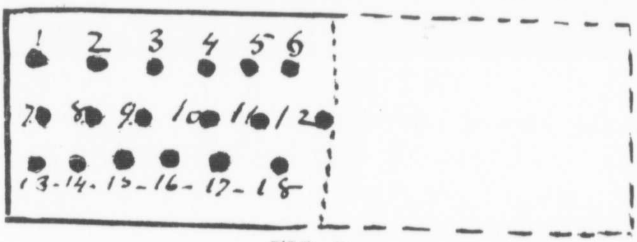


FIG. D.

A board which represents in shape half of the upper side of the pig, is bored with 18 holes equally distant from one another. This board is then laid upon the pigs to be sampled ; The first pig is bored all the way through where hole No. 1 comes. The second pig is bored where hole No. 2 comes, etc. In this way every bar is bored once all the way through, and in every 18 no two are bored in the same relative positions. The borings, of course, must be thoroughly mixed.

One cause of the great difference in assays on argentiferous copper is due to the fact that some assayers are not careful to grind their material fine before weighing out the portion for assay. In fact, samples are sometimes sent to us which are supposed to have been divided equally as to quantity and quality between ourselves and other assayers, and the bottles contain "curles" sometimes two inches long, just as they came from the drill. After careful search we have found a mill which will grind samples quite fine, as you will note from the samples submitted herewith.

This then, in my opinion, represents the last word as to sampling by boring. It is the safest, whether the concentration of precious metals be in the centre or near the sides; whether the pigs be of the usual form, or whether the material be cast in slabs or plates.

We always urge upon both buyer and seller to agree in their contracts as to the method of sampling and assay to be employed, and this method we follow. This relieves the assayer of responsibility, but when he has to take this responsibility he should not shirk.

Sampling by Sawing. The difficulties in obtaining average samples by boring has led to a number of experiments to see whether or not the copper bars could not be sawed cold, and the sawings assayed with some expectation that they would represent the average of the material sampled. This, in my opinion, is the ideal method of sampling and will be adopted in future, but at present there are some difficulties in the way of the application of the saw in this busy commercial world of ours, because the results are slow. Some people, in fact, have told me that they believed it would be impossible to saw certain copper cold, but when we have urged upon them the experiment they have admitted that they were suprised that it could be done so rapidly.

This suggestion originated in England. At the works of a prominent refiner the sawing is done by a special machine designed for this purpose. The saw is circular, being two feet three inches in diameter and set up upon a powerful frame. The device for forcing the bar against the saw is a carriage operated by electric power. The saws do not wear out as rapidly as one would expect, and cut through a pig six inches in diameter, in about five minutes. The saw dust is all fine and in an ideal condition for assaying.

In some works where sawing has long been employed for trimming anode plates, it is now used for sampling.

The saw is forced up vertically against the pig, and does not cut all the way through, but cuts out a groove, say three inches deep, on the top of the pig, and the next pig which is sawed is placed bottom side up, so that an average of both top and bottom is obtained In one works an ordinary band has been employed and is said to give satisfaction. These band saws wear out quite rapidly when pushed, but are not expensive and are readily replaced.

In all works in Europe and America where sawing has been adopted, the five-bar method is employed, which should be plain from the following diagram :

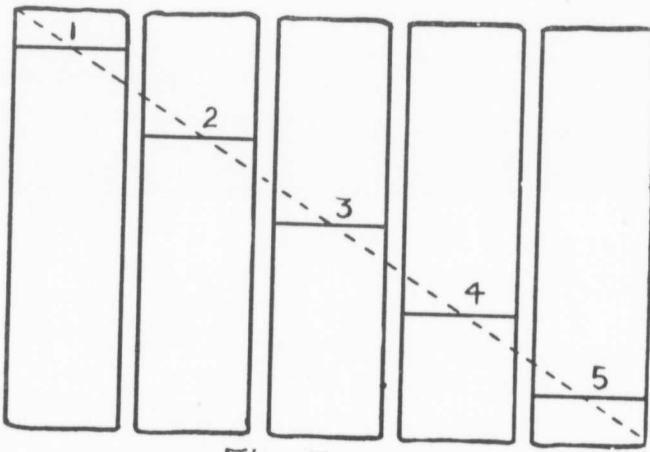


Fig. E.

In this case a diagonal line is drawn across the bars, but instead of boring a hole where this diagonal line crosses the centre line of each bar, the bars are sawed all the way through where these lines intersect. In this way we have an absolute average sample of each bar on a line different in its location from that of any other, and the sawings mixed together give us an accurate average for assay.

From what I have said the mechanical method of sampling as the art now exists to-day, may be stated again to be :

First, boring by the eighteen hole method, or sawing by the five bar method.

Dip Samples. A last word remains to be said under this head. Many works, both shippers and receivers of copper furnace material, contend that the only proper way of sampling is by dipping. The bars are melted up and samples are taken at stated intervals during the melt, which are granulated or cast into a sample ingot, which is then bored and the borings assayed. There are many difficulties in the way of this method of sampling and many precautions to be taken to insure accuracy. Both buyers and sellers are inclined to accept it if done at their own works. But it requires the independent sampler who is representing the interests of absent parties to be present during the entire melt; his men must be at the furnaces night and day to see that the dipping is properly done, and, after all, especially in comparatively low grade material, as far as copper contents are concerned, there is always an enrichment and concentration; so that the assay does not represent, in copper at least, the material which went in. In order, therefore, to arrive by calculation at an average assay of the lot as received, the weight of the material which entered the furnace must be taken; the weight of the anodes or plates which come out must be ascertained; the slag produced during the melt must be collected, weighed and assayed, and finally, there is always the suspicion on the part of sellers that the furnace bottoms have absorbed some of the values; or the fear on the part of the refiner that the furnaces may have given up some precious metal which may have been present as a residue from former charges.

Canada has added considerably to the anxiety of the refiners of the United States and to the burden of samplers, since the production of gold bearing copper mattes and bars from the British Columbia mines. If the receiver of furnace material was anxious on account of the variations in bars containing not over two ounces of gold per ton, imagine his mental state when he began receiving Rossland products in which the gold will average perhaps 18 ounces per ton, and the variation in parts of individual pigs is almost infinite! But even these 20 ounce mattes and the bars made from them are now safely sold and bought by the 18 hole method, or by sawing.

On the Gold Measures of Nova Scotia and Deep Mining.

—

By Mr. E. R. Faribault, B.A.Sc., Geological Survey of Canada.

The gold measures of Nova Scotia became known about the year 1860. The earliest discovery was followed by so many others, that it was believed that the whole of the Province was auriferous. Gradually, however, it became evident that the workable deposits of free gold were confined to the metamorphic rocks of the Atlantic coast, along which they form a continuous belt, from one end of the province to the other, a distance of some 260 miles, varying in width from ten to seventy-five miles.

They cover about half the superficies of the province, exclusive of Cape Breton Island, and their extent may be roughly estimated at 8,500 square miles. Of this area, probably 3,500 square miles are occupied by granitic masses, barren of gold, leaving an area of about 5,000 square miles of gold-measures.

The granite intersects the stratified gold-bearing rocks, in many places, in large masses or dykes, but for the most part it forms a prominent ridge, almost unbroken, from one end of the province to the other. Its intrusion took place at the close of the Silurian period, probably about Oriskany, and was accompanied and followed by disturbances, faults and much local metamorphism of the stratified rocks. It occurred after the folding of the gold-measures and the deposition of the quartz veins; for granite dykes and veins have been observed to always cut the interstratified quartz veins wherever they come in contact with them. The granite has thus no relation to the auriferous character of the veins, and need not again be referred to.

Although, no well defined fossils have so far been found in the sedimentary rocks constituting the gold-measures, most geologists agree to classify them, provisionally, as Lower Cambrian.

They certainly, in many respects, resemble the auriferous Cambrian of the Eastern Townships of Quebec, and knowledge gained in the

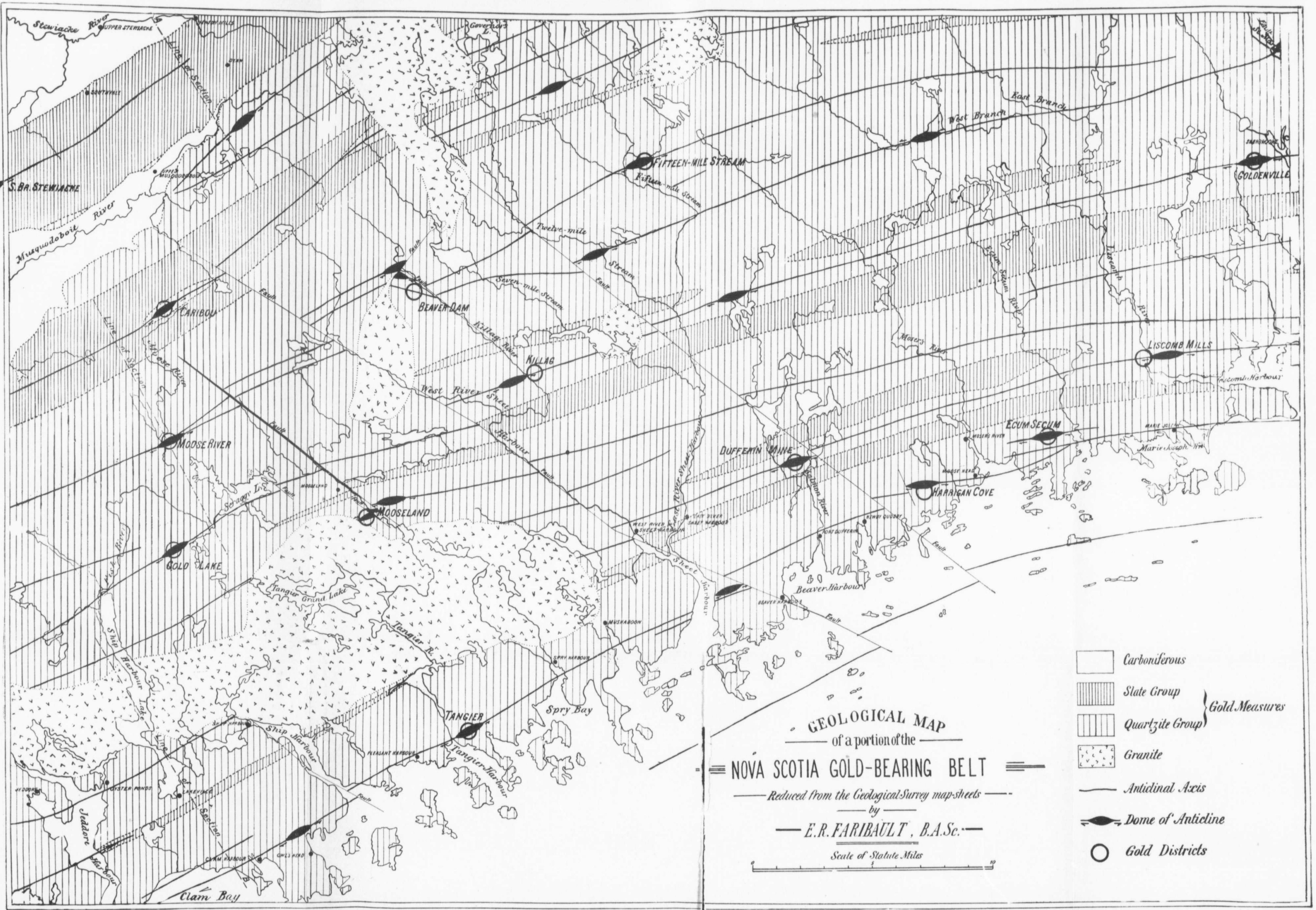
Nova Scotia gold-fields may prove of the greatest practical importance in prospecting for veins below the alluvial deposits of Quebec.

The gold-measures of Nova Scotia fall naturally into two well defined and distinct groups, viz., a lower or "quartzite group" and an upper or "slate group."

The mapping of the eastern part of the province, by the Geological Survey, places the thickness of the quartzite group, as far as denudation has exposed these rocks to view, at about three miles, and the thickness of the upper or slate group at about two miles, giving a total known thickness of strata of over five miles.

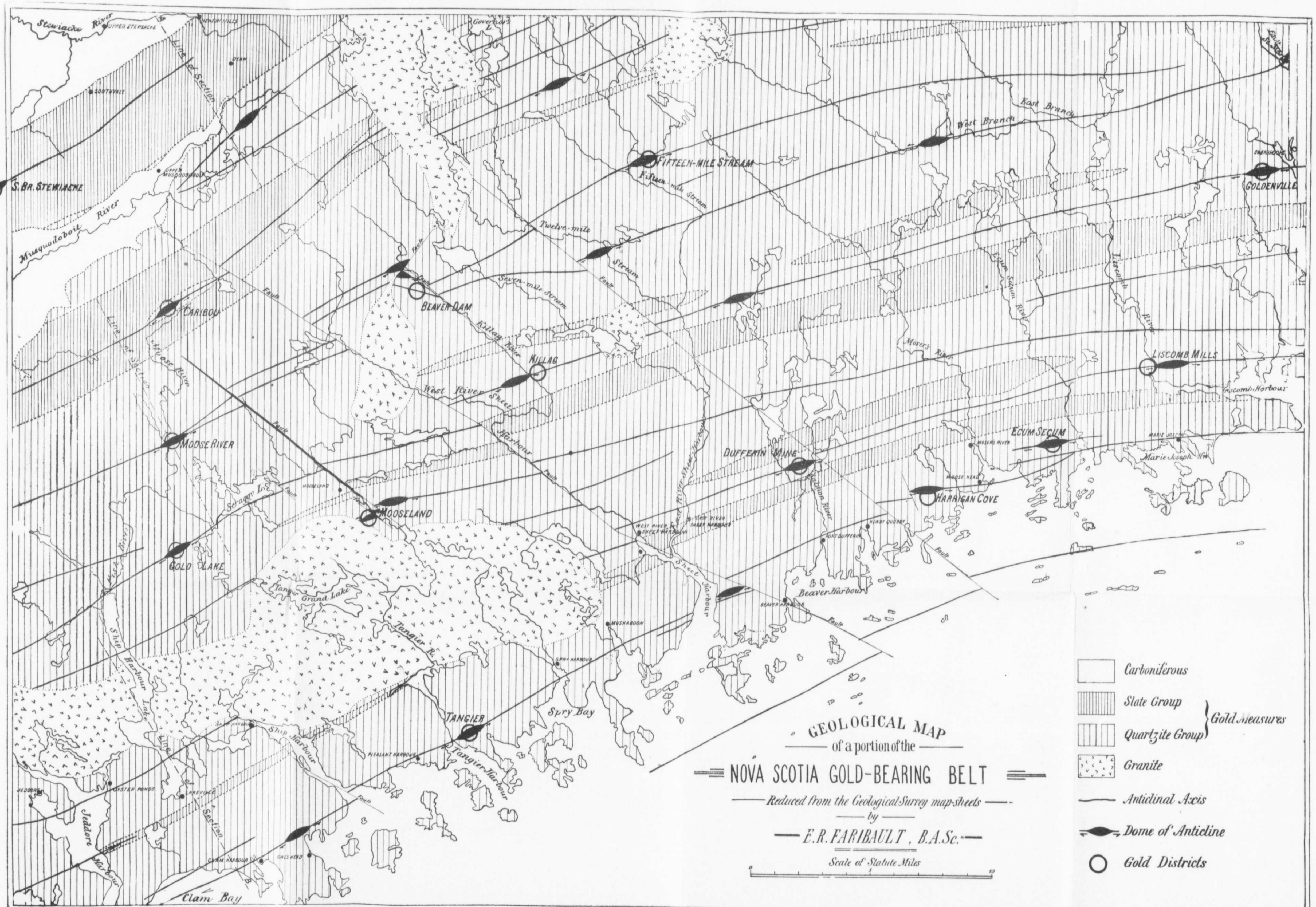
The lower division or quartzite group is mostly composed of thick-bedded, bluish and greenish grey felspathic quartzite, locally named by miners "whin," a term used in Scotland for an igneous rock or greenstone. Interstratified with the quartzite are numerous bands of slates, of different varieties and colors, from a fraction of a foot to several feet in thickness. The upper division or slate group is mostly composed, east of Halifax, of bluish-black slate, often graphitic and pyritous, rusty-weathering, with occasional layers of flinty quartzose rock. The lower part of this group is characterized by greenish, argillaceous and chloritic, soft slate, of but little thickness at the east end of the province, but increasing to a great thickness at the west end. A few layers of magnesian, siliceous limestone have also been noticed at different places, at the base of the group, overlying conformably the quartzite of the lower division. The line of division between the two groups is thus well defined by characteristic bands, which form valuable data to work out the sequence and structure of these rocks, at any point, with certainty.

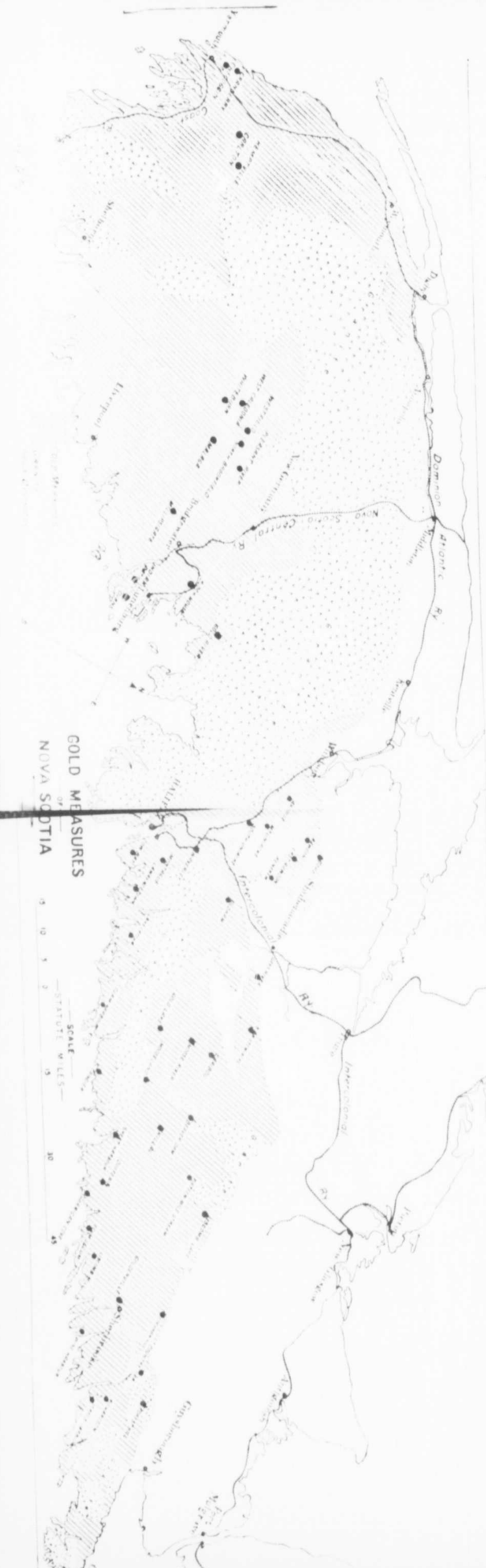
The beds of quartzite and slate, forming the gold-measures, were originally deposited in the sea, and therefore horizontally. These horizontal beds were then subjected, during a long period of time, to forces that have produced prodigious results. A close study of the present structure of these rocks shows that they have been slowly moved by a powerful and uniform pressure, which has folded them into a series of huge, sharp undulations, roughly parallel with the sea coast. They have indeed been buckled, bent and folded to such a degree that they

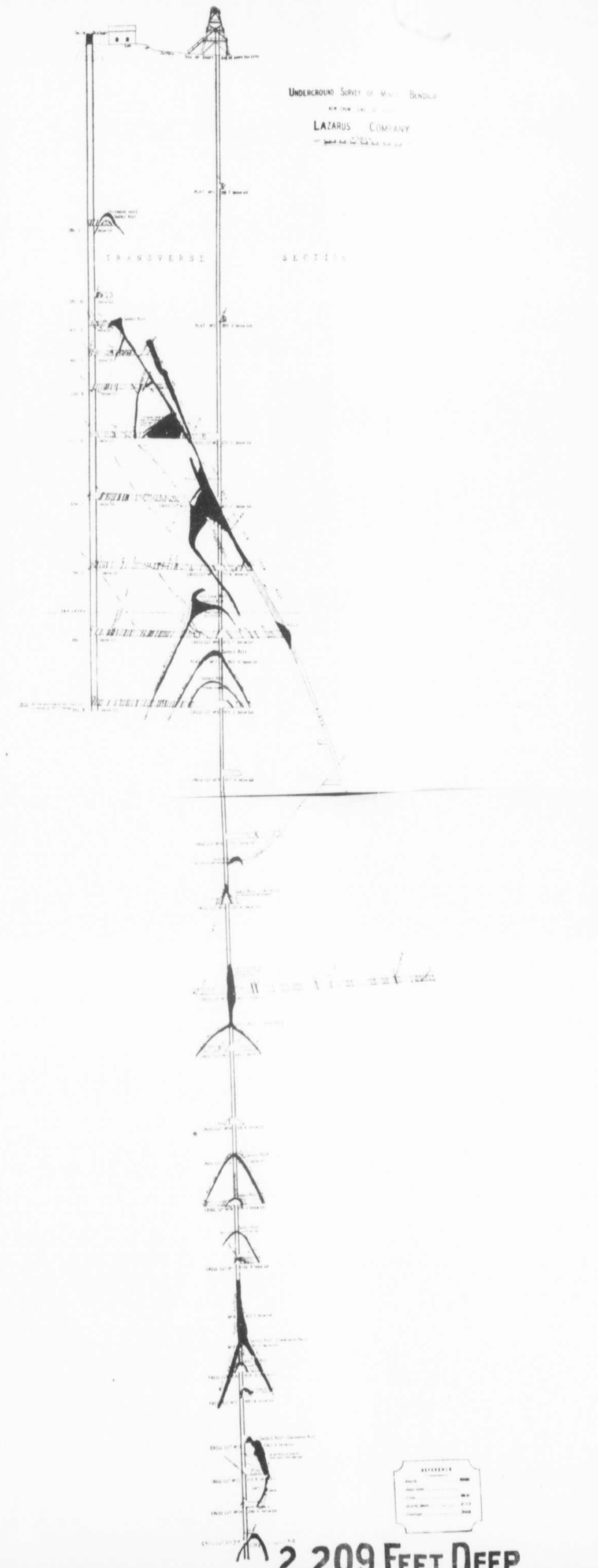

GEOLOGICAL MAP
of a portion of the
NOVA SCOTIA GOLD-BEARING BELT
Reduced from the Geological Survey map-sheets
by
E.R. FARIBAULT, B.A.Sc.
Scale of Statute Miles
Carboniferous
Slate Group
Quartzite Group
Gold Measures
Granite
Anticlinal Axis
Dome of Anticline
Gold Districts
S. BR. STEWIACKE
Stewiacke River
Musquodoboit River
Line of Section
CARIBOU
MOOSE RIVER
GOLD LAKE
MOOSELAND
BEAVER DAM
KILLAG
Killag River
Seven-mile Stream
Twelve-mile Stream
FIFTEEN-MILE STREAM
Fifteen-mile Stream
West Branch
East Branch
GOLDENVILLE
LISCOMB MILLS
Liscomb River
Liscomb Harbour
ECUM SECUM
Marie Joseph Hr.
DUFFERIN MINE
Salmon River
HARRIGAN COVE
Moser's River
Beaver Harbour
West River Sheet Harbour
Sheet Harbour
Tangier Grand Lake
Tangier R.
TANGIER
Tangier Harbour
Spry Bay
Ship Harbour
Ship Harbour Lake
Jeddore Harbour
Clam Bay
Fault

The Gold Measures of Nova Scotia and Deep Mining.

PLATE II.




GOLD MEASURES
OF
NOVA SCOTIA
SCALE
STATUTE MILES


LAZARUS COMPANY
TRANSVERSE SECTION
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occupy only one-half of their former width, measured at right angles to the strike.

Since these rocks were deposited and folded they have been under the unceasing influences that tend to level the hills and fill up the valleys, and, at more recent date, the greater part of the surface was subject to glacial erosion. Extensive denudation has worn away the folded measures to the present level. Some of the sharpest and highest folds have been truncated to a depth, as far as we know, of over eight miles, exposing at the surface a section of gold measures of over five miles in thickness.

The map (Fig. 2) is a reduction of map-sheets published by the Geological Survey on the scale of one mile to one inch. It represents a portion of the gold-measures, thirty-five miles wide and sixty miles long, east of Halifax, between Musquodoboit Harbour and Sherbrooke. The black lines show the anticlinal axes of eleven folds, into which the measures have been plicated; the narrow, dark shaded bands indicate remnants of the upper slate group, left undenuded along the deepest troughs or synclinal axes of the folds, the other areas indicate the granite masses.

A diagram (Fig. 3), gives a section of thirty-five miles in length, drawn across the whole belt of the gold-measures, along the line of section A B in the plan (Fig. 2).

Below (Fig. 3) is given, for comparison, a diagrammatic section of the Bendigo gold fields of Australia, on a scale ten times as large as the one above. The heavy black lines indicate gold mines on four different anticlinals, worked on the line of section.

The amplitude of the folds, or the distance between the different main anticlinal axes in these two gold fields respectively, varies considerably. The Nova Scotia section of thirty-five miles gives eleven anticlines, or an average distance of three miles between each anticline, and a maximum distance of nearly five miles; while in Bendigo gold district, it ranges from 300 to 1.300 feet. So that in Nova Scotia, the amplitude of the folds, is nearly twenty times greater than in Bendigo.

The mapping of the gold-measures by the Geological Survey during the last fifteen years, has been extended, under my charge, as far west as Lunenburg. The study of the structure of these rocks, over that region, has afforded an opportunity of acquiring many important facts and data by means of which gold mining may be carried on with more confidence, under more exact conditions, and with greater economy.

The most important feature disclosed, is that all the rich veins and the large bodies of low grade quartz worked in Nova Scotia, with few exceptions, follow the lines of stratification, and occur at well defined points along the anticlinal axes of the folds.

It was during the progress of the slow folding of the measures, that the rich quartz veins and large saddle-lodes of quartz were formed, at favourable places, along the planes of bedding on the anticlinal domes of the folds.

Thus a thorough knowledge of the structure of the anticlinal folds becomes necessary, to locate the auriferous quartz deposits on the surface, and to develop them in depth.

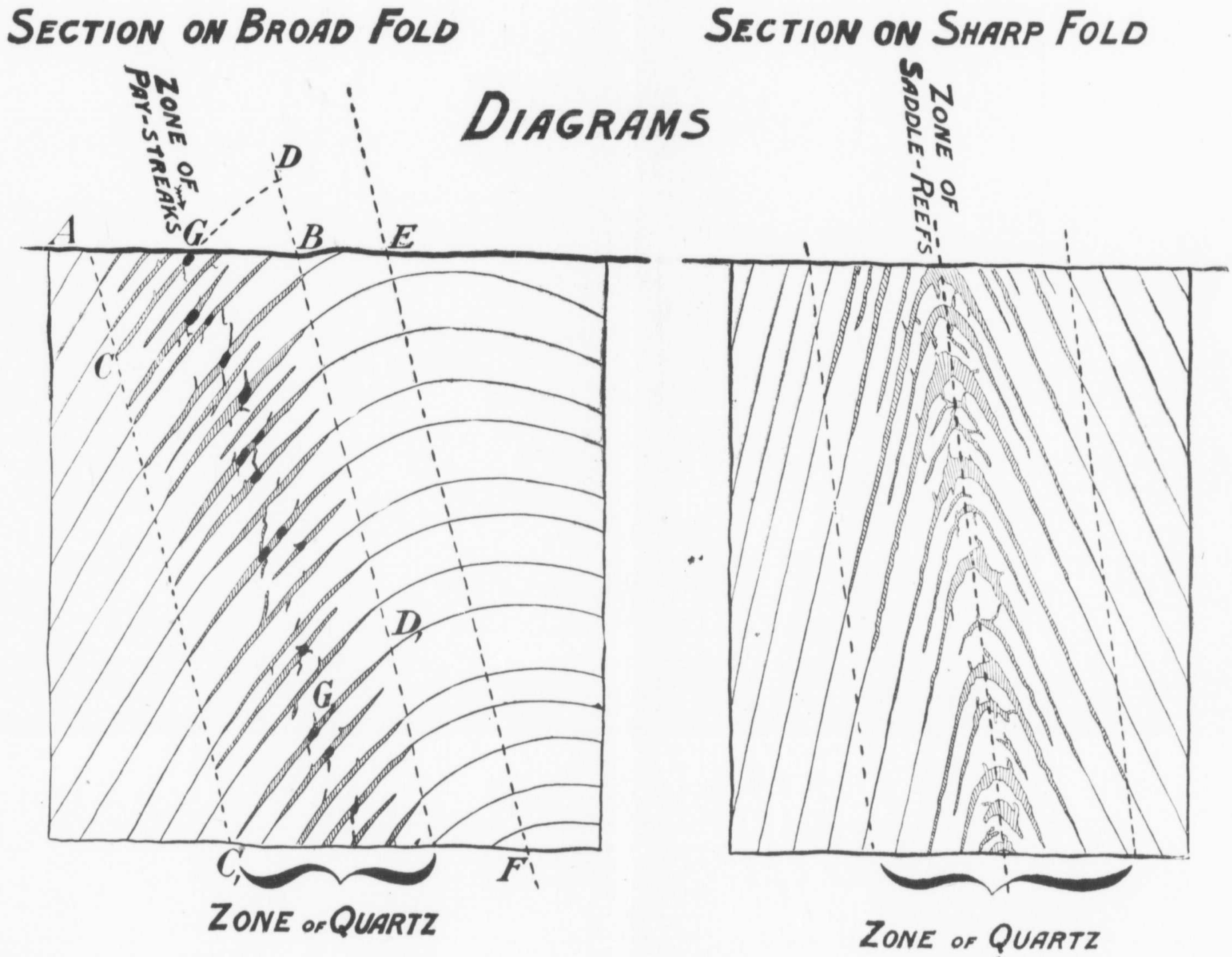
In tracing the axes of the folds at the surface, the dip of the rocks is the chief guide. If the strata are found to dip towards each other, it is clear they form a synclinal axis or trough; while, if they dip in opposite directions they form an anticlinal axis or ridge.

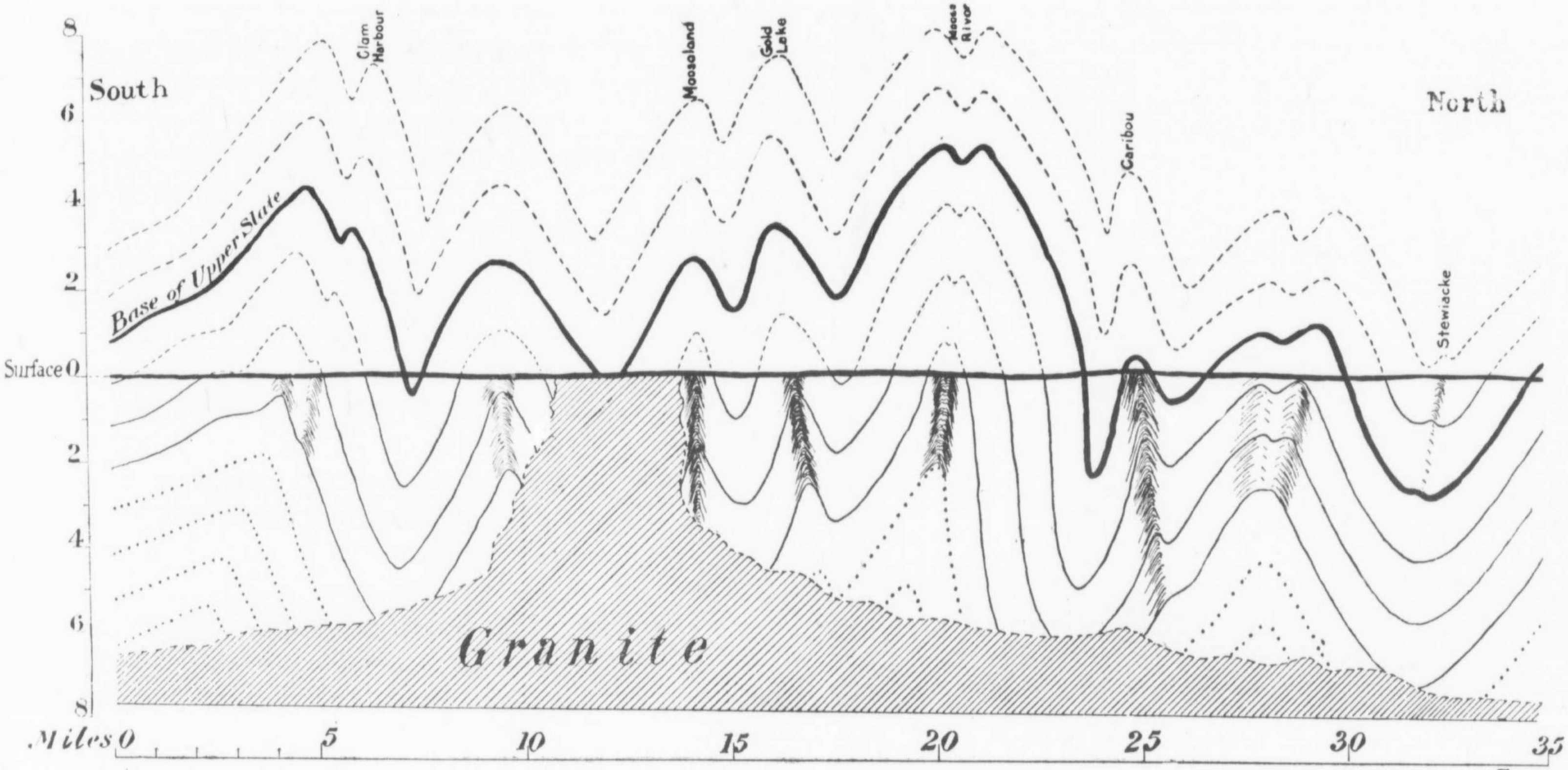
The rocks, on opposite sides of anticlinal axes, generally dip at angles varying between forty-five and ninety degrees from the horizon, seldom lower than forty-five degrees, and overturned dips are frequently noted.

The deviation of any bed from the horizontal, along the axial line, is its "pitch." A longitudinal section, made east and west along the axis of an anticlinal fold, will show the strata and the fold to pitch either to the east or west, at low angles, seldom over thirty degrees from the horizon.

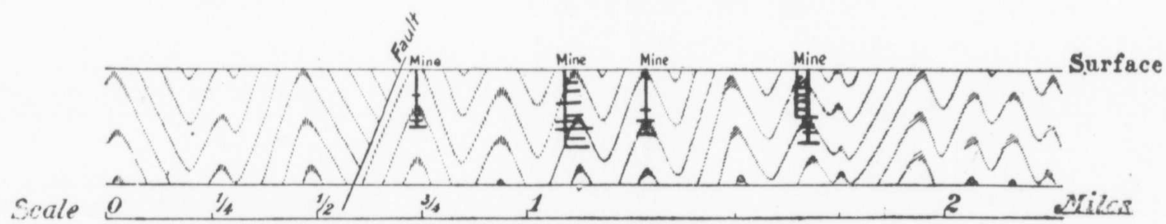
Owing to the pitch, the outcrop-edges of the beds, on each side of an anticline, are not parallel to the axial line; if they converge towards the east, the anticlinal fold dips east, and if to the west, it dips to the west.

When the pitch inclines both ways from a central point, that point is the centre of an elliptical "dome," and marks the position of one of the most favourable points on the main anticlines for the occurrence of quartz veins.


DIAGRAMS
SECTION ON BROAD FOLD
ZONE OF PAY-STREAKS
A
G
D
B
E
C
D,
G
C,
F
ZONE OF QUARTZ
SECTION ON SHARP FOLD
ZONE OF SADDLE-REEFS
ZONE OF QUARTZ



SECTION OF GOLD MEASURES IN NOVA SCOTIA.



SECTION OF BENDIGO GOLD-FIELD, AUSTRALIA.

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The average distance between one dome and the next, along the same anticlinal axis, varies from ten to twenty-five miles.

It has been thought by some, that these domes were caused by gentle north and south undulations, crossing the sharp east and west folds. Such does not, however, appear to be the case, generally, as it can clearly be seen by looking over the geological maps of the region, that the pitch at corresponding points on the various main anticlines is often quite different.

It will be seen that most, if not all, of the gold mining centres operated are situated on these domes.

Moreover, it has been observed that most of the anticlinal domes, upon which mines are not in operation, show indications of gold, and many will eventually prove to be important auriferous centres, only a few of them being without the structure necessary for the formation of quartz veins.

Of the twenty-one domes, in the region covered by this map (Fig. 2) fourteen have been worked more or less, six have shown auriferous quartz in situ or in float, and the remaining one has not yet been proved.

The gold districts operated to the east of Halifax are here given, together with their horizon or the distance of their strata below (and in one case above) the base of the upper slate group.

Moose River .... about	3¼	miles.
Tangier .... "	2¾	"
Fifteen-mile Stream and Beaver Dam	2½	"
Lawrencetown	2	"
Goldenville, Harrigan Cove, Gold Lake and Forest Hill	1½	"
Waverley and Renfrew	1¼	"
Mooseland, Killag, Liscomb Mill, Richardson, Lower Isaac's Harbour, Wine Harbour and Montague ...	1	"
Ecum Secum, Middle Isaac's Harbour, Cochran Hill, Lake Catcha, and Oldham, ...	¾	"
Salmon River	½	"

Caribou at the base of the Slate group.
Stewiacke about ¾ mile above the base of the Slate group.

There is no doubt that certain kinds of slate are more favourable to the segregation of gold than others, and that the prevalence or absence of the former, at certain horizons, will necessarily give zones of different richness.

The fact that important mines have already been worked at different horizons, from the top of the series to the bottom, is sufficient proof that strata favourable to the formation of auriferous veins are met with throughout the whole thickness of the lower quartzite group, and perhaps also in the upper slate group, though apparently less frequently. This is an important fact with regard to deep mining on the domes of anticlines.

The manner in which the strata are bent over the axial lines is worthy of note. The strata in folding do not bend round a centre, to form circular curves, but their curves are more like parabolas, superimposed upon one another. This is due to the immense lateral pressure which has compressed these beds, especially the slate bands, on either side of the fold, producing a thickening of the strata and openings between them on the apex of the folds.

In a certain thickness of sheets of paper or cloth, bent into an anticlinal fold, a "slipping" of the several layers on each other will take place; the sides of the fold will be tightly compressed, while, on top, openings will be formed. In the same manner in the folding of this great thickness of strata, the beds separated along the planes of stratification, and moved along these planes, the upper bed sliding upward on the lower inclined bed.

This slipping is clearly proved by the striations and slickensides that are to be seen in most mines on opposite bedding planes, and by a certain thickness of crushed black slates or gouge between the walls.

Such movements naturally took place between strata, where the cohesion was slightest, and thus, we find quartz veins following layers of slate, especially when the state is intercalated between thick beds of hard quartzite.

These slips may be considered as fault-fissures along bedding planes, and it is along these fissures that the quartz began to be deposited, and as, usually, these movements were very slow and intermittent and extended over the whole period of folding, the quartz was also deposited very slowly, usually in thin coatings accumulating one over the other, as the fissures widened, until veins of different thickness and extent were formed. The quartz often holds minute scales of slate, peeled off the walls, and subsequently covered over by other layers of silica, giving a banded structure to the veins; while the gold also often occurs in streaks parallel with the banded structure.

The large-scale plans made during the last two summers by the Geological Survey, including the most important districts to the east of Halifax, have brought to light important facts bearing on the relations of the structure of the anticlinal domes to the thickness, extent and auriferous streaks of the quartz veins.

In the case of sharp anticlinal domes, such as those of Salmon River, Mooseland, the Richardson mine, Fifteen-mile Stream and others, where the dip of both legs of the anticline forms an angle of less than forty or forty-five degrees, large bodies of quartz, called "saddle reefs" in Victoria, are found to occur along the anticlinal axes, and to bend conformably with the bedding.

On the course of the anticlinal axes, the saddle reefs generally keep their size for a great distance, pitching with the strata both ways from the centre of the dome, and eventually pinch out at a certain limit, which may be called the limit of the formation of quartz on the axial line.

They also curve sharply and follow the strata on the north and south dips, but generally thin out much more rapidly on the legs than on the pitch. Many legs have been mined in Nova Scotia to the depth of several hundred feet, and the quartz has still been found of a fair width. In Bendigo, where the folds are on an average, twenty times smaller than in Nova Scotia, the legs of quartz are said to very seldom extend to greater depth than one hundred feet below the cap of the saddle reefs; which would correspond proportionately to 2,000 feet in Nova Scotia.

These saddle reefs in Bendigo, are not only of great size and of remarkable persistence in length, but are also notable for recurring in depth, one below the other.

At the Lazarus mine, Bendigo, there are from the surface to the 2,200 foot level, no less than twenty-four of these saddle reefs, thirteen of which are auriferous to a payable degree, and some of great size.

At Bendigo, on the 31st Dec., 1897, six mines were worked over 3,000 feet in depth, and twelve over 2,700 feet; the deepest, the

Landell's 180 mine, was down 3,352 feet, and these were all worked on anticlinal folds.

No operation has yet been carried to any depth, through the arch-core of the folds in Nova Scotia, but the important developments done along the anticlinal axes at Salmon River, the Richardson mine, Waverley, Oldham and Mooseland, should be sufficient to convince the most sceptical, that quartz saddle-reefs and legs may be found underneath one another, to even a greater depth than in Bendigo.

The Montreal-London Gold and Silver Development Co., largely composed of Montreal capitalists, which acquired lately the Dufferin mine at Salmon River, is at present sinking on the dome of the anticlinal fold a vertical shaft, with cross-cuts and levels, which has reached a depth of over 300 feet. I am glad to call the attention of the meeting to this development, which may be considered the first important step in the introduction of a new system of mining and will, no doubt, be the inauguration of a new era of extensive and permanent deep mining in Nova Scotia.

Few reliable data can be obtained regarding the relative richness of the different parts of the saddle reefs and legs on a sharp fold, but many veins, worked on the apex of the fold, such as the Richardson lead at Isaac's Harbor, the Dufferin lodes at Salmon River, and the Bismarck lead at Mooseland, show that the vein is richer or can be worked with more profit on the saddle than on the legs.

In the case of a broad fold, when the angle formed by the dips on both sides of the anticline is over forty-five degrees, the veins do not acquire any great development along the axial lines, and the enlargements are found rather at a certain distance from the axis.

The thickness of the strata denuded, chiefly since the folding, has already been shown to be very great, reaching on some anticlines eight miles. This superincumbent mass of rock exerted a powerful pressure which has to be taken into account in the folding process. It is evident, that in the sharp folds this pressure has been completely overcome by the lateral pressure, but it has had undoubtedly much influence on the shape of the broad folds and the development of quartz

This pressure accounts, no doubt, for the fact that large veins are seldom found between strata dipping at lower angles than forty or fifty degrees.

Moreover, on a broad fold, at the surface, important veins are found only at a certain distance from the anticlinal axis, and within a limited zone of strata, AB varying between 200 and 1,000 feet. That is to say, quartz veins were formed on a part CD of the fold, where the combined forces of the lateral and of the downward pressure have determined the greatest strain and have produced most sliding and fissures. The outer limit of the zone A, corresponds generally to a point at which the strata begin to dip at an angle which remains constant for some distance.

Likewise, in depth, quartz veins were formed on that part of the fold which was subjected to the same conditions, and is similarly situated. As the structure of a fold will not change much for some distance in depth, the extreme limits C, D, of the zone of quartz veins will be found at about the same distances from the anticlinal axis of the fold, that is to say, parallel with the axial line EF.

If the fold gets sharper in depth, the zone of quartz veins will approach the axial lines EF downward, and if it gets broader, the zone will recede from the axial line. The distance B E of the zone of quartz veins varies considerably in the different districts according to the flatness of the fold. The axial line E F may also coincide with B D, in a sharper fold, and in a still sharper fold it may come half way between A and B, and we have then the typical saddle-reef fold.

Again, at the surface, in the same district, as at Goldenville, the fold may be sharper at one end and broader towards the other end, and in that case the zone of quartz veins will recede from the anticlinal axis, towards the broader end.

The quartz veins are sometimes very numerous on both sides of the anticlinal domes. On the Goldenville anticlinal dome, where developments have, perhaps, been more extensive than on any other districts in the province, some fifty-five different veins have been worked or uncovered, in a width of strata of 1,300 feet on the north side of the anticline, dipping north at forty-three degrees, and some fifty veins in a width of 500 feet on the south vertical dip of the anticline.

They extend in many cases on the surface for thousands of feet and they have been mined to depths of 700 feet in their vertical extension

The thickness of the veins varies considerably. The saddle-reef deposits are by far the heaviest bodies; those worked at Salmon River, Richardson and Mooseland mines attaining fifteen to twenty-five feet in thickness, and others not operated, at Fifteen-mile Stream, Cameron dam, &c., are probably larger.

The veins along the legs of the folds are much smaller, averaging from four inches to one foot, but often larger.

Many quartz veins are also found cutting the stratification at various angles; some are of great thickness, many are auriferous, and a few have been operated with notable profits. They are of later origin generally, than the interstratified veins, and some of them may be roughly contemporaneous with the intrusion of granite. Their richness is generally influenced by the nature of the adjacent strata.

In the interstratified veins the gold is sometimes distributed uniformly over considerable areas; usually, however, it is more or less concentrated within certain limits, leaving spaces on each side, comparatively barren. These enrichments are known as pay-streaks, and have hitherto been the principal source of the gold production

Most pay-streaks are well defined enrichments of twenty to sixty feet in breadth, often accompanied by enlargement in the size of the vein. They dip at low, constant angles, parallel generally with the well defined lines of schistosity of the rocks, and often with striations and corrugations on the walls, giving the veins a crumpled structure, locally called "barrel-quartz."

These corrugations and crumplings are more pronounced in the slate and quartz, and owe their origin to the sliding of thick beds of quartzite over one another, between which the softer bands curve and buckle in a wonderful manner. The pay-streaks lie at right angles to the sliding movement, that is to say, approximately parallel to the anticlinal axis.

Many of the pay streaks have been proved very rich and some have been traced from the surface along a gentle incline for as much as 1,800 feet, with extraordinary uniformity. In many instances, two or three pay-streaks have been determined in the same vein lying parallel under one another for some distance. This mode of occurrence is necessarily limited to the portion of that vein situated in the pay-zone.

The laws governing the position and extent of the pay-ground or pay-streaks are intimately connected with the structure of the anticlinal folds and are similar to those already laid down for the position and extent of the zones of quartz veins. The data necessary to explain their many peculiarities in the different gold districts are difficult to obtain with any degree of precision, as few plans or records have been kept or are obtainable. As a general rule, the best pay-ground, in most districts, is situated at about the middle of the zone of quartz veins A B, where fissures with angular-veins are most numerous. These small angular-veins or "angulars" which run into the walls at different angles, and sometimes connect one vein with the next, play an important part in the concentration or segregation of gold from the adjacent auriferous rocks, and, causing an enrichment or impoverishment of the main veins, they are well called locally "feeders" or "robbers."

In depth also, the zone of pay-ground G G, should be situated at about the middle of the zone of quartz veins G, parallel with the axial line E F.

It will then be readily understood, that one individual vein, if it cannot hold gold in paying quantity to a great depth, may nevertheless, be sufficiently rich to be worked with profit for a great length along certain lines parallel with the anticlinal axis ; that a vein barren at the surface B may be rich in depth in the pay zone, and that a vein which does not come to the surface B, may also be found payable on that pay zone G'.

The problem then consists of developing a zone of pay ground or portions of veins included within certain limits, along a plane G G, parallel with the axis E F, and that to depths practically unlimited.

This problem will, I am sure, prove interesting to mining engineers, and it only awaits their skill and knowledge to be put in practical operation and place the Nova Scotia gold-fields among the most productive in the world.

Test of a Two Stage Compressor.

By Mr. JOHN PRESTON, Montreal.

This test was made at the Caledonia Colliery of the Dominion Coal Company, Cape Breton, on August 6th, 7th, 1898.

It was undertaken by the officers and members of the Summer School in Mining of McGill University, in return for the courtesy shown them by the Dominion Coal Company. Owing to the number of simultaneous observations necessary, some of the officials kindly gave their services.

The compressor is of the well known Rand construction of the horizontal type. It is one of the largest in Canada, and the one which the Rand Company exhibited at the Chicago Exposition of 1893.

The diameters of the steam cylinders are 40 and 22 inches, with a 48 inch stroke. The air cylinders are 34 and 22 inches, arranged in tandem with the steam cylinders. The clearance volume of the air cylinders is 0.53 per cent. of the volume swept through by the piston, which is for the Low Pressure Air cylinder 0.133 cubic feet, and for the High Pressure cylinder 0.055 cubic feet.

A very large intercooler consisting of a series of 6-inch pipes is submerged under the floor of the compressor house; through this the air passes on its way from the low pressure to the high pressure cylinder. The purpose of the intercooler is to absorb heat from the air leaving the low pressure cylinder, and to enable it to begin the second stage of compression at as low a temperature as possible.

The air for the compressor enters through an intake trunk 24 x 30 inches in section, passing under the floor to the low pressure cylinder, where it is compressed up to 40 lbs. absolute or 25 lbs. gauge. It then passes through the intercooler to the high pressure cylinder where it is compressed up to 95.5 lbs. absolute. It is then discharged through an 8-inch pipe to the fan shaft and is used for power underground.

The purposes of the test were: –

1st. To determine the number of pounds of air per min. compressed per effective horse-power in the air cylinders and hence the thermal efficiency of the compressor as compared with an ideal compressor

2nd. To examine the action of the compressor valves

3rd. To determine the mechanical efficiency, that is, the proportion between the work done in the air cylinders to that in the steam cylinders.

Also incidentally to determine the rate of transmission of heat through the cooling surface of the jackets and intercooler. For the purposes of this test a wooden box 14 x 13⅞ inches, and 12 feet long, was attached to the discharge pipe. All the air was allowed to pass a valve and then escaped to the atmosphere.

Near the end of the box next to the discharge pipe was fitted a fine wire screen to break the flow of the air and prevent eddies, which would otherwise have affected the accuracy of the anemometer observations. To determine the velocity of discharge, both Anemometers and Pitot tubes were used. The Anemometer was placed in the open end of the box and the Pitot tubes in the middle. Unfortunately during the progress of the first test the Pitot tubes were broken. The results of the observations taken with them agreed satisfactorily with those from the Anemometer.

For calculating the weight of the discharged air the humidity of the air had to be known. This was determined from the rapidity with which water evaporated in the air, which rapidity, is measured by the cooling of a thermometer the bulb of which is kept wet.

If then

t = temperature of the air (dry bulb reading).
t_1 = wet bulb reading.
e_1 = maximum pressure of water vapor at temperature t_1, as taken from table in Kholrauch Physical Measurements.
b = height of the reading in m. m.

The actual pressure $e = e_1 - 0.0008\ b\ (t - t_1)$.

The absolute humidity (f) which is the water contained in one cubic meter of air is

$$f = 1.06 \left(\frac{e}{1 + 0.003665\ t_1} \right)$$
$$= 8.9 \text{ gms. per cubic meter.}$$
$$= 0.00538 \text{ lbs. per cubic ft.}$$

Therefore at this pressure and temperature 1 cubic foot of air = 0.0651 × 0.00538 = 0.07048 lbs. Barometer readings were taken before and after the trial and the pressure 14.7 lbs. per square inch, was found to be practically constant. This method for calculating the humidity of air is taken from Kholrauch's Physical Measurements.

The velocity of the air was taken as 3,300 feet per minute, giving a discharge of 4,427 cubic feet per minute.

The circulating water from the jackets was allowed to run into barrels and weighed. The temperature of the inlet and outlet water being measured by thermometers placed in the flowing water.

The pressure of the air in the intermediate cooler and discharge pipe, and also the steam in the main steam pipe was taken with Crosby gauges, these gauges being afterwards checked with a standard test gauge. Accurate thermometers placed in copper tubes screwed into the intercooler near the low pressure air cylinder, and near the high pressure air cylinder were used for getting the temperature of the air entering and leaving the intercooler. A thermometer similarly arranged was placed in the discharge pipe close to the high pressure cylinder to get the temperature of the discharge air. Crosby indicators were used on each of the four cylinders. The indicator cards taken from them were measured by the system of ordinates, and a mean card sheet made from these results. In order to obtain mean diagrams representing as nearly as possible the average of those taken during the trial, each card from the air cylinders was measured, the height of the different ordinates tabulated, and the average value of each ordinate obtained. From these numbers a mean diagram was constructed for each cylinder. This mean card was then plotted for both cylinders as in the figure, the abscissae representing volumes, and the ordinates pounds per square inch absolute

In a perfect air compressor the air would be drawn in at atmospheric pressure and compressed isothermally, that is at constant temperature to the desired pressure and finally discharged at the pressure in the main. Under these conditions the work done in compressing a given amount of air would be the least practicably possible.

To get the thermal efficiency from the cards we have—

Area of H. P. Card	=	24	Sq. in.
Area of L. P. Card	=	24.25	"
Total area of Air Cards	=	48.25	"
Area of Isothermal Card	=	34.5	"

The corrected area of which is $\frac{13.7}{14.7} \times 34.5 = 32.2$.

So as to compare the two cards from the same pressure—

$$\text{Efficiency} = \frac{\text{Area of Isothermal Card}}{\text{Total area of Air Cards.}}$$

$$= \frac{32.2}{48.25} = 67\%.$$

To find the number of British thermal units lost on the cooling surface of the inter-cooler we may check the air delivered per minute through the low pressure cylinder.

The volume compressed is only 24.3 cu. ft. on account of the air left in the clearance space and therefore the weight =

$$24.3 \times 0.0807 \times \frac{13.5}{14.7} \times \frac{461}{541} = 1.53 \text{ lbs. per stroke.}$$

Or $1.53 \times 130 = 199$ lbs. per min.

We have then 199 lbs. of air cooled from 280° F. to 145° F. that is 135° F.

The B. T. U. per minute $= 199 \times 0.2377 \times 135 = 6380$.

The number of square feet of cooling surface of inter-cooler is 542. Therefore B. T. U. lost per minute per square foot of surface is

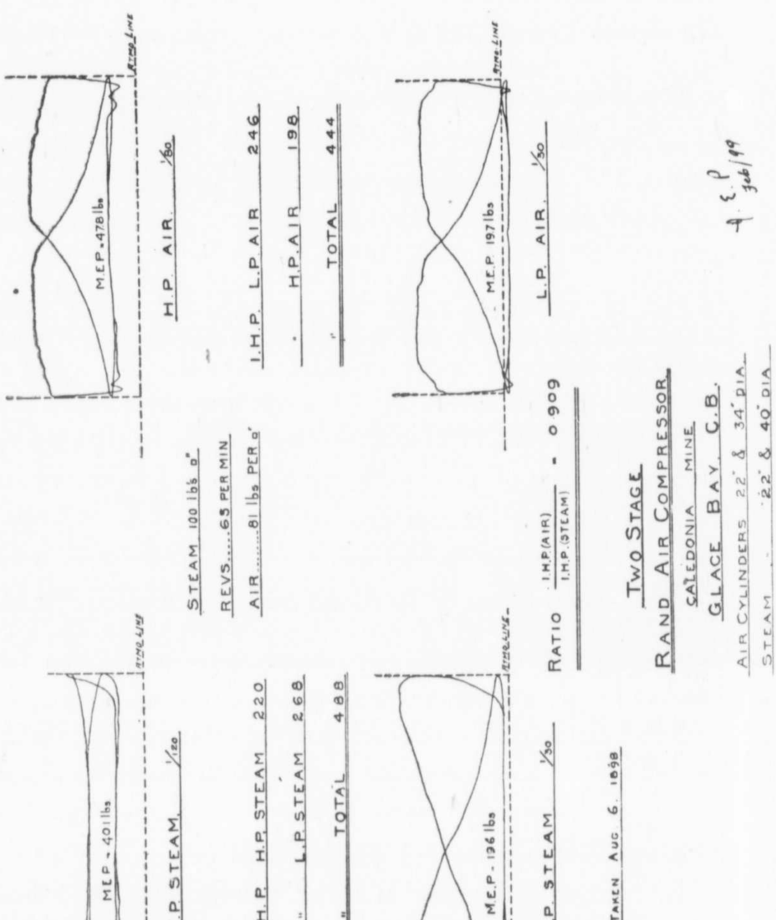
$$\frac{6380}{545} = 11.7$$

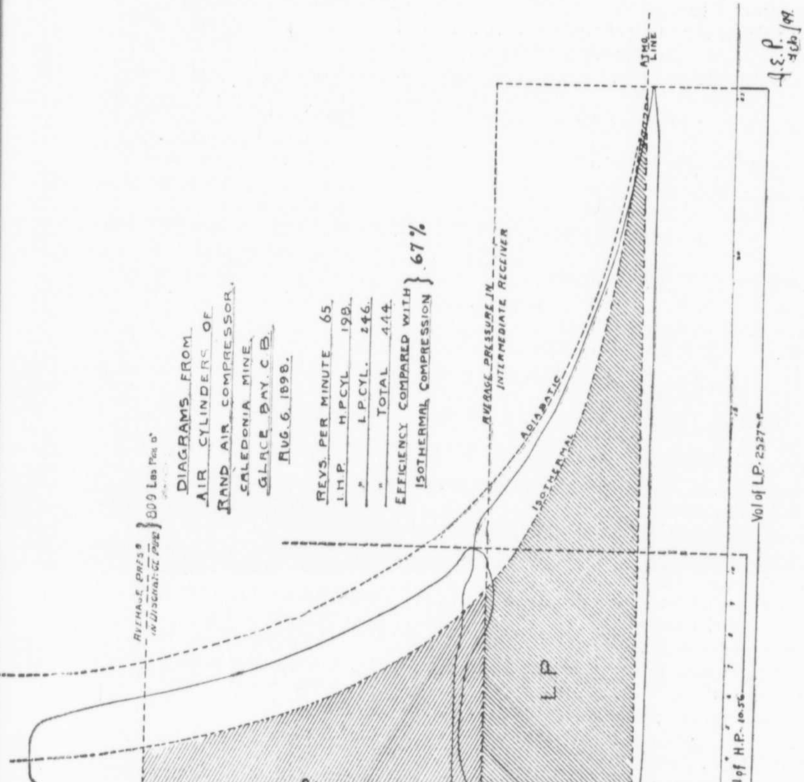
On analysis of the mean card it is seen that—

(1) By increasing the flow of water through the low pressure jacket, the compression curve may be made to come nearer the isothermal.

(2) That the cooling of the air in the inter-cooler is not enough to start the second stage of the compression at a point sufficiently near the isothermal curve to give good results.

(3) That the discharge valves stick, or do not open early enough, thus allowing the pressure in the cylinder to rise considerably above the reservoir pressure and increasing the amount of work to be done by the compressor.


ATMO. LINE
M.E.P. - 40 lbs
H.P. STEAM 1/120
I.H.P. H.P. STEAM 220
" L.P. STEAM 268
" TOTAL 488
ATMO. LINE
M.E.P. - 136 lbs
L.P. STEAM 1/30
TAKEN AUG 6. 1898
STEAM 100 lbs □"
REVS.....65 PER MIN
AIR.......81 lbs PER □"
RATIO I.H.P.(AIR) / I.H.P.(STEAM) - 0.909
TWO STAGE
RAND AIR COMPRESSOR
CALEDONIA MINE
GLACE BAY, C.B.
AIR CYLINDERS 22" & 34" DIA.
STEAM " 22" & 40" DIA
STROKE 48"
ATMO. LINE
M.E.P. = 47.8 lbs
H.P. AIR 1/80
I.H.P. L.P. AIR 246
" H.P. AIR 198
" TOTAL 444
ATMO. LINE
M.E.P. 197 lbs
L.P. AIR 1/30


DIAGRAMS FROM
AIR CYLINDERS OF
RAND AIR COMPRESSOR,
CALEDONIA MINE,
GLACE BAY, C.B.
AUG. 6. 1898.
REVS. PER MINUTE 65
I.H.P. H.P.CYL. 198.
" L.P.CYL. 246.
" TOTAL 444
EFFICIENCY COMPARED WITH ISOTHERMAL COMPRESSION } 67%
AVERAGE PRESS IN DISCHARGE PIPE } 80.0 Lbs Per □"
AVERAGE PRESSURE IN INTERMEDIATE RECEIVER
ADIABATIC
ISOTHERMAL
H.P
L.P
ATMO LINE
Vol of H.P. 10.56
Vol of L.P. 2527

(4) That the low pressure suction valses are not opening sufficiently, this is shown by the fact that the pressure in the low pressure cylinder during the suction stroke is more than two pounds below that of the atmosphere.

AVERAGE RESULTS OF AIR COMPRESSOR TRIALS.

1. Date of trial	August 6th, 7th, 1898.
2. Compressor	Rand Two Stage.
Condition of test	Ordinary working.
Dia. and stroke of air cylinders	34″ x 48″ and 22″ x 48″.
" " of steam cylinders	40″ x 48″ and 22″ x 48″.
Dia. of air piston rods	H. P.=3.86″, L. P. 3.85.
" of steam " "	H. P.=3.86″, L. P. 3.87″.
Steam pipe pressure by gauge	100 lbs.
M. E. P., H.P. steam cylinders	40.10 lbs. square inch.
M. E. P., L. P. " "	19.68 lbs. square inch.
Barometric pressure	29.94 = 14.7 lbs. per square inch.
Air pressure in intercooler	25 lbs. gauge.
" " in discharge pipe	80.9 lbs. reduced to atmospheric at end of pipe.
M. E. P., L. P. air cylinders	19.79 lbs. per square inch.
M. E. P., H. P. " "	47.87 " " " "
Mean revolutions per minute	65 " " " "
I. H. P., H. P. steam cylinder	220 " " " "
I. H. P., L. P. steam cylinder	268.4 " " " "
Total I. H. P. steam	488.4 " " " "
I. H. P., L. P air cylinder	246.5 " " " "
I. H. P., H. P. air cylinder	197.6 " " " "
Total air I. H. P	444. " " " "
Clearance Vol. L.P. air cylinder, fraction of piston displacement	=.0053=0.133 cubic feet.
Clearance Vol. H.P. air cylinder, fraction of piston displacement	=.0053=0.055 cubic feet.
Piston displacement L. P. air	25.14 cubic feet.
Piston displacement H. P. air	10.51 cubic feet.
Volume of Intercooler	73.6 cubic feet.
Cooling surface Intercooler	545 square feet.
Cooling surface of L. P. jacket	60.29 square feet.
Cooling surface of H. P. jacket	37.09 square feet.
Air leaving lbs. per minute	199.
Rise in temperature L.P. jacket water	4.96° F.
Flow in lbs. per minute	186.1.
Rise in temperature H. P. jacket water	5.3° F.
Flow in lbs. per minute	182.1.
Air temperature leaving L. P. cylinder	268.8° F.
Air temperature entering H. P. cylinder	145.4° F.
Air temperature leaving H. P. cylinder	65 8° F.
Temperature of air at suction	71.7° F.
Temperature of air at wet bulb	65.8° F.
Wk. actually expended per lb. of air compressed	78 : 800 ft. lbs.
Wk. expended if comp. Isothermally	52,800 ft. lbs. per lb.
B. T. U. per sq. ft. per min. in L. P. jacket	15.
B. T. U. per sq. ft. per min. in Intercooler	11.7.
B. T. U. per sq. ft. per min. in H. P. jacket	25.47.
Ratio $\frac{\text{Air I. H. P.}}{\text{Steam I. H. P.}}$	0.9093.
Effy. compd. with Isothermal Exp.	67 per cent.

Notes on the Driving of Simplon Tunnel, Swiss Alps.

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By Mr. Leopold Meyer, M.E., Ottawa.

In taking up as subject the driving of this tunnel, I do not intend to expound beyond measure the facts appertaining to it. I simply wish to give a general insight of the work, having had the opportunity of examining it and being acquainted personally with the engineers in charge of this gigantic work.

The object of the Simplon tunnel is to extend the line "Jura Simplon" by going through the Simplon Mountain and permitting the junction of this road with the Italian System.

The tunnel will be approximately 23,000 meters long. It starts at Brigue on the Swiss side, and has its outlet in Italy at Isellen.

The project designed, and now in course of being carried out, work having started two months ago or so, provides for the construction of two parallel tunnels which shall be joined by cross-cuts driven every 100 meters. The object of this second tunnel is to improve and facilitate the ventilation of the tunnels during the course of the work as well as after the completion.

The firm, Brandt & Brandan, of Hamburg, which is well known for having driven different tunnels such as "Arlberg," "Caucasus" and part of the "St. Gothard," has taken the contract *en bloc* for the work. In five and a half years the two tunnels must be completed, masonry work finished and tracks laid down. For each day of delay after this the contractor shall have to pay a fine of 5,000 francs ($1,000). On the other hand for each day gained on the agreed time he shall receive a bonus of 5,000 francs. The contractor feels satisfied that he can gain half a year, and I must say that the measures taken by them seem to fully justify these hopes.

It is rather difficult to realize what preparations have been necessitated by such an enterprise. Thorough soundings, by borings, have been made of the whole mountain, which have revealed to the contractor the exact section and what rocks he has to deal with, and to provide himself with the necessary apparatus.

Yet the problem to be solved is very complicated, and can be classified as follows. We shall review it rapidly under the following headings :

1. Surface installations.
2. Mode of work for the driving and power used.
3. Ventilation.
4. Refrigerating plant.

Surface.—A small town has sprung up at each end of the tunnel. To describe one is to describe both, for the tunnel has been started from both sides, on the Swiss side at Brigue, and on the Italian side at Isellen.

Besides dwelling houses for the workmen, a dynamite factory has been built, on account of the great quantity of explosives necessitated by such a colossal enterprise.

The principle of all the power employed is the use of water under high pressures. Where natural falls can be utilized under the natural head of water, it is used as such. But for the drills working by hydraulic pressure a series of compressors have been put up which give pressures at the drills of 50 to 150 atmospheres. This corresponds to 2,700 lbs. per sq. inch.

It is remarkable to notice with what ease such huge forces are transmitted without leakage at the joints or bursting of pipes.

Mr A. Brandt, the head of the firm, works with machines of his own design, which are made by Seilzer Brothers, of Wentlrthur, who are very skillful and conscientious constructors.

I would strongly advise all persons interested in such works, and who have a chance to do so, to pay a visit at the work shops of this firm, which owe their origin to private enterprise, in a country without coal or iron and having as only advantage on the other constructing firms of the world, the qualities of industry and heartiness to work which are the distinguishing features of the Swiss people. In a small town, without apparent prospects, the Seilzer Brothers have given rise to an industry which employs more than 3,000 men, men to whom they are insuring a life prosperous and happy.

The compressors used by Mr. Brandt are made very carefully. The principle is quite simple. The engines are double or coupled; on each side are two steam cylinders, one high pressure and one low pressure. On the same axis, on each side is a differential or force pump which forces the water directly to where the force is used, with an intermediate so-called accumulator, which is only a safety valve, which is laden with weights to obtain the required pressure. If the rock is very hard additional weights are put on the accumulator of which the reaction or throbs are checked by strong steel springs.

This enormous pressure is obtained without noise and the power is taken to the workings without the observer being able to detect the least abnormal noise.

I think that the success of these apparatus is mainly due to the excellence and perfection of construction.

Therefore, in the surface plant of machinery, the power is generated according to those principles. High pressure everywhere even the boilers. The boilers are small and yield enormous quantities of steam at very high pressure, which is a principle eminently economical and practical. None of those huge boilers with low and costly pressure. This principle of high pressure is apparent everywhere and seems to influence the workmen, who also appear to work under high pressure.

The power is received at the different working places to work the ventilating fans and drills. We are going to consider these and say a word about the working of them and show the efficiency obtained from them.

Work Carried on in the Tunnel.—The rock is attached by rotating drills worked by hydraulic pressure. A light frame on a carriage carries to the breast work a horizontal column with a piston, on which two drills are attached. The whole is arranged so as to take up as little room as possible. It is like a closed umbrella which is opened when the carriage has reached the working place.

Then the column is put in place and wedged in. A tunnel of small dimension is always first driven. This is subsequently widened to the size of the finished section.

When the column is set in place, water under pressure is introduced through a small flexible copper pipe of less than a fifth of an inch. This acts on a large piston which wedges the column in an immovable position.

The drills proper, which can be moved on their axes in all directions, are then fixed on and the bit attached; the drill is then put under the pressure as explained before.

The bit is made of hollow tube through the interior of which passes the waste water. In this way it is used to clean the hole. The bit is made of exceptionally hard steel and has three teeth which tear the rock. When the holes are completed the machine is taken away and the blasting is made. Here, a point which may be of use to the miner may be noticed. The quantity of dynamite used is so large that the rock is not only torn asunder, but powdered and almost burnt.

No savings are made of explosives. This is an essential point when time is the real factor.

The mode of working the drills is very ingenious. The apparatus as a whole is simple. The movement of rotation of the tool is obtained by two small hyraulic motors of which the dead centres are cranked at 90°. The forward motion is given by the water under high pressure, acting directly on a large piston, placed below the bit. The backing motion is obtained by turning a valve. The workman in charge of the machine has complete control of it and can easily take off two of them. I had the opportunity to work one of these machines myself and succeeded in obtaining in an ordinary granite, an advance of 21 feet a day in a drift of a section of 7x7 feet.

The changing of the bit is very rapidly made, and the lengths are graded to obtain the maximum advance.

If the sum spent in getting out of the "debris" could be saved, an economy of time of 50 per cent. could be effected.

Here Mr. Brandt proved himself equal to the occasion. He has not suppressed the carting away of the clearings, but he has succeeded to effect it simultaneously with drilling and blasting. On one side of the tunnel he has placed a large pipe with water at high pressure. This pipe is about ten inches in diameter. At the end, near the breastwork is a fixed elbow with a flattened conical nozzle, directed in the axis of the rails. Immediately after the shafts have been fixed the whole of this apparatus is covered by the debris, the quantity of which however is a minimum on account of the large quantity of dynamite used. The valve is now opened, and the enormous volume of water under pressure sweeps the fallen rock out of the way, clearing the rails and breastwork sufficiently to allow the drills to advance and resume work. The clearing goes on therefore below the drills and to their right and left while they go on with their work.

While this small opening tunnel is being driven forward, other apparatus are at work behind widening the section to the required size.

But the organization of the work is such that everything is effected systematically without disorder. Each section works without interfering with the other. One goes on unimpeded over the other, and the masonary work advances without interruption night and day.

It is interesting to see entering the tunnel simultaneously, the material for the timbering of the temporary drift, the bricks and cement for the masonary of the finished section and at the same time the debris of the blasting are carted out. And these do not in the least interfere with one another. The work follows its normal and regular course ; such is a bee hive where every individual has h s work cut out and knows exactly what is to be achieved.

Ventilation.—It is easy to conceive that ventilation in such a work is of first necessity and importance. In spite of the two tunnels, an energetic artificial ventilation has to be resorted to.

Mr. Brandt has solved the problem as follows :

He uses high speed fans, not less that 3,000 turns a minute. The air forced by this fan is received by a second and forced to a third and so on. By this means, with a series of apparatus comparatively small and unobstructive, he has succeeded in providing enormous quantities of air at suitable pressure. This is another of those simple ideas which give the best results.

Refrigeration of the Workings.—This is another point which is a source of worry to the contractors. It is the heat which is met with at distances of 10,000 feet underground. A temperature of 130° Fah. is expected. Then the question comes up, how is the work to go on in such temperature.

The driving of the St. Gothard tunnel has demonstrated that beyond a certain temperature few temperaments can resist and the sick lists attain alarming proportions.

It is intended to solve the problem as follows: After each shot, a shower of ice-cold water derived from the glaciers, shall be sprinkled on the breastwork. As water absorbs a large amount of heat the temperature after this operation shall be considerably lowered.

Also, the air from the fans will be made to pass through coolers and over material absorbing moisture. For, it is not sufficient to send cold air where ventilation is needed, but this air must also be dry. Experience has shown that excessive moisture has a depressing effect on the men.

I think that these few lines, written as thoughts came, will give some idea of an enterprise of first magnitude, by pointing out in a brief way the difficulties to overcome, and the means taken to do so.

If some members of the Institute should happen to have the opportunity of visiting this work, it would cause me great pleasure to give them letters of introduction to the contractors, whom I know personally and with whom I have worked and learned.

(NOTE BY THE SECRETARY :—The Institute is indebted to Mr. Theo. C. Denis for translating this paper from the French.)

An Occurrence of Free-Milling Gold Veins in British Columbia.

By Wm. Hamilton Merritt, F.G.S., Assoc. R.S.M., &c.

The free milling gold ores have not as yet been developed to the same extent as the smelting ores in British Columbia. Indeed it might very correctly be said that (excepting possibly the "Poorman," near Nelson,) until comparatively recently the "Cariboo" at Camp McKinney was the only mine that had been constantly at work for some years back on a free milling gold ore of sufficiently high grade to yield its owners handsome dividends.

Somewhat similar conditions prevail about 25 miles from Camp McKinney in a locality known as the Fairview Camp, and while it cannot be said that developments up to the present have demonstrated ore-shoots as extensive, and perhaps as high-grade, as on the "Cariboo"; yet there is high-grade ore, there are strong and permanent veins, and I think I may very properly take a portion of this camp as a type of the occurrence of free milling gold veins in British Columbia.

Intrusive granite appears to be the rock most intimately connected with the free-milling gold ores in the southern part of the Province, that is to say, perhaps not of necessity as forming the walls of the veins, but, as in Nova Scotia, occurring in the immediate vicinity.

Here in one part of the camp in question an immense mass of intrusive granite forms the major part of a mountain. This is bounded on the north-east by a schistose quartzite (microscopic examination, referred to later, would allow it to be classified as a mica-schist).

The schistosity of this rock is parallel to the edge of the granite. A couple of strong quartz veins occur in the schists running with them. The veins have been opened at various places along a length of a couple of miles and are found to follow in a general way, and sometimes to be quite close to, the edge of the granite.

Here and there protrusions of the granite mass have caused disturbances and have thrown the veins, in well-defined faults, to the north-east. Fig. 1 is a photograph of one of these faults. Where the faulting occurrs the schist is also much twisted.

The veins above alluded to vary from 2½ to 12 and 15 feet in thickness, and so far as their width and permanency go they are everything that can be desired. The mineralization is similar to that of the Camp McKinney veins, consisting of varying proportions of iron pyrites, galena, zinc blend and gold.

A number of mill runs showed that the free milling value was some five times that of the value of the concentrates obtained per ton of ore milled, but at the same time a considerably larger value, per ton of ore milled, escaped in the tailings than was caught by the Frue vanners; indeed the loss in the tailings in some trials was nearly half the value of the bullion caught in the battery and on the plates.

In higher grade ore the tailings sometimes ran to $4 and $5 a ton.

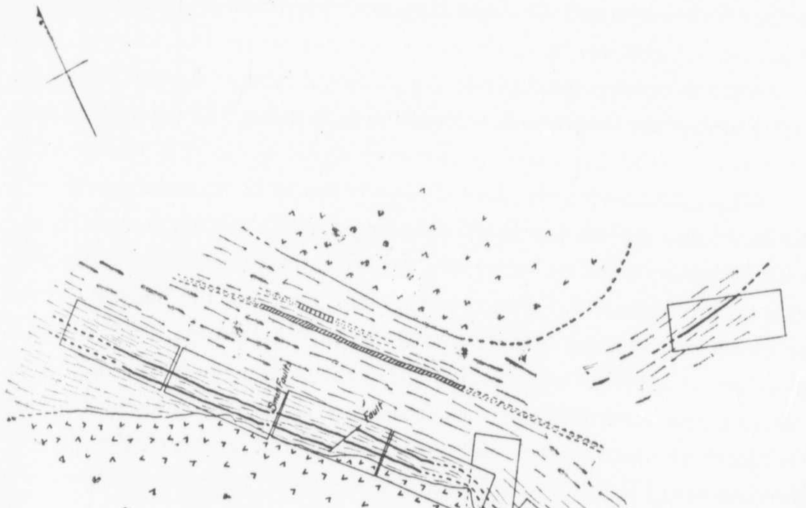
The loss in the tailings is probably carried over by slimed concentrates. This is a matter that will bear careful watching in the development of the Fairview and Camp McKinney camps, and it would be no matter of surprise to me were it found that all the tailings run away from the Cariboo mill would bear treatment. Cyanide tests have given an extraction of 90 per cent. gold and 75 per cent. silver of both concentrates and tailings, the samples tested being from above mentioned test runs.

When running on a pay grade of ore the yield of concentrates is about 2 per cent., and their average value is about $70 a ton. They have been generally shipped to the Tacoma smelter.

As is usually the case elsewhere, the rich places appear to occur as shoots, and in the claim about 100 feet was quarried along the outcrop yielding results running well into the double figures, and from a width of over 12 feet in places.

I understand that the part of the vein which paid so handsomely on the surface is being opened in depth.

It should be mentioned that while most of the veins have been developed in the schistose rock, yet there are cases where veins have been opened in the granite. In one of the latter instances ore was obtained which yielded upwards of $30 a ton in the mill, but it was reported that this vein was very irregular and all the pay ore mined out.


Fault
Intrusive Granite
Mica Schist (Schistose Quartzite)
Band of Limestone
Greenstone
Quartz Vein.

The geological features of the portion of the camp above alluded to is the more immediate object of these notes. The accompanying sketch map shows the veins following the edge of the great granite mass. It might appear that there were at least two series of upheavals—the first may have caused the fissures in which the veins were deposited, and the second, accompanied by constant great pressure, has produced the faults in the veins and also the schistosity parallel to the strike of the vein and at right angles to the evident thrust from the mountain of granite.

This is another example of the so-called "bedded vein" structure, but in this case they are as typical "fissure veins" as it is possible to imagine.

This is shown much more distinctly again in another strong vein which I have included in the sketch map further to the east. Here the vein occurs in a darker schist, but on microscopic examination its wall rock shows identical features to the wall rocks of the main system of veins beside the great granite mass. In this latter case, however, it is clearly shown in the rock-section (described later on) that the original bedding has been disturbed by pressure and that the present bedding has been set up at some 50° from the original bedding, the present bedding being parallel to the vein.

An example such as this is of value to offset the too often indulged in depreciation of a vein where the bedding is parallel to it, and for which reason it is sometimes held that it is not a fissure vein, though indeed the bedding or schistosity may have been formed subsequently to the original fissure.

The following are the descriptions of the granite and schistose quartzite (or mica schist):—

Biotite Granite.—Rock light in color, of medium grain and somewhat porphyritic, owing to the biotite being as phenocrysts scattered rather sparsely. The section shows granitic quartz with the usual inclusions; orthoclase rather fresh looking; plagioclase which is much altered, and shows much secondary mica in small flakes all through it. The plagioclase is in excess of the orthoclase and the two are predominant in the rock. No accessory constituents are to be noticed in the section.

Muscovite Granite.—Resembles the above closely in color and general structure, but it is finer grained and is without porphyritic crystals of mica. The specimen was taken from the same intrusion as the above, but nearer the edge, where it has cooled more rapidly. The rock is more altered than the one just described. The microscope shows much muscovite, most of which seems to be derived from the felspar. The little flakes show very high polarization colors; granitic quartz in normal proportion; felspar present in large quantity, part of it seems to be orthoclase and part probably plagioclase, but very much altered, the muscovite being all around and through it. Some small scattered grains of ferric oxide, in the centre of some of which pyrite is visible where decomposition has not yet oxidized the whole mass.

Mica Schist ("Schistose Quartzite").—The specimen represents the general character of the formation in which the veins occur along the edge of the large granite mass. The rock is a rather fine and very evenly grained mica schist. The quartz grains are rather irregular in size, but in general they are very minute. There is an abundance of both biotite and muscovite, the two kinds intimately mixed and forming pretty continuous strings. Both are in fairly well defined crystals, the former in small oblong prisms and the latter in long needles. Scattered quite profusely through the section are irregular pieces of pyrite, considerably decomposed, and with their longer axes also usually following the direction of schistosity.

Mica Schist.—This specimen represents the rock in which the vein to the east occurs. The constituents of this rock are identical with those of the last described and they have probably both been formed together, but this rock is less evenly grained, as it shows evidence of having had another bedding previously and the present bedding is naturally therefore not so perfect. The rock is stained dark with iron oxide and microscopically has the appearance of a fine-grained gneiss. It is seen to be made up of dark layers alternating somewhat roughly with lighter and thinner layers. Under the microscope the darker bands are seen to be made up of fine grains of biotite and the lighter of irregular rounded grains of quartz. There are also some angular grains of microcline and other triclinic felspar to be seen occasionally throughout the section, and disseminated grains of iron oxide with pyrite in the interior in cases where decomposition has not changed the whole mass.

This section shows by the direction and arrangement of its mica constituents that there has been a previous bedding of the schist inclined to the present bedding at an angle of just about 50°. The original schistosity may then have been parallel to that of the previously described specimen of mica schist, and the present bedding subsequently formed by heat and pressure at an angle. The difference of strike of the two schists, and of the veins occurring in them, is about 50°.

The Adjustments and Control of the Stamp Mill

By Prof. Courtenay De Kalb, School of Mining, Kingston, Ont.

In submitting this paper it is necessary to preface it by saying that I am not aware that I will be able to advance a single new fact or proposition, but a discussion upon even so hackneyed a theme as the adjustments of the stamp mill may prove of some value by calling the attention of millmen anew to the importance of guarding well the minute details of practice, and of adapting their treatment to the peculiarities of the ore with which they have to deal. This may seem so obvious a necessity that the mere statement of it may strike some of you as being superfluous. But against this I must urge in my defence that it is a comparatively rare thing to find a stamp mill either in its design or management exactly suited to the ore passing through it, except where a mining belt yields (as sometimes happens) practically identical ores over large districts, and where some millman of judiciously investigating habit has worked out his problem for the benefit of himself and his neighbors. But ores from mines in the same district, no matter how restricted, nor how similar may be their appearance and geological setting, are very seldom identical in character. They may even vary greatly at different points in the same mine, and the millman who ignores these variations, however slight they may seem, will find fluctuations in his extraction, for which in many cases there might be a simple remedy if he knew how to determine the right one and apply it.

The first error that is usually committed in faulty accommodation of the mill to the ore is chargeable to the recklessness of the mine owner in ordering " a stamp mill " from the manufacturer. He sometimes does specify the weight of stamps he desires, without as a rule having the remotest idea why he wants any particular weight, except that he frequently assumes that capacity is the great thing to strive for, and he reasons that heavy stamps (if not too heavy on his purse) must necessarily be superior, forgetful that in amalgamating mills there are two distinct capacities to be aimed at, viz., crushing capacity, and extracting capacity. The economical line between these two is the one that will be of the greatest importance to his company in the payment of dividends. But in ordering a stamp mill there are many considerations besides weight of stamps to be taken into account, such as the width and depth of the mortar, length of feed hole and character of automatic feeder, number and positions of inside plates, shape of discharge lip, slope of screens, etc. These are points which cannot be guessed at if the highest practical efficiency is to be attained. Obviously then a very considerable ore body should be in sight, not simply as a surface outcrop, but well explored below ground, so that its character may be fully known. The next step should be to make practical mill tests on average lots of the ore, the *average* involving not only value, but character of the ore. One mill test will commonly be insufficient to determine the design of mill required. If the extraction is well above 90 per cent. of the gold available by amalgamation the test may be regarded as ample so far as the mortar and stamps are concerned. The millman should then by careful attention to the finer adjustments reach a very high extraction. But if the test falls below 90 per cent. of the gold which should be saved by amalgamation, samples, identical with those first tested, should be experimented with in another mill of different design as to details of mortar, etc. If the difference in the design of the two mills was considerable, very useful deductions may be drawn from these tests. Manifestly such testing as this is expensive, and the outlay may amount to no insignificant percentage of the cost of the mill finally ordered, but the propriety of incurring such an expense should not be judged of on that basis, but rather as compared with the loss in gold which would have gone irretrievably to the tailings dump had not these precautions been taken.

Although the design of mortar is a subject apart from that under discussion in this paper, it may be briefly pointed out that the two chief considerations are its width, measured at the discharge lip, and its depth from that line. Depth can be modified to a considerable extent by the simple device of chuck blocks, but width is absolutely fixed. Other things remaining the same, increase of width reduces scour on inside amalgamating plates, and lowers crushing capacity, or, what comes to the same thing, it lessens the discharge of relatively coarse material. Thus to some extent it increases the amalgamating power of the mill, more particularly on account of the improved efficiency of the inside plates. If the greatest possible amalgamation of gold is sought to be accomplished inside the battery it is always safer to err on the side of width than narrowness, for the millman can accomplish more by his adjustment with a relatively wide mortar. Likewise regarding depth it is safer to adopt a shallow instead of a deep mortar, for shallowness can be remedied, but its opposite imposes an unalterable condition. Depth favors fine crushing and high amalgamation at the expense of capacity.

The length of feed-hole is also important. Many mortars are now made with a feed-hole little more than one-third the length of the mortar. This imposes a concentration of the feed at the central stamp. This can scarcely be regarded as other than a serious defect in mortar design. Though differences of opinion exist upon this matter, it can hardly be questioned that the central feed results in a preponderance of ore under the central stamp, and though this is soon worked off to the sides this stamp is, during a large part of the time, falling a less distance with each drop, thus reducing its crushing efficiency, and thereby lowering the output of the mill. The ideal condition is a uniform feed to each of the five stamps of the battery, and if the ore fed is previously reduced by rock breaker to a proper degree of fineness, so that the legitimate work of the rock breaker is not imposed upon the stamps, there should be no trouble experienced with banking of ore at the battery ends. In passing it may be noted that, for purposes of amalgamation, the proper size of ore to be fed should be determined by experiment. Capacity is of course increased by feeding smaller stuff, and this may result in decreased saving of gold, but the remedy for this, up to a certain point, lies in those adjustments which either limit capacity, or, while hastening barren gangue through the screens, retain the gold longer in the battery. Where the gold in the free state is not exceedingly fine, such adjustments are easily possible. In any case, since the manner of feeding plays an important part in the efficiency of the stamps, there would seem to be no reason why a mill should be tied to a central feed, since central feeding can, if found desirable, be accomplished just as well through a long as through a short feed-hole.

The weight of stamps, another fixed condition, should be carefully considered. The crushing power of the stamp depends partly on its weight, and also, other things being equal, on its momentum. Now there is a practical limit, which is a very narrow one, for the height of drop of heavy stamps. A lighter stamp with higher drop will acquire a momentum which will develop equal crushing capacity. While of course the element of time enters into the calculation, this sinks into comparative insignificance where the difference in height of drop is no more than two or three inches, and the greater flexibility as regards adjustability of a mill which has a possible range of say 4 inches in drop as against a mill with a range of 1½ to 2 inches is an advantage of no small consequence. An 800 lb. stamp has all this in its favor over a 1,000 lb. stamp. There are undoubtedly many cases in which the greater weight is desirable, but the working conditions of such a mill are so much more limited that its adaptability to the ore should be very definitely known before venturing thus to tie the hands of the millman. Where doubt exists lighter stamps should be chosen.

As mills are commonly constructed, the slope of the screen is also fixed. The vertical position is rarely adopted, and for a good reason. It is perhaps the crudest and least economical method of limiting discharge from the battery. Screens should be set sloping, and the angle should be capable of a certain amount of adjustment. There would be no difficulty in effecting a tight seal around the edges of a screen under such circumstances, and the millman would thus be enabled to adjust his discharge to the quantity of water used with far greater nicety, giving him added control over the fineness of crushing.

The adjustments of the mill are, height of drop, number of drops per minute, height of discharge, kind of screen and size of mesh, and quantity of water. The order of drop of the stamps is also a matter of importance.

The height of drop can be adjusted within certain limits, dependent upon the design of the mill. With an increase of height a longer time will be taken in falling, and a proper interval must be allowed for the rebound and settling back of the stamp before being again lifted by the cam. The speed should be adjusted to this, so that no more than the necessary interval is allowed in order that the stamp may perform its maximum duty. Prolongation of the period of rest, however, may be beneficial at times by permitting the heavier particles to settle, keeping them longer in the battery and thereby insuring a finer crushing of this material. If these particles contain gold, as is not unlikely to be the case, an increased saving by amalgamation will result. But care must be taken that such increased recovery of gold is not economically over-balanced by a reduction in total output of the mill. On the mechanical side the limits of this adjustment lie between a position of the tappet so low down on the stem as to incur the danger of "camming," and the opposite position at a height so great that the cam will not strike it until it has completed too much of its revolution, causing a risk of breaking the cam arm on account of the high speed at which the cam begins to lift the tappet. Further changes in the height of drop may be accomplished by substituting new cams designed specially to favor the object in view.

Height of discharge is to a limited extent independent of height of drop. The general practice in the best gold mills today is toward such a height of discharge that the stamp is never lifted entirely out of the water. This avoids any violent splashing of the pulp against the screens which not only retards the escape of the crushed ore, but occasions an undue wear of the screens. The regular pulsation of the pulp when working as above stated keeps the ore in suspension better than when the splash is violent, the coarser particles are not lifted so high above the dies, and the finer particles are afforded a superior opportunity to escape by the gentle flow of the waters over the screen surface. The resultant crushed product will be of more uniform size, and for the degree of fineness and crushing capacity sought, the inside amalgamation will be higher when this method is followed. In general it may be said that height of discharge should be increased in proportion as the ore contains either pyrites or harder portions of gangue locking up gold. On the other hand if the "sulphurets" are of such a character as to promote "sickening" of the mercury, lower discharge will be necessary.

One of the most delicate adjustments of stamp milling operations is in the quantity of water fed to the battery. It should be uniformly distributed to the several stamps, and not delivered at one point. There should always be enough to make a pulp sufficiently thin so that the stamps may keep all of the material in the battery in motion. Any tendency to banking is fatal to good work. Addition of water beyond this point facilitates rapid discharge. If there is a considerable quantity of gold in the softer portion of the ore, thinning of the pulp will so hasten its escape that losses may be occasioned. On the other hand, if the softer portions of the ore is relatively barren an excess of water will so effectually discriminate between it and the harder portion that it will be hurried through, leaving the stamps free to do their work where it will yield the larger economical results. As a general thing the quantity of water should be increased with greater height of discharge, but these two factors in milling should bear a relation to each other which should be very carefully determined for each individual ore in order to insure the maximum efficiency.

The slope of screen has already been mentioned. The difference of a degree will make a great difference in the rate of discharge. It will often make an even more important difference in the life of the screen. Very little dependence should be placed on the slope or the mesh of the screen for regulation of the discharge. This should be accomplished through other adjustments. The screen in a stamp mill, moreover, should not be regarded too much in the light of a sizing device. Regulation of size can be very neatly and accurately accomplished by suitable height of drop, height of discharge and quantity of water. If these are properly adjusted the screen should have comparatively little to do in sizing the pulp, serving mainly to arrest a relatively small amount of oversized stuff which has been thrown too high. This is particularly true where the stamps are set so as to drop in water instead of upon it.

Concerning the kind of screen and character of openings opinions and practice differ widely. It might almost be said that these have changed arbitrarily like fashions, with scarcely more justification. We have woven wire screens (the old standard), round-punched tin plate and Russian iron, diagonal slot and horizontal slot Russian iron and steel sheet, both punched and cut. The woven wire screen gives the larger area of open surface, and accordingly facilitates rapid discharge. Where the adjustments are so made as to depend least upon the screen for sizing, there can be no doubt that this is the best kind to adopt, for in such a case a very large amount of pulp thrown against its surface is presumably ready to be ejected. The flow of the pulp over a surface of this kind is also considerably retarded, which likewise promotes a free discharge. The outflowing pulp will therefore contain a relatively larger percentage of coarse material. Crimped steel wire is always to be preferred, except where the battery waters are corrosive from high acidity. Brass wire, and certain alloys, such as alluminium bronze, would then be found superior. These will absorb more or less amalgam, and the worn-out screens will ultimately be melted into bars and sold to refiners. The other forms of screen are manifestly used with a distinct view to their function in sizing the pulp. There may be cases where such sizing and restriction of discharge as they produce would prove more economical than the accomplishment of the same result by other means. The point is one to be decided with great care in each instance. The diagonal slot, ratio of open and blank areas being the same, will yield a faster discharge than the horizontal slot screens, and the cut metal will pass pulp more readily than punched or "burr" slot. It appears also that the "burr" slot is adapted only to mills where the stamps fall on the surface of the pulp, producing a violent splash. Round punched tin plate, which is usually prepared on the ground, is rarely advisable, except as a means of using up accumulations of suitable material which would otherwise go to waste. Round punched Russia iron is recommended by some manufacturers, and is used to a considerable extent in Australia, but the author has no knowledge as to its efficiency.

The order of drop of the stamps exercises an influence on the crushing capacity of the mill, on the amount of scour of inside plates, and on the wear of screens. For high amalgamation the order adopted most generally in the West is 1, 4, 2, 5, 3, and it is perhaps the best for all around purposes, though it has a slight tendency to crowding material somewhat away from stamp No. 1. Another good order is 1, 5, 2, 4, 3, which, however, tends to bring a slight excess of battery sands toward the middle stamps. The orders 1, 5, 2, 4, 3, and 1, 5, 3, 2, 4, both produce a very uniform distribution of sands in the battery, giving high crushing and discharging effect, at the cost of larger scour on inside plates with increased wear of screens. As an example of a bad order, 1, 4, 2, 3, 5 may be given, an order which rapidly tends to banking under stamp No. 5.

By control of the stamp mill is understood the maintenance of the same degree of pulverization, once the proper conditions have become established. Manifestly the mill must be adjusted to suit the ore, but on the other hand the ore must be adapted to the milling conditions. It is a great misfortune to have the ore which comes to mill frequently varying in character, so that either new adjustments must be made or loss allowed to take place. Such irregularities happen far more frequently than is necessary at many mines. The mine foreman can often adapt his work to the changing character of the ore (where the relative quantities of the different sorts of ore do not vary too erratically) so as to ship to mill at all times approximately the same mixture. Where the conditions of mining forbid such selective work the difficulty may be overcome, at least to an important extent, by crowding the production of ore ahead of the needs of the mill and "stocking" this in horizontal layers in large square or rectangular bins with flat bottoms. On removing the front of a bin thus "stocked" the material will fall down very uniformly mixed, so that the ore going to mill will present no wide differences in character.

To maintain the same degree of crushing it is necessary that the height of discharge lip above the die should follow the die down as it wears, which can only be accomplished by starting with chuck blocks under the screen so that these may be successively removed. The tappets will also require re-setting at intervals to preserve the same height of drop of stamps. Care must be observed likewise to prevent "cupping" of shoes and dies, that is, an unequal wear forming hollows and prominences. No mill is doing efficient service where "cupping" is permitted. The remedy of course exists in shifting the dies methodically so as to insure a uniform wear. There is always a tendency to slipping of tappets on the stems which should be watched. The use of set screws for attaching tappets has been almost universally discarded in favor of gibs and keys. When properly tightened up they will rarely slip, but the danger must not be overlooked. The rotation of the stem is supposed to promote uniform wear of shoes and dies, but its importance is perhaps somewhat over-estimated. Still, as stamps are made to be revolved, it is the duty of a careful millman to see that they do so, and that they do it uniformly. The number of lifts for one revolution of the stem depends mainly upon the lubrication of the cam arms, but, in general, things are assumed to be going well when one revolution is accomplished in from six to ten lifts. A tendency to a reverse rotation on dropping, if occurring with each drop throughout the revolution, indicates unequal wear of the stamp guides, which means that the stamp is not falling perpendicularly, and hence is not giving its full crushing effect If the tendency to reverse rotation occurs during only a part of the revolution it indicates serious "cupping," which the millman should have discovered previously.

Difficulties in crushing are too commonly ascribed to some peculiarity of the ore, and the millman is thus allowed an easy escape from responsibility. The fact is that all ores crush practically alike, so long as the crushing conditions remain unchanged, granting that the material is discharged as soon as it has been reduced to the requisite degree of fineness. Bearing this in mind, it is easy for the millman to make his adjustments so as to produce the requisite results. The matter of course is complicated by the necessity of securing a high inside amalgamation of gold, and there is altogether too great a tendency to neglect the possibilities of amalgamation in the stamp mill, and resort to devices for outside amalgamation, which are frequently less efficient, and add largely to the costs of extraction. The stamp mill should be looked upon as primarily a combined crusher and amalgamator. As a crushing machine it is mechanically crude, and wasteful of power. For simple crushing there are appliances far more efficient, particularly where large quantities of ore are to be treated. But in its proper sphere the stamp mill has no rival, and the exceeding delicacy of the adjustments possible for the production of specific results will be hard to attain by any other machine.

As a single example of what may be accomplished by slight modifications, the author may cite a test made some time ago in his own

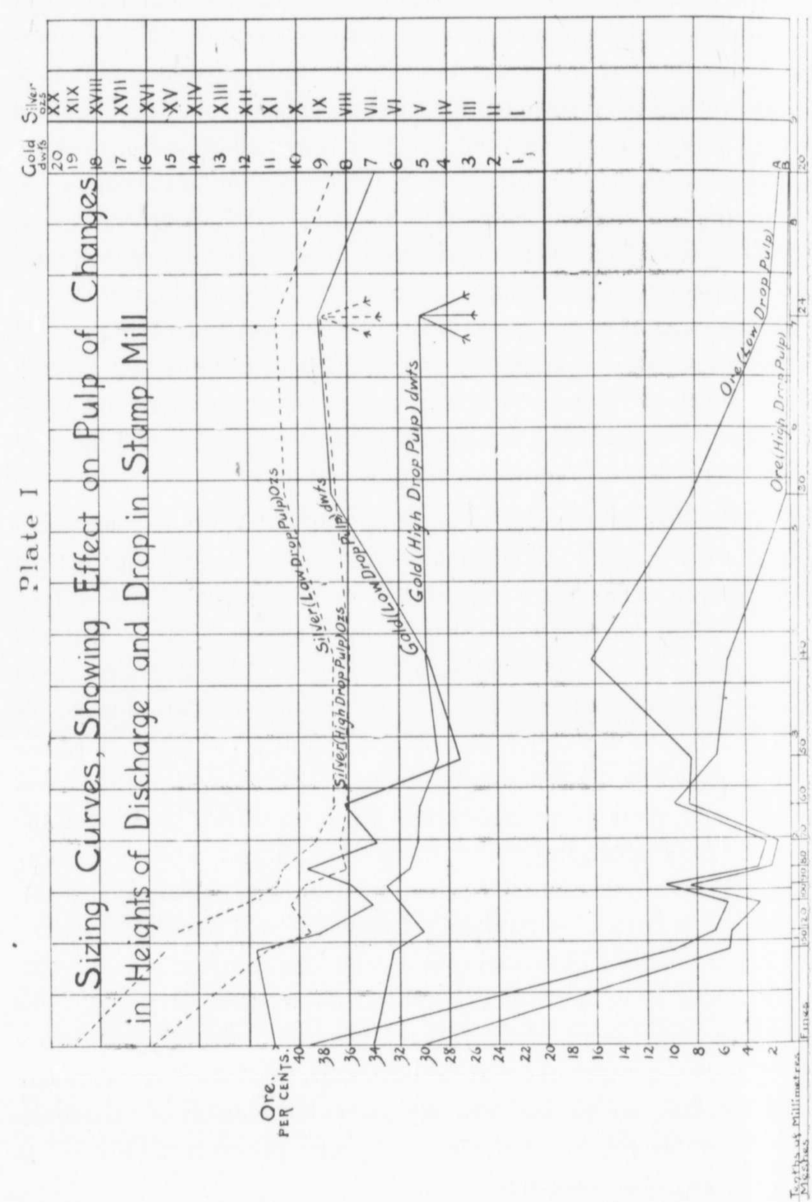
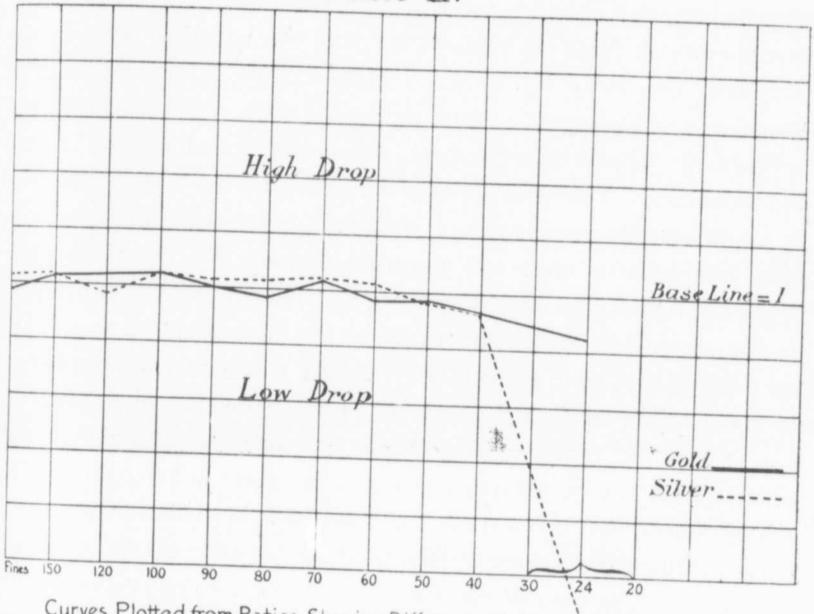


Plate I
Sizing Curves, Showing Effect on Pulp of Changes
in Heights of Discharge and Drop in Stamp Mill
Gold dwts
Silver ozs
Ore. PER CENTS.
Silver (Low Drop Pulp) ozs
Silver (High Drop Pulp) ozs
Gold (Low Drop Pulp) dwts
Gold (High Drop Pulp) dwts
Ore (Low Drop Pulp)
Ore (High Drop Pulp)
Fines

Plate II.



Curves Plotted from Ratios Showing Difference between High Drop, High Discharge Pulp and Low Drop, Low Discharge Pulp, as to actual quantities of Precious Metals remaining in different sizes of Pulp.

practice. The ore was being crushed for subsequent treatment by the cyanide process. The height of drop was 6 inches; height of discharge $5\frac{1}{2}$ inches; 102 drops per minute, with copious (but unmeasured) water supply; stamps weighing 850 lbs.; screens used, No. 20 mesh. A battery was set so that the stamps dropped $7\frac{1}{4}$ inches, with discharge $7\frac{1}{2}$ inches, and the water supply slightly reduced. The accompanying sizing curves show the difference in the character of the resultant pulp, curve A representing that produced originally, and curve B that obtained after making the changes mentioned in adjustment. It will be seen that in curve A 35.48 per cent. of the pulp was included between the sizes from No. 20 to No. 50 mesh, while in curve B this has been reduced to 12.61 per cent. Again in curve A only 28.83 per cent. lies between No. 50 and No. 150 mesh, which has been increased in B to 47.68 per cent. The ratio between the sizes on Nos. 50 and 150 mesh is approximately as 2.49 : 1, a difference quite wide enough. The more this ratio is increased the more densely will the sands pack in the leach tanks, thus opposing a free percolation. When the quantity on No. 40 mesh is large, with a ratio to No. 150 mesh ore as 4.02 : 1, the difficulties of good extraction by cyanide are increased. The excess of fines, amounting to 8.36 per cent., is not as deleterious as might at first appear, for subsequent treatment has shown that about 70 per cent. of these can be separated in a granular and leachable form. It is worthy of note that such a result could not have been obtained by using finer screens without greatly lessening the capacity of the mill, and causing excessive wear of the screens themselves. The product, moreover, would have been dissimilar. To further show what has been accomplished in this case ratios were computed in which the comparison is made between the two methods of crushing, taking into account the assay values of each size of pulp and the total weight of ore of the corresponding sizes. Thus we are enabled to compare the actual amounts of precious metals going with each size of pulp. For convenience in plotting, to the ratio $\frac{1}{x}$ in each case x is increased by 1, making the ratio $\frac{1}{x+1}$. The results are presented graphically in Plate II.

TABLE showing Effects Produced by changing from Low Drop and Low Discharge to Higher Drop and Higher Discharge in Stamp-Milling the same Ore.

Meshes.	Corresponding size of grains, millimeters.	Per cent. of Total Ore remaining on each Screen.		Assay Results.				Ratios of Actual Amounts of Precious Metals in each grade of Pulp between High & Low Drop Pulp.				
				High Drop.		Low Drop.		Excess on High Drop Side.		Excess on Low Drop Side.		
		High Drop.	Low Drop.	Gold. oz.	Silver. oz.	Gold. oz.	Silver. oz.	Gold.	Silver	Gold.	Silver.	
20	0.85	.01	0 88	......	....	0.34	8.51	......	......	}		
24	0.708	.04	1.96	0.25	8.98	0.455	10.70	......	......	} 1/6.06	1/40.82	$\frac{1}{x+1}=\frac{1}{7.06}$ and $\frac{1}{41.82}$
30	0.535	.26	8.16	......	....	0.43	10.44	......	......	}		
40	0.374	5.96	16.14	0.245	7.875	0.235	8.565	......	......	1/2.61	1/2.49	
50	0.279	6.34	8.34	0.22	8.105	0.175	8.665	......	......	1/1.04	1/1.40	
60	0.232	9.70	8.54	0.255	8.04	0.405	8.58	......	1/1.06	1/1.35		
70	0.197	2.37	1.21	0.26	8.29	0.345	9.275	1/1.45	1/1.75			
80	0.171	3.10	1.96	0.28	8.105	0.485	10.615	......	1/1.20	1/1.09		
90	0.155	10.54	8.62	0.325	9.80	0.40	10.81	1/1	1/1.10	1/1		
100	0.139	5.58	2.90	0.30	10.29	0.355	12.195	1/1.62	1/1.62			
120	0.110	6.57	5.25	0.25	9.49	0.455	14.93	1/1.45	......	......	1/1.26	
150	0.093	9.82	5.35	0.31	11.33	0.585	15.385	1/1.02	1/1.35			
Finer than 150	....	39.55	30.19	0.35	15.95	0.50	19.135	......	1/1.09	1/1.05		
Totals..	....	99.84	99.50									

Gold Mining in Nova Scotia from 1860 to 1899.

—

By Dr. A. R. C. Selwyn, C.M.G., late Director Geol. Survey of Canada.

In the Geological Survey Progress Report, 1870-71, this subject was fully treated both from practical and theoretic aspects. The former embraced mechanical and metallurgical appliances then in use ; average yield of gold per ton and the great loss in the tailings ; the latter the geological age, the general character and the probable depth and permanence of the veins and their origin. Also the probable occurrence in Nova Scotia, if properly sought for, of rich alluvial deposits like those of Australia, California and British Columbia.

Apart from the adoption of improvements in mechanical appliances and metallurgical processes, there does not seem to have been any marked or substantial progress made during the past quarter of a century and we find that the yield of gold from Nova Scotia ores thirty years ago, in 1867, was more than it was in 1896, viz : 27,314 ozs. in 1867 and 26,112 ozs. in 1896.

In the Geological Survey Reports of Progress above referred to, practical recommendations were made by which the production of gold in Nova Scotia might be largely augmented. Again in 1871 Professor H. Youle Hind addressed a very detailed and exhaustive report in seven chapters to the Chief Commissioner of Public Works and Mines, in which similar recommendations were made. In a paper by the same author read before the Society of Arts, London, 25th May, 1870, the subject was discussed, and even now, in 1899, the remarks then made by Mr. Sopwith and the Chairman, the late Sir Warrington Smith, are still largely applicable to gold mining in Nova Scotia. Mr. Sopwith said he had just returned from Nova Scotia and he could to the utmost corroborate the statements made by Professor Hind as to the manner in which gold mining was conducted there.

One of the most important points in any large gold producing country was the treatment of the tailings and arsenical pyrites from which the gold is more difficult to separate than from any other metals with which it is found combined. He might mention that in the Montague mine, which is one of the most interesting in the Province, and is near Waverley, there were found in the foot-wall of the lode masses of arsenical pyrites, about the size of two fists joined together, at very short intervals, and this really amounted to a very considerable portion of the lode, which was only two inches thick. It was very probable that this pyrite would give from £80 to £120 per ton. Sir Warrington Smyth said that it appeared quite certain that there was throughout this district—Nova Scotia—a sufficiently large portion of gold extending throughout these quartz ore deposits, whether bed or veins, to pay well for mining enterprise, and the question might therefore be asked: Why had it not succeeded better?

For a number of years only 600 or 800 men had been engaged in this work, but only a few mines had been successful. Was it not possible instead of these 600 or 800 men to employ 6,000 or 8,000 or even more in raising gold ores, to the advantage of all concerned?

Undoubtedly it ought to be so, for there was no doubt that in Nova Scotia there was a gold field such as was seldom to be met with, and there ought to be machinery and appliances brought to bear on it such as would ensure a very handsome return to capital invested in undertakings such as this, intended to last over a long series of years. This was really a point of almost Imperial importance, for it appeared that up to the present time the auriferous resources of the country had been developed to a pitifully small extent; and no doubt this was because the undertakings had been conducted by persons unprovided with money or with the intelligent guidance which it might be presumed they would have had if the matter had been taken in hand by persons better provided with money, without a good supply of which nothing can be successfully carried on. He could not help remembering, when mention was made of the large quantities of ore which had been stamped or crushed in order to extract the gold that it was not above two-thirds of the quantity that one single tin mine in Cornwall was in the habit of stamping per annum. This showed that the work in Nova Scotia had not been undertaken upon such a scale as to render any great success probable. Mr. Robinson remarked on the number of shafts sunk to extract quartz from a lode 1,500 feet in length. Now it must be remembered that these remarks were made in 1870, and with a few exceptions, as the mill at North Brookfield described at page 179 of the May number of the MINING REVIEW, are still very largely applicable and we may still ask why, in such a gold country as Nova Scotia are there so few people (only about 4,000, according to late statistics) employed in this industry, and why, after more than thirty years of work, is the quantity of ore treated still so small and the yield of gold no larger than in 1867? and this notwithstanding that the number of tons treated has more than doubled—31,385 tons in 1867, and 65,673 tons in 1896.

The answer is not far to seek or very mysterious. It may be summarized as follows:—

1st. Want of attention to the recommendation of such scientific and practical writers as: Marsh, 1861; Stillman, 1864; Selwyn, 1869; Hind, Sopwith, and Warrington Smyth, 1870.

2nd. The poor system of mining, always giving way to the temptation to carry out a hand-to-mouth policy, than which nothing is more effectually ruinous to successful mining. Paying all the proceeds out in wages and dividends, by which the manager soon finds himself with an empty treasury and an exhausted mine; while the stockholders, looking only for dividends, refuse to put np the money necessary to develop new "ore grounds," matters are at a dead lock and the mine is closed. This has been the frequent history of gold mining in Nova Scotia. Good reserves of capital and the unremitting exploration for new ore ground is the only remedy. The amount and richness of ore ground in Nova Scotia is such that disaster can follow only from a gross neglect of the fundamental principles of all good mining, that exploration must precede extraction and payment of dividends.

3rd. Want of reliable assayers and metallurgical chemists connected with the mine.

4th. The entire neglect of tailings and pyritous residues, which as stated by Sir Warrington Smyth, often contains a very large percentage of the total gold contents of the vein.

5th. No systematic attempts to follow up and develop the discoveries of alluvial gold. In Professor Stillman's report we find the following statement respecting this matter :—

"The alluvial detritus in the bed of Copper Lake near Tangier has been found by experiment to yield not less than $122.00 to the ton. Thirty-three thousand tons of this soil are computed to exist in the bed of this lake. The Boldue lot at Sherbrooke has yielded a considerable amount of gold from the glacial drift and is rewarding its owners handsomely. Probably too little attention has been given to this source of gold, the quartz veins alone having been the chief object of attention."

The reasons that have been given by theorists for the absence of alluvial gold deposits in Nova Scotia have prevented any intelligent and systematic efforts to find it. The long, narrow lakes in Nova Scotia certainly represent the dry "flats" and "gullies" in Australia and there is not much doubt that many of these lake beds will prove, if properly tested, rich in alluvial gold. It is utterly incredible that none of the detritus from the richly auriferous quartz veins and leads of Nova Scotia, which must have accumulated in tertiary, post tertiary and preglacial times, as it has in all other countries, in the existing depressions of the surface, whether these are valleys, river channels or lake basins, should not still remain in parts of these depressions as they do in British Columbia, Quebec, California and Australia. Whether these depressions are creeks, dry, grassy flats as in Australia, gulches or lake basins in no way alters the conclusion that alluvial gold in paying quantities must exist in Nova Scotia as it does in all the other countries named.

That gold can be profitably mined as at Bendigo, Australia, to a depth of 10,000 feet is now proved, and there is certainly no reason why similar depths should not be profitably exploited on the quartz veins in Nova Scotia. That such depths could and would be profitably worked in Australia was predicted by the writer in 1853, when about 600 feet was the deepest quartz mine then worked in Australia, the yield from which seldom exceeded 10 pennyweights to the ton.

In connection with alluvial gold in Nova Scotia reference may be made to pages 276 and 277 of the Geological Survey Report of 1870-71, where the writer's opinion is fully stated. No actual discovery of gold in Nova Scotia was known to have been made in 1855, the date of the publication of Sir W. Dawson's "Acadian Geology."

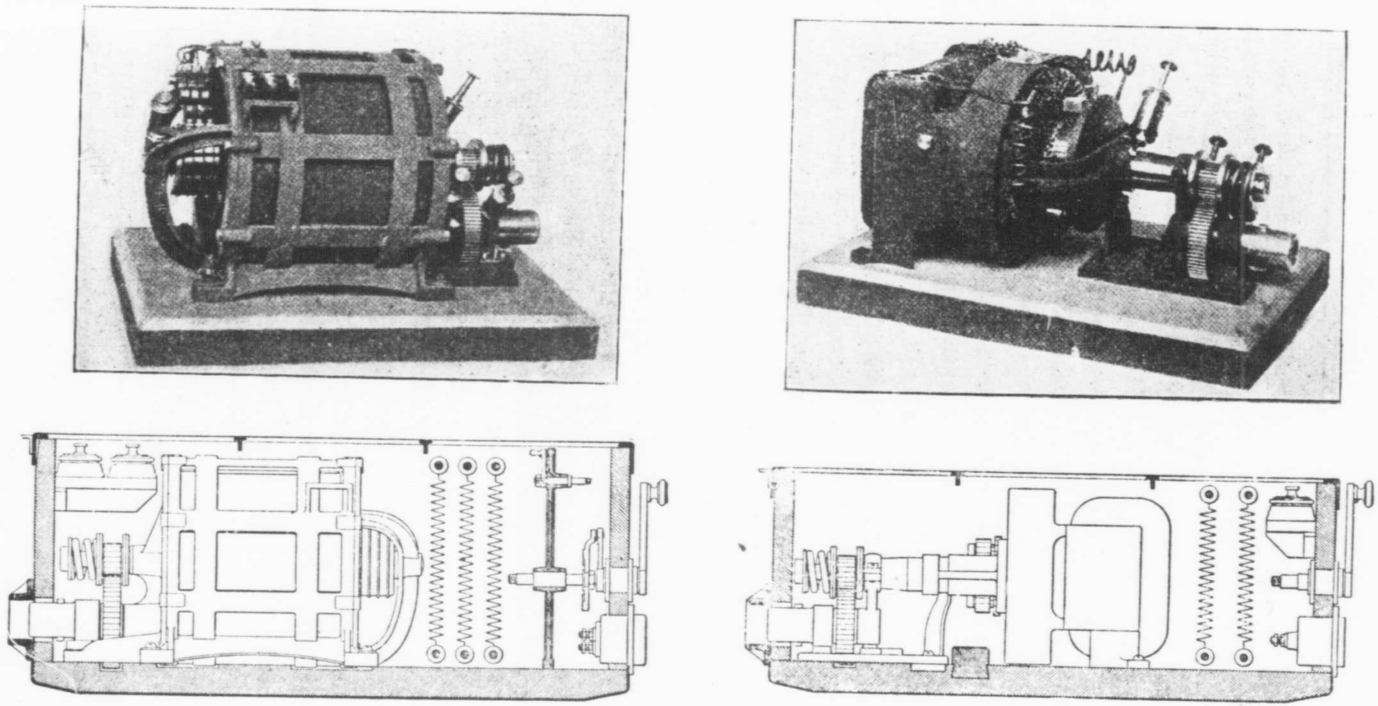
Electric Transmission and Electric Drills for Mines.

—

F. Hille, M. E., Port Arthur, Ont.

When we see that in the neighborhood of a number of our mines the fuel supply for motive power is, or is nearing to become, a question of grave concern, and that this is heightened through the burning off of valuable timber by careless and unwise men, or through accidental igniting of the dry bush by the sparks of the locomotives, or even through lightning in the course of thunder storms, then we are very vividly reminded to look for another medium that can drive the machinery and apparatus in our mines. Now what can impress itself more quickly on us, than the numerous falls of our creeks and rivers whose roaring and thundering has become to many of us who roved around this country so often, a familiar music, and which has lulled us many a night into the arms of Morpheus. How often has that little dream god shown us these wild rushing waters harnessed into useful occupations, and how long will it be ere these dreams materialize, and we shall see every one of these at present useless spending powers utilized for the benefit of one or another of our industries? But before I proceed with this subject I take this opportunity of warning our people for this vandalic destruction of the forest by fire, or we shall experience the consequence, that in a few years most of the little creeks and rivers, and with them the lakes small and large, will dry up, and we would be deprived of the present very convenient way of travel and the cheap medium for power. One who has known this country for years has seen with regret the diminishing and disappearing of many of our water courses. Even Lake Superior is lower by nearly twenty-four inches since I first knew it, and this is principally caused by the burning off of the forest.

I mentioned above that we have numerous falls in our country from which we could derive motive power, and I do not exaggerate when I say that I know of nearly an hundred in the districts of Rainy



Direct Current Motor.

River and Thunder Bay, some of considerable size and beauty. Many of them are right in our gold mining region, others in close proximity, and others again farther off, but many so conveniently situated that they would not cause a great outlay of capital in transmitting the electricity profitably to the mines. We all know that distance is now-a-days no great obstacle any more since improved machines and a better insulation are at our disposal. Even as early as 1891, at the time of the Frankfurt electric exhibition, the first long-distance power transmission of 110 miles in length proved a success, for the loss was only 26 per cent., although different pressures from 65 to 28,000 volts were tried; and now we talk of distances of 500 miles and losses of only 10 to 15 per cent. Distance has to be considered only, then, when the consumption of power in a mine is small and it is within easy reach of cheap communication. The question will arise then, if it would not be more economical and convenient to use a different motive power, produced either with gasoline, or better yet, refined or crude petroleum, for instance with a Diesel motor.

The advantages of long-distance transmission are specially noticeable when high voltages are transmitted for large industrial centres, or for the distribution of power among a greater number of mines, situated in close proximity, or for a mine far off from the sources of fuel. But, as I said above, it is very questionable if it will be always advantageous for a single mine to go to the great expense of establishing water power and transmit it from afar to the workings. This has to be determined in every instance by closely figuring all the different conditions. We have, therefore, to consider transmission for greater distances, and such for electricity generated at the mine. Now let us suppose for instance we needed a larger amount of horse power for different machines, and wish to sell our surplus power to others, and know we can get this power from a rather distant waterfall. We take also for granted that the utilization of this fall and the establishing of the primary motor—here the turbine or any other water wheel—causes no difficulty whatever; therefore, the next thing to be taken into account would be the dynamo, that is, has it to be a direct current, or an alternating current machine? Now we know we need a greater number of horse power, the distance is not inconsiderable, and we wish the current to do different work. In this case the only acceptable machine for us would be the alternating dynamo, because the direct current machine has a limited transmission of only about 2,000 volts, and this current cannot be divided in the manner we wish. This is different with the polyphase current which can easily be transformed into direct current of any strength which we might desire, or charged into as many motors as its pressure will permit us. I come now to the second question: the production of electricity by some other medium than water and directly at the mine. The building of dams, the laying of pipes, and the erecting of a power-house with all its machinery and other installations near a waterfall for the transmission of electricity over a long costly wire, is rather an expensive thing, and not every mine owner is in the fortunate position to indulge in such expensive enterprises. We conclude, therefore, to buy a Diesel Petroleum Motor which offers the most convenient and economic way to solve that problem. Also in this case the dynamo is a polyphase current machine, is coupled directly to the primary motor, and the generated electricity transmitted to the transformer and thence to the electric motors driving the various machines. This mode of generating electricity will prove in many instances more advantageous and economic than the first system, for, what we spent more in petroleum to run the motor, we save again in wages for attending to the different machines and line of wire, and also on interest of capital expended, and not less so on loss of time in repairing, in telephoning from the mine to the power house at the falls, and if I have a right to mention it, a saving of power in the shorter transmission. These are considerations of much importance which will, I have no doubt, decide in many instances the choice between the two systems of primary power, especially in places where railroad or water communications are near at hand and the freights reasonable.

A mine which is in the fortunate position of having electricity as motive power should make use of this advantage and drive with electric motors everyone of its machines or works. The great convenience which accrues out of such an installation is obvious when we consider the difficulty which we experience often in transmitting the power of

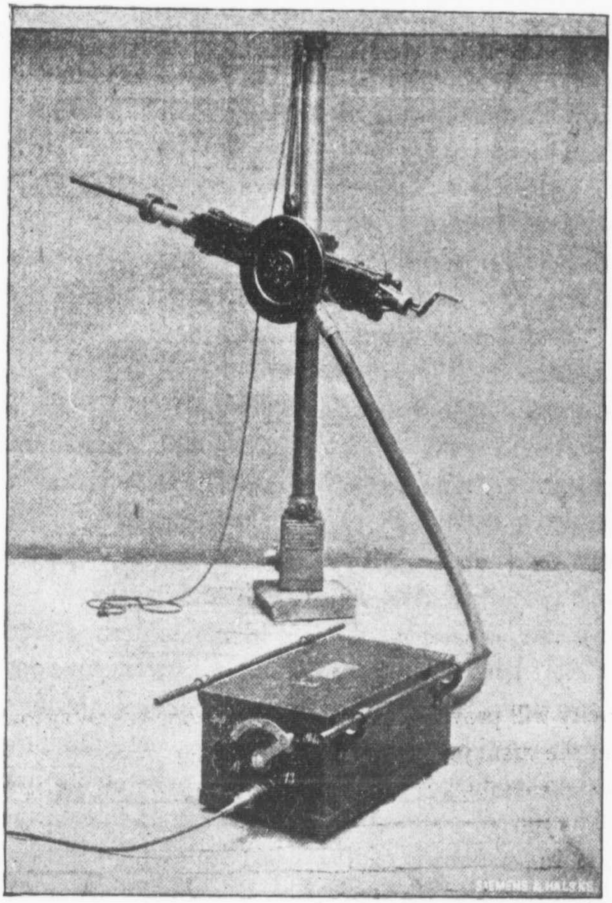


FIG. I.

Percussive Rock Drill with Electro-Motor.—The percussive drill is also worked by an electro-motor and flexible shaft, the action being maintained by means of a crank, a fly-wheel, and strong springs. The feed is generally given by hand but it can also be arranged for automatic working. Bits of the different lengths required can be put in and taken out at the back of the machine, so that any hole can be completely bored without shifting the apparatus. The axle of the machine is hollowed out for the purpose and the bits are held tight by a key. The percussive drill is intended for the harder qualities of rock; with an expenditure of 1 H.P. it will bore a hole of 1¼ inch diameter and 3 to 4 inches deep in the hardest granite or quartz in one minute. The maximum depth of the holes which can be drilled is 6½ feet. The drill is fixed to an hydraulic stretcher-bar, and is raised or lowered most readily by means of a block and tackle. The separate parts of the machine, viz., the drill, with stretcher-bar, fly-wheel, flexible shaft, and motor-box can be easily carried by two men.

FIG. 2.

Percussive Drill with Electro-Motor.—The mode of supporting the drill on a stretcher-bar as shown on the preceding page is useful for driving work in the mine, whereas the four-legged stand shown above makes the machine suitabl for over-ground work in quarries, and in connection with railway construction. The stand is so firm and rigid that that the drill can be worked at any angle.

the steam boilers and engines, be it steam, air, or rope transmission to our various mine workings. I might mention, however, that machines which need more than 50 h. p. would be better driven by a generator of their own, because the switching in and out of large motors would cause inconvenient differences of pressure in the main line and would affect the other motors to some extent. What advantage it is, but especially in larger works, to disconnect or switch out any machine or apparatus at any moment without being obliged to shift belts over loose or friction pulleys, nor being able to stop the humming and buzzing noise of the overhead shafting with its tangle of belts which are a constant menace to everyone's dear existence, not to speak of the great convenience to convey the power with ease from place to place and from any machine above or below ground to another.

Now I wish to direct your attention to one of these machines which has, strange to say, found in this country very little or no attention, although it deserves it very fully. It is this, an Electric Drill of a very ingenious but simple construction and of great efficiency. The reason that we have heard and read but little of it in this country, and even in the States, is that we are too indifferent in acquainting ourselves with what other nations do in the various industries, and this is especially the case in the mining industry. We patronize in many cases the home industry too much to the disadvantage of our miners and mines. To some extent it might also be attributed to the prejudice which seems to exist against electric drills on account of the poor success which the so-called Solenoid machines of Van Depoele and Marvin had. These machines were constructed after Werner Von Siemen's so-called electric hammer principle,* but soon abandoned by the latter. The principal fault of these machines was their inefficiency and weak return pull of the bit, although the consumption of energy was large, too large compared with the newer drills of Siemens and Halske. But even that earlier machine is surpassed in waste of power by the air drills so much in vogue at the present time. These earlier machines had the Solenoids—the motor—in the drill itself, which was a great disadvantage considering the shocks which they received with every stroke of the

* D. R. P. 9469, Oct. 22, 1879.

piston; besides, it became soon hot and lost on account of this a large amount of energy, that is, efficiency. Different is this with the newer percussion drill of Siemens & Halske. The motor is here separated from the drill and is connected with it by a flexible shaft of about 8 ft. long. This arrangement enabled the inventors to construct a more compact solid machine, but at the same time a more simple mechanism. The axis of the piston could be placed near the one with which it is fastened to the upright or tripod, therefore a more rigid position was secnred and a shaking when in operation was avoided. But to give the drill a still more steady working a fly wheel was fastened on the crank shaft of the machine, whose inertia would hinder the power-transmitting mechanism, especially the teeth of the cog-wheels, to clatter upon each other. Another good arrangement is connected with the machine—the piston rod for the drill steel is hollow throughout, therefore it is not necessary to change the position of the machine when a new bit has to be inserted. It can be done from the hind end by releasing the key with which it is fastened in its place. Further, the feed of the steel is on these machines either by hand or automatic, but always self-regulating according to the hardnesss of the material to be drilled. A jamming of the bit in the hole, which is with most percussion drills a very common occurrence, happens very rarely, for the return pull of the piston is so strong that on account of this and the powerful percussion the columns or stretcher bars had to be constructed especially strong, and instead of the common tripod, a quatripod, if you will permit me to give the four-legged stand (Fig. 2) that name, had to be provided for this percussion drill. In regard to the consumption of power this machine excels in economy every other percussion drill so far invented or in the market. A drill working with full capacity will use from 0.8 to 1.3 kilowatt, or six drills in operation will need 10 horse power of a steam or water engine, if the length of the transmission of power is not too great, and 12 horse power if it is great. It will drill a hole in the hardest rock from 1¼ in to 1½ in wide and from 2 in. to 12 in. deep in one minute. For instance, in very hard granite 3 in. to 4 in. deep per minute. There is not one percussion drill, steam or air driven, which could show such results, combined

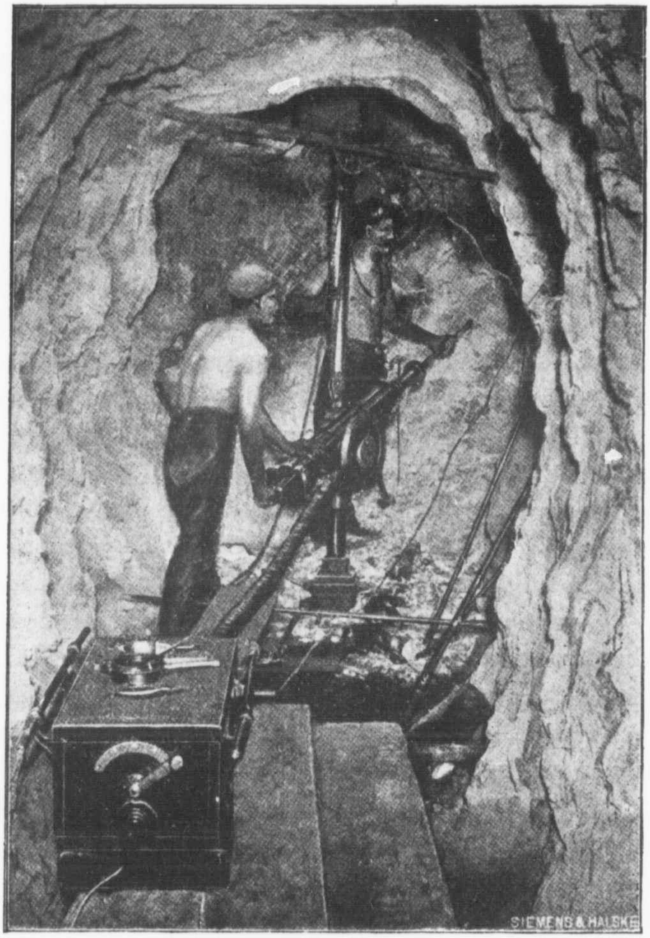


FIG. 3.

Percussive Drill at the Face, in use in the Ober-Gruna Mine near Freiberg (Saxony.)—This sketch and the following one shows a percussive drill at work at the face of a drive. The drill is fixed to a hydraulic stretcher-bar with blocks of wood above and below the latter to secure the utmost rigidity.

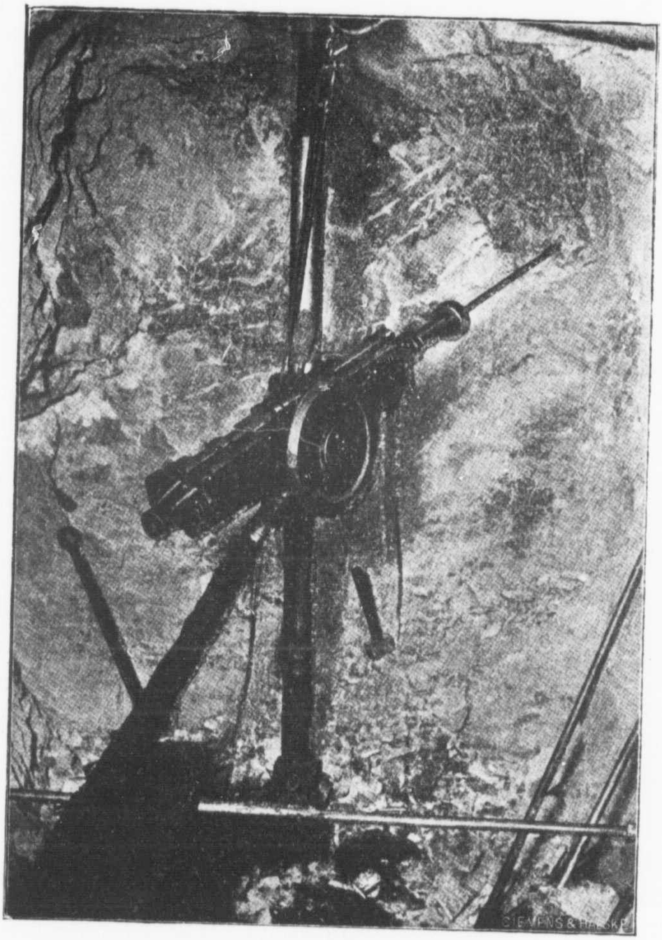


FIG. 4.

Percussive Drill at the Face, in use in the Ober-Gruna Mine near Freiberg.—The rock-drill itself is more clearly seen than in the preceding sketch. The block and tackle for raising and lowering the drill on the stretcher-bar are also shown.

with such economy. To make a comparison, only the largest size of air drill might be able to drill a hole of the same depth and in the same time above mentioned, but would need *6 to 8 times the power of one of the smaller electric drills.* The vertical depth drilled with this machine is 6½ ft., and the depth bored without changing bits is 16 in. with about 420 strokes per minute. The weight of the machine is about 240 pounds, and to raise and lower it on the stretcher bars with ease a small block and tackle is used for that purpose as seen in Figs. 1 to 3.

Besides the percussion drill the firm of Siemens & Halske manufacture also a "Rotary Drill." This machine, which is used for boring in rocks and fossils of a softer nature, is of simpler construction and lighter weight than the former. No fly wheel was necessary for this drill, because the drill barrel has only to follow the rotation of the flexible shaft, and the forward feed of the inner mechanism, which is automatic and self-regulating according to the hardness of the material to be drilled. The consumption of energy is with this machine as with the former, about 800 Watt=to one horse power, and will bore in rock-salt a hole $1\frac{6}{10}$ inches wide by 12 to 16 inches deep, or in saltclay, gypsum or oolitic iron ore, etc., 8 to 10 inches per minute. With two bit changes the machine can bore a hole of over 6 ft. Its weight is not more than 70 lbs., and breakage or parts showing wear and tear can be easily and quickly replaced by new ones. The construction of the stretcher bar or column can be seen in fig. 4 to be a very handy apparatus.

I have to say now a few words about the flexible shaft which connects the drills with the motor. This shaft consists of two parts; the outer protecting flexible tube is made of a steel wire spiral and surrounded with leather, while the inner, the real power transmitting part, is a very pliable apparatus made of a number of right and left wound conaxial steel wire spirals, provided on both ends with massive steel pins and couplings, with which they rest smoothly against the ends of the outer protecting tube, and connect firmly with the motor and machine. The whole shaft is very solidly made so that a rough handling in the workings will not injure it very easily.

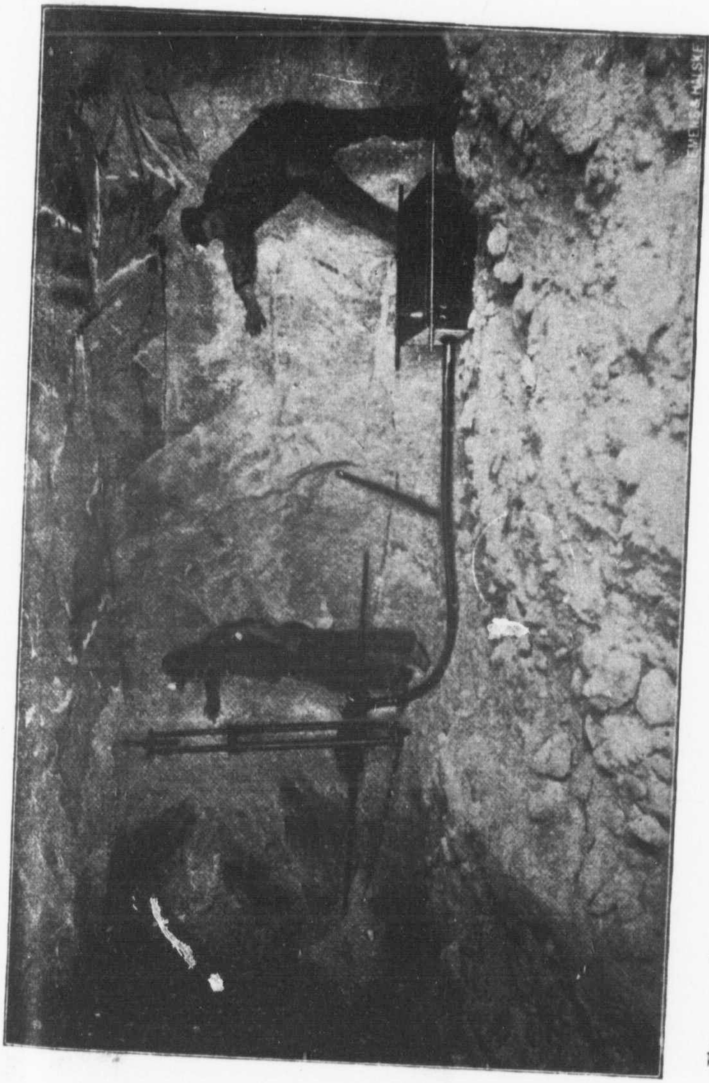


FIG. 5.—*Rotary Rock Drill with Electro-Motor in use in the Salzburg Mine at New-Strassfurt.*—The drill is fixed to the stretcher-bar in as simple a manner as possible so as to suit the small space between the floor and crown of the drive. The apparatus is worked by two men.

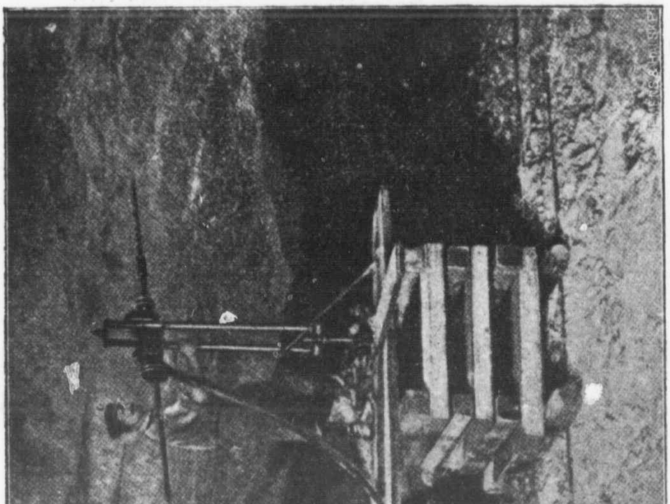


FIG. 6.—*Rotary Rock Drill with Electro-Motor in use in the Salzburg Mine at New Strassfurt.*—In order to bring the drill into position, a staging of wooden beams is used. The motor-box is on a trolley, so as to enable holes to be bored in the crown of the drive.

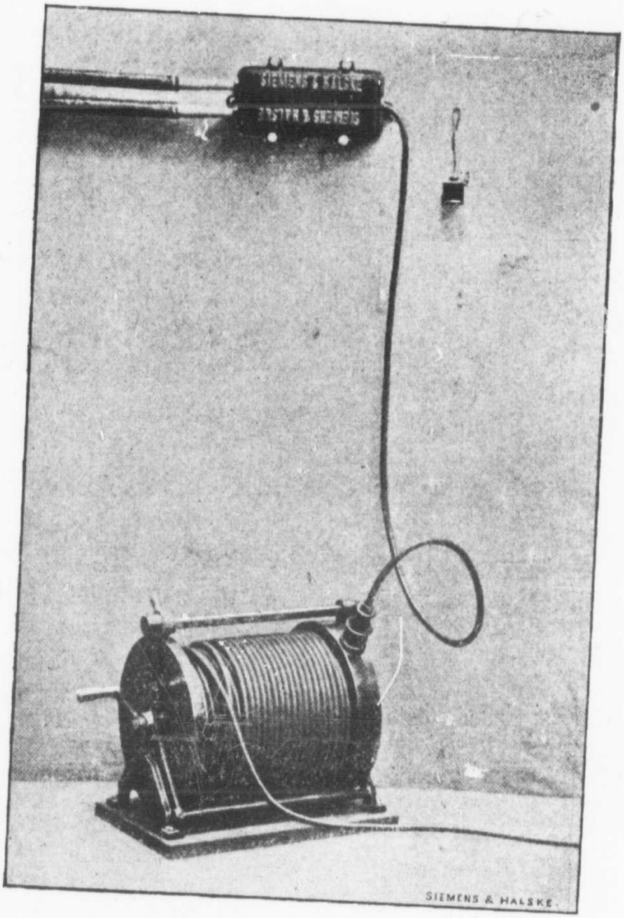


FIG. 7.

Cable Drum for Rock Drills with Electro-Motor.—The fixed conducting wires are connected with a joint-box secured to the wall near the place where the work of boring has to be done. A transportable drum holding about 65 yards of twin-conductor cable is put near the joint-box; the connection between the cable on the drum and the fixed wires is effected by means of a short length of double-conductor cable, having on its free end a union plug that fits into a corresponding socket on the flange of the drum. Before the shots are fired the cable can be wound back on the drum. As the work advances, the fixed conductors are lengthened and the joint-boxes fixed in a more forward position.

The next part we have to deal with is the motor, which is enclosed in a strong wooden box covered on the outside with heavy sheet steel, of which is also made the cover, strong enough to allow of a stepping or standing on it. The lower corners of the box are bevelled to bear a pulling over the rough floor of the workings. Attached to it are two handles for a convenient carrying from place to place ; also a lever for the starting or setting at rest the motor on whose sides the words "is going" and "is stopping" are marked, to avoid a mistake from the side of the drill men. There are further two openings on both ends of the box, one for the pin of the transmitting cable, and the other for the shaft to connect the motor with the drill. Fig. 5 represents the motor and schematic the inner part of the box, that is, the motor with its different parts in somewhat detailed form ; this is a direct current motor, while Fig. 6 is the alternating motor with its schematic representation in the box. Both are one-horse power machines and have equal advantages ; the efficiency is alike. Motor and box weigh only about 220 lbs, and are therefore easily carried by two men wherever they are wanted. It would go out of the scope of this paper to speak more in detail about these motors. I will only mention the transmission cable and the handy way it can be carried along in the workings. It is very heavily covered with rubber and strung along the roof or walls of the drifts or shafts, till it ends at a certain distance from the breast or bottom of the workings in a so-called connection box, Fig. 7. From the latter leads a shorter piece to a reel upon which about 300 ft. of cable can be wound, whose end connects with the motor This reel is light and can be easily carried by one man.

Now when we consider with what ease all the different parts connected with these drills can be carried from place to place, and compare it with the work that is necessary and the difficulty which exists in carrying the air or steam along in a mine, we understand readily the saving of time, but also the saving of expenses, especially when we compare the much greater efficiency of these electric drills with those of steam or air. It is, therefore, surely not to be wondered at that we could not work with the two latter systems cheaper than by hand. Some might say : "But see the advantage of the air drill in furnishing constantly a

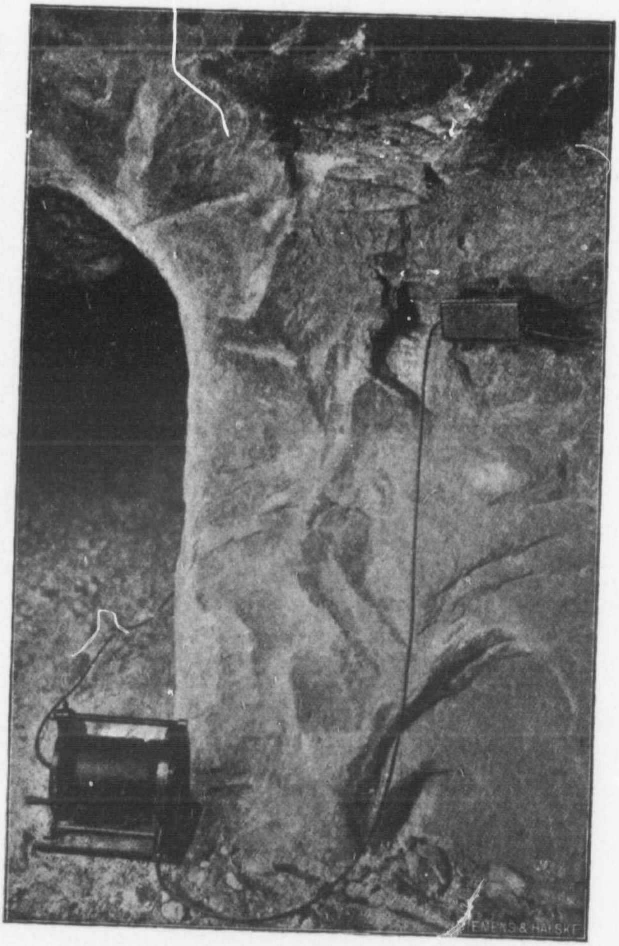


FIG. 8.

Joint-Box and Cable Drum for Electric-Drill as used in the Salzberg Mine at New-Stassfurt.—This sketch shows the mode of fixing the joint-box to the wall of the drive. The whole of the cable is unwound from the drum and led to the rock-drill, which is about 65 yards away.

certain amount of fresh air at the face of the workings." Permit me to reply, "that when we most need fresh air in these places, that is, after blasting, your fresh air is not there. If the air is so bad at the faces, provide in time for your air-ways, or lead a varnished tin tubing down to the workings and connect this overground with a fan or blower driven by a small electric motor. You have plenty of surplus power compared with the power consumption of the air drills" I ask you after what I have said above about the Siemens & Halske electric drills, in comparison with the other systems in vogue in this country, is a mine justified in using any other kind of drill than electric drill, if the motive power in that mine is electricity? I am sure every one of you gentlemen will answer negatively, because every one of you have the welfare and progress of our mining industry too much at heart not to sacrifice a certain predeliction for a dear, old, but antiquated machine which stands not any more upon the height of the progress of our present time. These drills are not by any means something new, or unproved. Ever since the beginning of the nineties these machines have been in in practical use and give complete satisfaction everywhere. Permit me to mention only a few places:

Rotary Drills—

In the iron mines of Stumm Bros., near Diedenhofen, Germany.
In the iron mines of the Société par Action des Usines, Luxembourg.
In the salt and potash mines of New Stassfurt, of Sondershausen, Germany, and of Ischle, Styria.
In the iron mines near Marcusfalva, Hungary.
In the silver mines near Aranyidka, Hungary.
In the construction of the Transbaikal R'y, Tiflis-Kars, Caucasus.
In the construction of the Transbaikal R'y, Siberia.
In the silver mines of Konsberg, Norway.
In the iron mines of Gellivare, Sweden.
In the gold mines of Island of Celebes, India.
In the coal mines of Laurahütte, Silesia, Germany.
In the lead mines of Silberg, Wesphalia, Germany.
In the coal mines of Colliery Courl near Dortmund, Germany.
In the iron mines near Unterwellenborn, Thuringia, Germany.
In the iron mines of Laurum, Greece.
In the silver and gold mine of Silverton, Colorado

These are only a few places where they are in operation, but as we see, they are already well known in different parts of the world. "Now let us go and do the same for our own and our country's advantage."

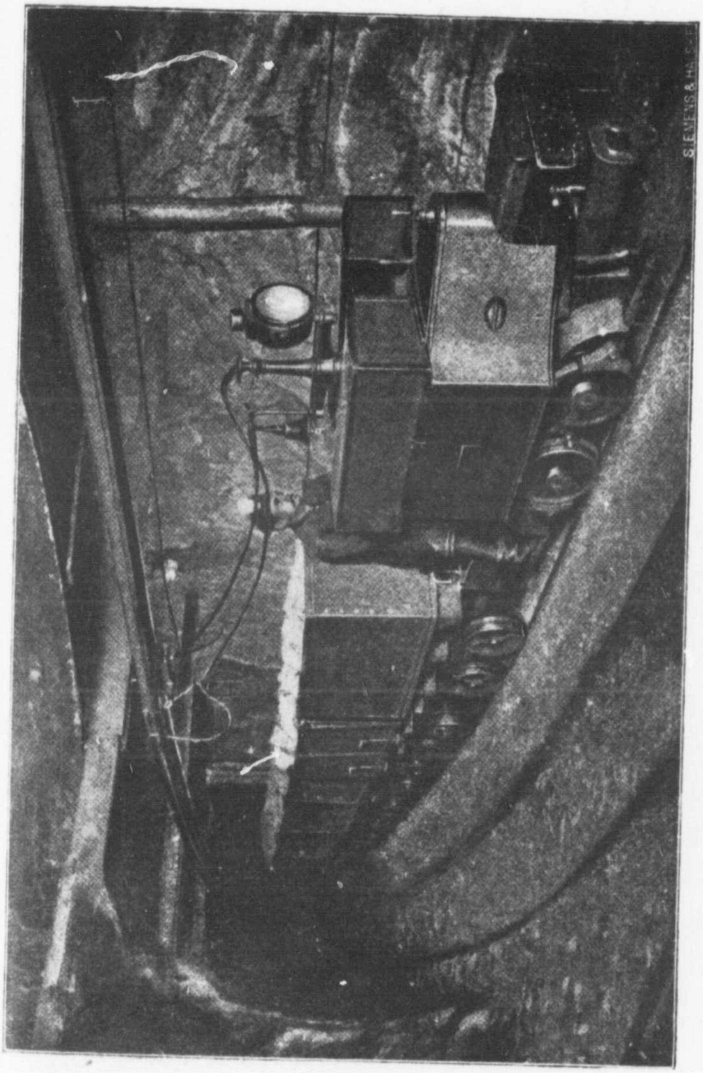


FIG. 9.—*Haulage by means of an Electric Locomotive in the Drive of the Salzberg Mine at New-Stassfurt.*—The axles of the locomotive are driven by a direct current motor of 15 H.P. Conducting bars or rails leading from the generator are supported by insulators fixed into the crown of the drive, and the current is taken from these rails and led to the motor by means of two travelling contacts.

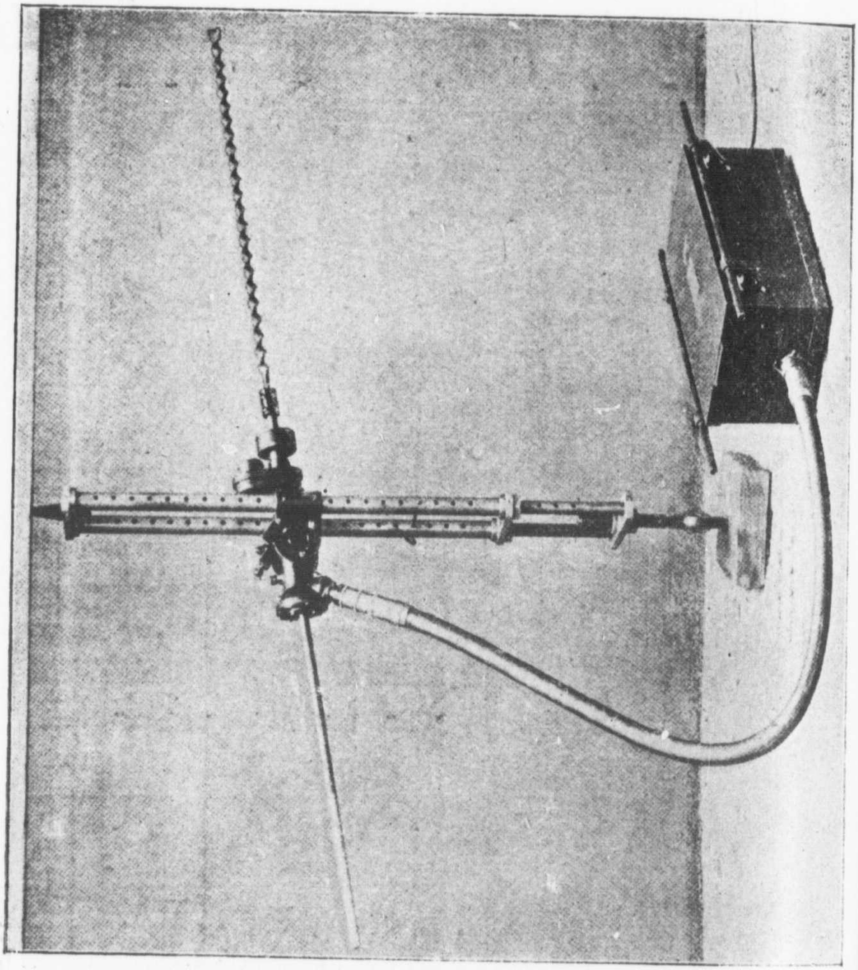


FIG. 10.

Rotary Rock Drill with Electro-Motor.—The drill which is carried by an adjustable screw stretcher-bar, is driven by means of a flexible shaft coupled to an electro-motor, the latter being enclosed in a stout box. The shaft can be readily uncoupled from the drill and motor. The motor-box can be easily carried by two men, whilst the drill with its stand and the flexible shaft form a load for one man. This drill is specially suitable for soft stone, such as salt, oolitic iron stone, &c. The feed is adjustable, automatic, and self-regulating. When two bits of different lengths are used, holes of more than six feet can be bored.

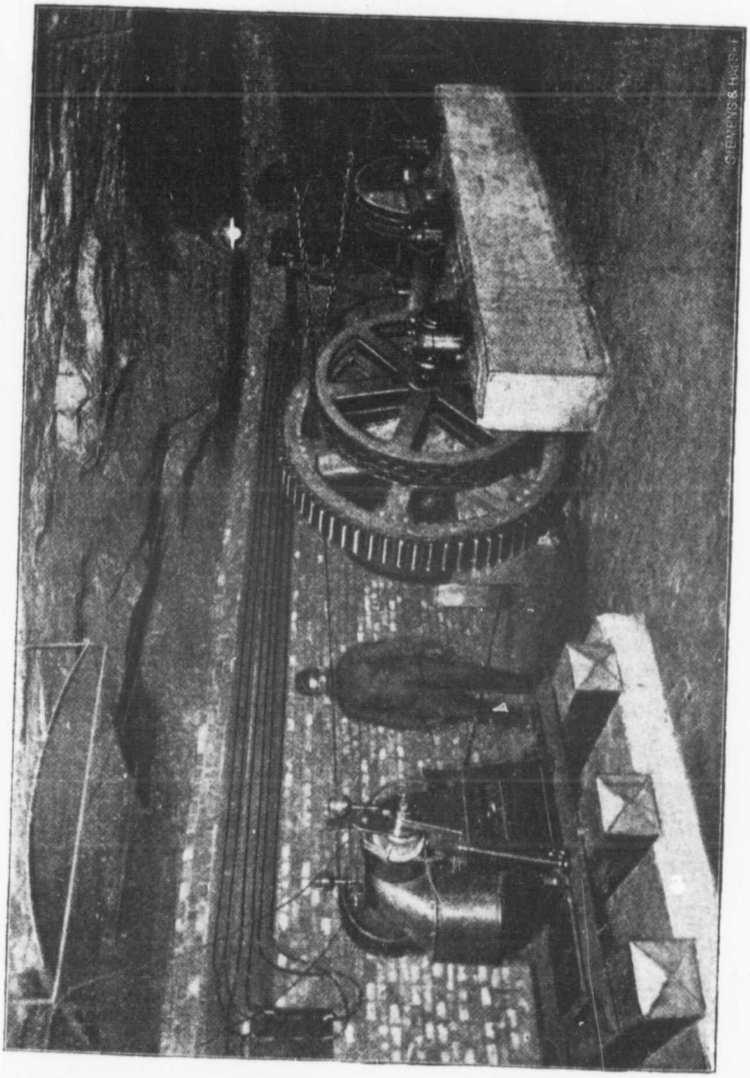


FIG. 11.

Chain Haulage Plant with Electro-Motor. In use in the Alkali Mine at Aschersleben.—The haulage machine is driven by an electro-motor of 35 H.P. The straining gear for the chain is in the same chamber with the machine. A shield of sheet iron is fixed above the motor to the crown of the gallery to ward off the drops of water.

On a New or Hitherto Unrecognised Geological Horizon in the Gas and Oil Region of Western Ontario, Canada.

By Henry M. Ami, M.A., F.G.S.

The formation or geological horizon in question consists of a series of fine-grained calcareo-argillaceous pyritiferous shales associated with bands of marine fossiliferous limestone which overlie the Portage and Genesee shales of Western Ontario. The shales of Kettle Point on Lake Huron have, up to the present, been recognised as the highest strata in the geological scale of Palæozoic sediments occurring in Western Ontario.

These shales have been referred to the upper division of the Devonian system and are well developed at Kettle Point, where they crop, owing to a gentle arch or anticline occurring at that locality in the Palaeozoic series. In Ohio and New York States they were recognized by Prof. Orton and Dr. J. M. Clarke, whilst Dr. Johnson has identified similar shales from the drift of the Chicago boulder clays.

The new geological horizon which overlies the Kettle Point shales as stated above is marine in origin. It contains a fossil fauna of not less than seven distinct species of organisms, with which I shall not deal at present as being outside the scope of this brief note.

These organisms mark a distinct period of encroachment of the old Palæozoic sea when marine sediments were laid down.

This formation which is probably part and parcel of the true marine Chemung formation so extensively developed across the lake in Michigan and again and better in New York State across Lake Erie, was reached by the drill at a depth of 600 feet below the surface. The superficial or Pleistocene deposits occupy but a fraction of the upper 600 feet and in them are found fragments of rock belonging to the Portage and Genesee shales underlying the hitherto unrecognised and unrecorded marine beds at this horizon in Ontario.

The shales which underlie this new formation when subjected to a close examination have revealed many interesting features, foremost amongst which is the presence of numerous examples of the macrospores *Protosalvinia Huronensis* described by Sir William Dawson in his "Report on the Erian Flora of Canada" in 1871. These macrospores from the bore-hole and drillings when examined under a microscope show very marked characters. They are thus described by Sir William Dawson (loc. cit. supra): "Macrospores in the form of discs or globes, smooth and thick walled, the walls penetrated by minute radiating pores. Diameter about $\frac{1}{100}$ths of an inch or a little more. When *in situ* several macrospores are contained in a thin cellular sporocarp, probably globular in form. From the upper Erian and perhaps lower carboniferous shales of Kettle Point."

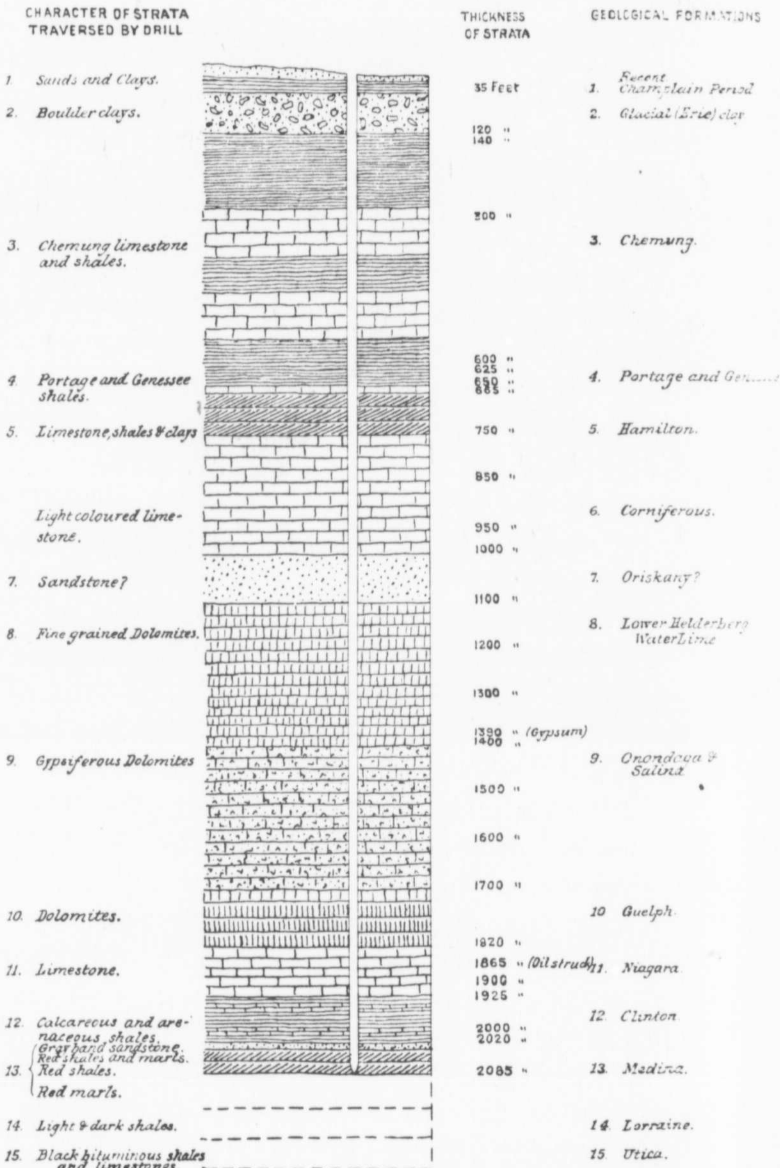
The Niagara and Clinton formations of the Silurian system and the Corniferous formation of the Devonian system, are the formations from which most of the gas and petroleum of Canada have hitherto been obtained in the Province of Ontario.

So far as I am aware, none of the oil or gas producing wells of Western Ontario derive their oil or gas from the Trenton formation of the Ordovician (Lower Silurian) system. (See discussion.)

That the Trenton formation of the States of Ohio and Pennsylvania is well known as a gas and oil-producing series of strata need scarcely be mentioned before this Mining Institute, and whilst in only one or two isolated instances the Trenton formation has been reached by the drill, nevertheless we venture to hope that before long wells sunk sufficiently deep to reach the Trenton formation, which underlies the Devonian and Silurian strata of the Huron-Erie peninsula of Ontario at a depth of some 3,000 feet, (more or less, depending upon the points of departure,) will reward the enterprising company which will make the venture.

It will be clearly seen that every few hundred feet of strata which overlie the gas- or oil-producing strata which are eagerly sought by the drillers makes considerable difference in the calculations as to the relative position and exact geological horizon indicated. From a very complete series of drillings recently received at the Geological Survey

SECTION OF WELL AT WALLACEBURG ONT.



Department from the County of Bothwell and placed in my hands by the Director for examination with a view to ascertain what geological formations had been traversed by the drill, I was able to ascertain very definitely just *where we were* owing to the presence of a large number of fossil organic remains detected in the drillings or small pieces and fragments not crushed to powder by the jumping drill.

And here let me make a suggestion which I hope will some day be carried out. In Western Ontario we need three or four typical log-sections from a diamond drill. The amount of money invested in our oil, gas, salt, gypsum, and associated industries and resources of the western peninsula fully justify such an expenditure. In examining drillings obtained from the jumping drill it is ofttimes a matter of considerable difficulty in eliminating the ever constant and recurring factors of error due to falling chips and broken fragments, reputed to come from certain definite depth, (but which from careful examination can be detected and to some extent checked,) especially when drillings are examined from the top downwards and not in the natural order of deposition of these formations, from the bottom upwards.

In the Bothwell drillings mentioned above, the new geological horizon was found to a depth of 600 feet, and below that and down to 670 feet the drill had struck and traversed the Kettle Point shales, charged with remains of *Protosalvinia (Sporangites) Huronensis* Dawson, which connects these Devonian formations of the Chemung, Portage and Genesee. The Hamilton shales and clays and limestones were then traversed and taking the drill down to a depth of nearly 800 feet, which amount, had the fossils not been obtained, would not have been reckoned from the *section* in that part of Canada and led to a grievous error in our calculations.

As it was, the drill traversed the above formations, then the Corniferous and the Oriskany (if present at all) through the lower Helderberg and Water Lime group consisting for the most part of fine-grained compact dolomites succeeded downward by the gypsum and salt-bearing dolomites of the Onondaga and Salina formations. The Guelph and Niagara dolomites and limestones were then traversed in the same succession or order as mentioned and the underlying Clinton shales likewise. At the last hearing and from samples received at the Department the "gray band" of the *Medina*—consisting of hard, dry, light gray sandrock—was actually struck at a depth of 2,035 feet, and lower down to a depth of 2,100 feet the typical red muds and shales of the *Medina* formation were being traversed, leaving no doubt whatever as to the geological horizon reached.

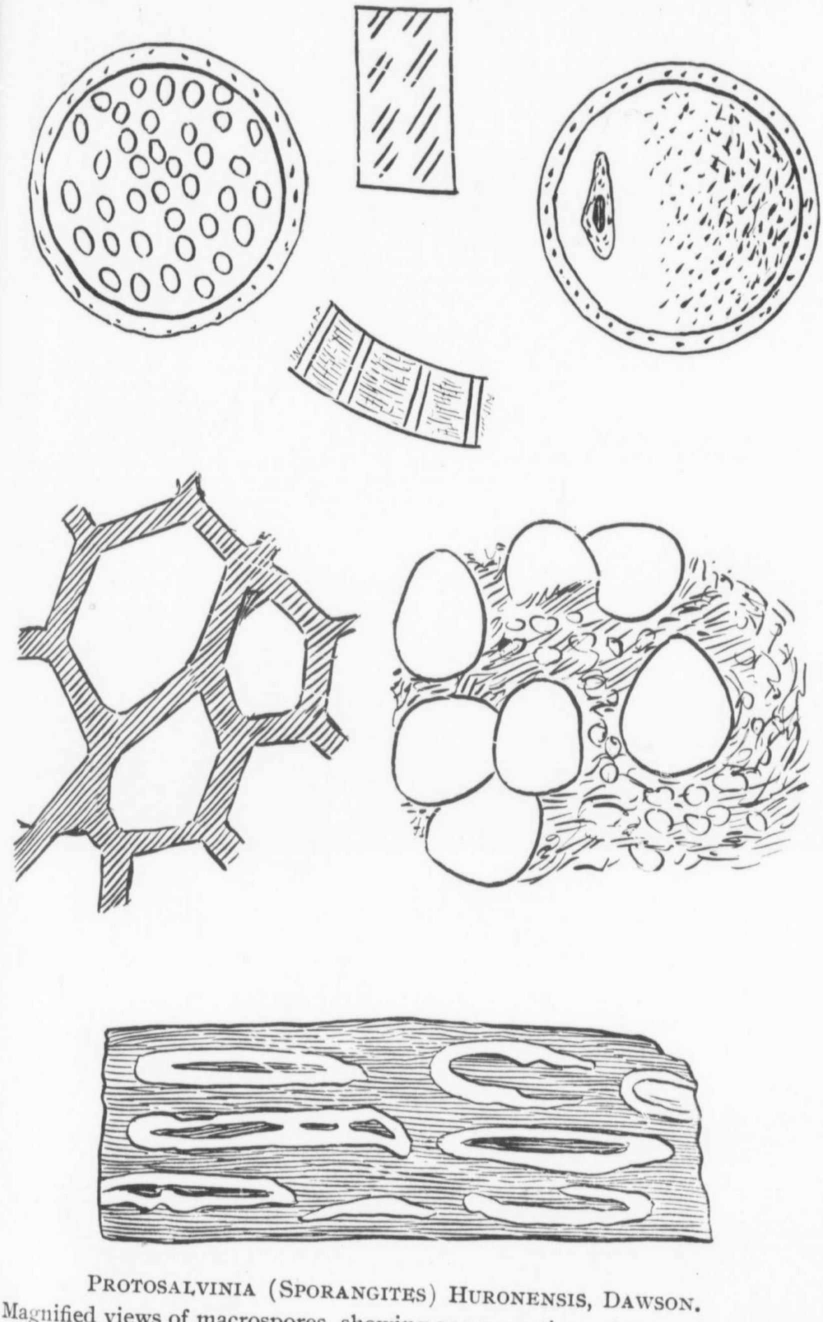
It would then follow from the above that—

1. The Hamilton formation of Western Ontario extends over a wider area than was at one time suspected.

2. That the Portage and Genesee or Kettle Point shales also extend south from Kettle Point to a point in Bothwell County beyond Wallaceburg.

3. That above the Kettle Point or *Protosalvinia (Sporangites)* shales there occurs a distinct series of marine beds containing numerous fossil organisms, including crinoidea, crustacea, brachiopoda, not previously recognised, and forming an important cover over the underlying Hamilton, Corniferous and older formations in the Huron-Erie peninsula. These marine beds with overlying and interstratified shales as ascertained from drillings, constitute the Chemung formation or uppermost member of the Devonian system in Ontario.

Characteristic Fossils from Devonian Strata in Gas and Oil Region of Ontario.



PROTOSALVINIA (SPORANGITES) HURONENSIS, DAWSON.

Magnified views of macrospores, showing pores, portions of the wall greatly magnified, the hilum and internal granular matter, group with remains of sporocarp, cellular tissue of sporocarp highly magnified, also cross section of Upper Devonian shale showing flattened macrospores.—(After Sir William Dawson.)

MEETINGS.

ANNUAL MEETING.

MONTRAL, 1ST, 2ND, AND 3RD MARCH, 1899.

The first annual meeting of the Canadian Mining Institute was held in the Club Room, Windsor Hotel, Montreal, on Wednesday, Thursday and Friday, 1st, 2nd and 3rd of March. The attendance, particularly of members from a distance, was distinctly good· Among others present were :—

Mr. John Hardman, S.B.M.E., Montreal, *President*; R. G. Edwards Leckie, M.E., Rossland, B.C.; Dr. G. M. Dawson, C.M.G., Director Geological Survey, Ottawa; Dr. Robert Bell, Assistant Director Geological Survey, Ottawa; John McLennan, Dominion Coal Co., Boston; H. M. Whitney, Dominion Coal Co., Boston; Charles Fergie, M.E., Intercolonial Coal Co., Westville, N.S.; George W. Stuart, M.E., Truro, N.S.; S. F. Andrews, Economy Gold Mining Co., Country Harbor, N-S.; Bernard Macdonald, M.E., Dufferin Mines, N.S.; James D. Sword, M.E., Rossland, B.C.; W. T. Smith, Greenwood, B.C.; Dr. A. R. Ledoux, New York; H. D. Lawrence, Sherbrooke, Que.; John J. Penhale, Black Lake, Que.; James F. Lewis, Rand Drill Co., Chicago; Dr. James Douglas, M.E., New York; Dr. B. J. Harrington, McGill University, Montreal; Major R. G. Leckie, M.E., Sudbury, Ont.; J. W. Evans, C. & M.E., Sudbury, Ont.; G. F. McNaughton, 15 Mile Stream, N.S.; C. C. Hansen, Montreal; B. F. Peacock, Montreal; D. Smith, Kingston; George E. Drummond, Montreal; R. W. Brock, Geological Survey, Ottawa; Wm. Hamilton, Jr., Peterborough, Ont.; Dr. James Reed, Reedsdale, Que.; A. C. McCallum, Peterborough, Ont.; J. M. Jenckes, Sherbrooke, Que.; A. W. Fraser, Ottawa; Lt.-Col. J. Wright, Ottawa; Geo. S. Davison, Ottawa; E. D. Ingall, A.R.S.M., Geological Survey, Ottawa; George Macdougall, Montreal; Frank Plummer, Montreal; Francis T. Peacock, Montreal; A. E. Hogue, Edmonton, N.W.T.; C. H. Bowen, Sherbrooke, Que.; Thos. J. Drummond, Montreal; C. E. Morgan, Toronto; E. Strachan Cox, Toronto; Robert Meredith, Montreal; J. F. Pigott, Montreal; J. Obalski, Inspector of Mines, Quebec; Eugene Coste, M.E., Toronto, Ont.; Jas. A Macdonald, Greenwood, B.C.; J. F. Higginson, Buckingham, Que.; Hugh C. Baker, B.A. Sc., Perkins Mills, Que.; Russell Blackburn, Ottawa; W. J. Nelson, Intercolonial Coal Co., Montreal; F. T. Snyder, Peterborough, Ont.; Prof. W. G. Millar, Kingston, Ont.; J. W. Craig, School of Mining, Kingston; J. H. Walsh, Sherbrooke, Que.; George J. Ross, Rat Portage, Ont.: J. Burley Smith, M.E., Winnipeg; H. W. DeCourtenay, Montreal; F. Bacon, Montreal; A. W. Stevenson, C.A., Montreal; W. T. Bonner, Montreal; D. W. Robb, Amherst, N.S.; Dr. H. M. Ami, Geological Survey, Ottawa; J. F. Latimer, Toronto; Alex. McNeil, Halifax, N.S.; Dr. W. A. P. Tiernan, Halifax; B. T. A. Bell, *Secretary*, Ottawa; also parties of mining Students from McGill University and the School of Mining, Kingston.

WEDNESDAY MORNING—BUSINESS SESSION.

The President took the chair at 10.30 a.m.

The Secretary having read the Minutes, the following were elected to membership.

NEW MEMBERS.

Russell Blackburn, Mine Owner, Ottawa.
Theo. C. Denis, Mining Engineer, Ottawa.
H. M. Whitney, Dominion Coal Co., Boston, Mass.
John S. McLennan, Dominion Coal Co., Boston, Mass.
George H. Campbell, Toronto, Ont.
S. F. Andrews, Mining Engineer, Country Harbor, N.S.
E. Strachan Cox, Toronto, Ont.
J. N. S. Williams, C. & M.E., Victoria, B.C.
C. B. K. Carpenter, Manager, Oil Wells, Gaspé, Que.
G. J. Ross. Rat Portage, Ont.
A. R. Ledoux, Ph. D., New York.
F. R. Mendenhall, Rossland, B.C.
W. A. Preston, Mine Manager, Mine Centre, Ont.
Herbert Paterson, C.E., Rat Portage, Ont.
Dr. Henry M. Ami, Palaeontologist, Ottawa.
Thomas Brown, Assayer, Nelson, B.C.
A. J. Colquhoun, C, & M.E., Savonas, B.C.
F. B. Gaylord, Iron Manufacturer, Desoronto, Ont.
J. B. McArthur, Mine Owner, Columbia, B.C.
William Mann, Montreal, Que.
Edwin E. LaBeree, Mining Broker, Ottawa.
George E. Townsend, Rossland, B.C.
Antoine Guilbault, Quebec.
John W. Bell, Demonstrator, Faculty of Mining Engineering, McGill University, Montreal, Que.
J. H. Tibbits, Mining Engineer, Forest Hill, N.S.
Lt.-Col. Joshua Wright, Mine Manager, Hull, Que.
Dr. Wm. H. Roughsedge, Mine Owner, South Edmonton, N.W.T.
E. T. Bartlett, Montreal, Que.
James C. Beebe, Mine Centre, Ont.
James Johnstone Riley, Montreal, Que.
Frank Plummer, Montreal, Que.
Frank Carrell, Quebec, Que.
W. H. Gallagher, Vancouver, B.C.
John H. Heal, Mining Engineer, Montreal, Que.
Chas. F. Smith, Montreal, Que.

Wm. Strachan, Montreal, Que.

Angus W. Fraser, Ottawa.

George T. Marks, Mine Owner, Port Arthur, Ont.

Col. S. W. Ray, Mine Owner, Port Arthur, Ont.

Victor E. Archambault, Sherbrooke, Que.

A. H. A. Robinson, Sudbury, Ont.

Edward Wallingford, Mine Owner, Perkins Mills, Que.

F. S. Wiley, Mine Owner, Port Arthur, Ont.

S. W. Jenckes, Sherbrooke, Que.

A. McNeil, Halifax.

Dr. J. Bonsall Porter, Prof. of Mining Engineering, McGill University, Montreal.

F. W. Cowie, C.E., Ottawa.

Student Members.

Philip W. K. Robertson, 32 McTavish St., Montreal, Que.

Stafford F. Kirkpatrick, 96 Barrie St., Kingston, Ont.

H. W. MacInnes, 5 North Park Street, Halifax, N.S.

N. M. Yuile, 133 Metcalfe St., Montreal, Que.

H. Stanley Atherton, Bolton, Lancashire, England.

John E. Preston, 196 Cowan Avenue, Toronto, Ont.

Selwyn G. Blaylock, Danville, Que.

George W. Waller, Bartonville, Ont.

Percy Butler, Guggenheim Smelting Works, Perth Amboy, N.J.

Report of Council, 1898-9.

The Secretary then read the Report of Council for the year as follows :—

Gentlemen,

In accordance with Section VI of the Constitution, your Council is required to "make a report, with a financial statement, at each annual meeting." In submitting this report to the Institute, the Council has deemed it advisable to briefly advert to the circumstances leading to the organization of the Institute out of the Federation of Provincial Societies then in existence.

Dissolution of the Federated Institute.

Briefly, this Federation in its two years' existence found that the revenues at its command were inadequate for the payment of its expenses, and the recurrence of a yearly deficit led to the appointment of a Committee by the Council of the Federation to consider how such deficit could be remedied. The report of this Committee was submitted at the meeting held on the 3rd March, 1898, and has been printed and distributed in Volume 3 of the Journal of the Federation.

The result of the thorough discussion which followed the report during that meeting was the organization of the present Institute, and the dissolution of the then existing Federation. The organization of the present Institute is on the same free lines which characterized the Federation, embracing in its membership any and all persons engaged in the direction or operation of mines and metallurgical works, or interested in the development of the Dominion's mineral wealth; and by a decisive vote at the first meeting it was deemed inexpedieut to attempt to regulate the practice of the mining engineering profession. It was also deemed best for the Institute, as a body, to refrain from expressing an official opinion on matters purely connected with trade or legislation, as the different provincial organizations still retained their identity, and were best fitted to deal with such questions.

MEMBERSHIP.

By Section V members in good standing in any provincial association are entitled to membership on payment of 75 per cent. ($7.50) of the regular fee of the Institute, under which arrangement 72 members of the General Mining Association of the Province of Quebec, and 14 members of the Mining Society of Nova Scotia, have joined the Institute. The Ontario Mining Institute has dissolved, but the remaining provincial organizations have retained their identity.

It affords the Council pleasure to congratulate the members of the Institute upon the success which has thus far attended its formation, and to announce that the number of members in good standing has grown from 63 in March, 1898, to 190 at 31st January. The residence of the membership is distributed as follows:

Nova Scotia	16
New Brunswick	2
Quebec	66
Ontario	44
British Columbia	42
N. W. Territories, including the Yukon	5
Great Britain	4
United States	11

Out of this membership it is to be regretted that but two applications have been received for student membership, and your Council has endeavored to obtain the co-operation of the mining schools of the Dominion towards increasing this number. It may not be generally understood by the class of persons eligible for student membership, that the Institute offers advantages to such persons in giving them the privilege of attending the meetings, and taking part in the discussions which may arise; by offering inducements for the contribution of papers; and also the not inconsiderable educational influence obtainable by intercourse with members at the meetings, with the advantages arising therefrom in the opportunities for inspecting mines and metallurgical works.

DEATH OF MR. G. R. COATES.

The Council regrets to record the first loss of a member by death since its organization. The circumstances attending the death of Mr. G. R. Coates while pursuing professional work in the Rainy River district were peculiarly sad. Mr. Coates was a very promising young member, recently graduated from the School of Mines at Kingston, and was possessed of a character which won him the respect and affection of all with whom he came in contact. Many of our members will remember him as contributing with his effective songs to our entertainment at the last dinner of the Federated Canadian Mining Institute.

Arrears.

The Council also regrets allusion to a feature which has occupied its attention at the close of the year, and that is the number of members who are in arrears for subscription. At the last regular Council meeting a resolution was adopted to drop the names of all members in arrears on the first day of February, and the membership which has been quoted to you is that only of members in good standing. While recognizing the inequality of the distribution of this world's goods, and equally recognizing the advisability of leniency in certain cases, it has nevertheless been thought best to establish the precedent that only members in good standing shall be counted as on the membership list of the Institute.

Amendments of the Constitution and By-Laws.

The experience of the Council during the year just closed has been that there are several clauses in the Constitution which, in practice, work with friction, or fail to work at all, and the amendments which will be submitted to you and upon which decision is asked to-day, are those which, in the opinion of the Council, are necessary, to facilitate business and to make the machinery of the organization work more smoothly. It will be noted that none of these amendments are of a serious character.

Council Meetings.

During the year there have been no meetings of the Institute, but there have been five meetings of the Council, the Minutes of which have been printed for distribution. The work which has been accomplished may be briefly summarised as follows:

Grant from Dominion Government.

(1) Through the representations of a committee which went to Ottawa last March, and were granted an interview by representatives of the Cabinet, the Dominion Government made us a grant for the year of the sum of one thousand dollars, to assist the Institute in its work and publications.

Charter of Incorporation.

(2) An Act of Incorporation was obtained from the Parliament of Canada, chiefly through the energetic efforts of our Secretary, to whom special thanks are due. We are now a legally incorporated body with a Dominion charter, and the advantages of this incorporation will be more apparent each year, as our membership, funds and organization increase.

Library and Reading Room.

(3) We have been enabled to open and equip Room 4 in the Windsor Hotel, Montreal, as a Library and Reading Room, and general headquarters of the Institute. By purchase, donation and exchange, the Library now includes 268 bound and 161 unbound volumes, besides numerous completed fyles of exchanges and divers pamphlets; also seven mounted maps of portions of Quebec, Ontario and B.C., with a fyle of the excellent Geological Survey maps of Nova Scotia made by Messrs. Fletcher and Faribault. The details under this head, with list of current exchanges, and a catalogue of the Library, will be found in volume I of our Transactions.

Many members of the Institute have visited and made use of the headquarters as a reading room during their stay in Montreal, and the Council has reason to regard the establishment of this Library with great satisfaction. They take this opportunity of suggesting to members of the Institute the propriety of donating to the Library any duplicate copies of volumes, pamphlets, maps, blue prints or photographs which they may have or obtain, as the funds of the Institute are as yet insufficient to permit of acquiring much of such material by purchase.

Publications.

(4) The Institute, under the arrangement adopted at its organization, has published Volume 3 of the Journal of the Federated Canadian Mining Institute, embodying some 220 pages, and containing 23 papers, a copy of which has been sent to each member in good standing; also Volume I of the Transactions of the Canadian Mining Institute. In addition Certificates of Membership and 1,000 copies of the Constitution and By-laws have been printed and distributed.

Information Bureau.

(5) Information and assistance have been given during the year to 23 persons who have sought our headquarters with inquiries, which have embraced the coal and iron deposits of Newfoundland, the gold and manganese deposits of Nova Scotia, the gold, mica aad chromite deposits of Quebec, the gold and mica deposits of Ontario, the oil fields of Alberta, and have had reference to the mineral wealth and maps of British Columbia and the gold fields of the Yukon. To these persons, and to others, have been given pamphlet copies of special papers whenever it has been practicable.

Financial Statement.

Herewith submitted, duly audited, is the financial statement of income and expenditure for the year ended 1st February, 1899.

RECEIPTS.		
Subscriptions, 99 at $10.00	$990 00	
do 87 at $7.50	652 50	
do Students, 2 at $2.00	4 00	
Sales Transactions, 1897	2 00	
Interest on Bank Account	6 17	
		$1,654 67
Grant from Dominion Government		1,000 00
		$2,654 67
DISBURSEMENTS.		
Incorporation—		
Gemmill & May, costs	176 00	
Montreal *Star*, advertising	20 25	
Canadian Mining Review, advertising	10 00	
Secretary's expenses	28 20	
		235 05
Library and Reading Room—		
Purchase of Books	259 00	
Simpson & Peel, Book Case	59 05	
Hawthorne, Maps and Mounting	21 50	
Wilson & Co., framing Photos	7 10	
		346 65
Library Expenses—		
Rent to 1st March, 1899	300 00	
Salary, Librarian	40 00	
Sundry expenses, casing books, ex. charges, postage	16 00	
		356 00
Insurance Account—		
Hartford Insurance Co. ($1,000)		14 25
Printing and Engraving—		
The Mortimer Co , Printing	442 27	
do Engraving	86 25	
Ottawa Printing Co	9 00	
Charges on Electros	2 10	
		539 62
Secretary's Office—		
Salary Account	400 00	
Travelling and Hotel expenses	153 00	
Books, Stationery, Postage and Telegrams	114 21	
Typewriting	50 00	
Stafford, reporting Meeting	15 00	
		732 21
Treasurer's Office—		
Services	100 00	
Books, Stationery and Printing	30 93	
Postage and Telegrams	29 26	
Bank Commission	20 88	
Cabinet File	30 00	
		211 07
		2,434 82
Cash balance on hand		$219 82

British Columbia Meteings.

The meeting which it was proposed to hold in British Columbia last September was postponed on the advice of members of the Council resident in that Province, but as will be seen by the circular which you have already received, your Council is making every effort for a successful British Columbia meeting, to be held during the month of September next. A further circular will be issued containing full details as to the places to be visited, the probable expense, etc., etc.

Necessity of Co-Operation.

The Council desires to remind the members generally that the success of the Institute, as an organization, is dependent upon the individual effort of its members; enrolled as members we have a large number of men well able to furnish matter worthy of being printed and distributed. The success of organizations like our own lies chiefly in the value of their literature. Subjects of a practical character, dealing with matters of every day occurrenee in the routine of mine, mill or furnace work, are of special value, inasmuch as the discussions provoked are often of greater value than the paper itself.

On behalf of the Council,

John E. Hardman, *President.*
A. W. Stevenson, *Tresurer.*
B. T. A. Bell, *Secretary.*

31st January, 1899.

Report of the Library Committee.

The Library Committee of the Canadian Mining Instltute beg to submit the following report to the Council:—

In the month of June the grant from the Dominion Government having been obtained, your Committee took possession of Room 4 in the Windsor Hotel, and opened the same as the Library and Reading Room of the Institute.

The nucleus of the Library having been obtained through the purchase from the Secretary of 150 volumes of standard works of reference and text books, and of the first 17 volumes of the Transactions of the American Institute of Mining Engineers, from the estate of the late Sir J. A. Macdonald; the same were placed in a book-case, and a small pamphlet case was also purchased in which to keep current numbers of exchanges received.

There are at present in the Library of the Institute 268 bound volumes and over 160 unbound volumes, with pamphlets and other loose material which would supply enough matter for at least twenty more volumes, and your Committee desire to bring to your notice the necessity of an appropriation to bind these. A visit to the Library will also convince the members that an additional book-case is urgently needed.

Three maps of the Province of Quebec, two maps of the Province of Ontario, a large map of the Province of British Columbia, a map of the Trail Creek District in

British Columbia, and a wall map of Canada have been mounted and placed on rollers for the use of members. Donations of maps of different sections have been received from the Provinces of Quebec, Ontario and British Columbia ; and a full set of the excellent Geological Survey maps of Nova Scotia and Cape Breton have been given by the Department of the Interior.

The Institute is in receipt regularly of the following periodicals, which are received directly at the Library :—

The Technology Quarterly, Boston, Mass.
Journal of the Chemical and Metallurgical Society of South Africa.
The New Zealand Mining Journal.
The Iron and Coal Trades Review, London.
The Institution of Mining Engineers.
The Colliery Guardian, London.
The Critic, London.
The Science and Art of Mining, Wigan.
Journal of the British Society of Mining Students.
Mines and Minerals, Scranton, Pa.
The Engineering Magazine, New York.
Journal of the Franklin Institute, Philadelphia, Pa.
Anthracite Coal Operators' Association Journal, New York.
The Canadian Mining Review, Ottawa.
Engineering and Mining Journal.
The Institute of Mining and Metallurgy, London.
The Mining Journal, London.
Journal of the Western Society of Engineers.
School of Mines Quarterly.
Mining Institute of Scotland.
Journal of the Royal Colonial Institute.
Mining and Scientific Press of San Francisco.
The Australian Mining Standard, and several others.

Your Committee is further desirous of supplementing the usefulness of the Library by the addition of a number of books which will have to be acquired by purchase. And foremost among these is the necessity for completing the set of the Transactions of the American Institute of Mining Engineers, for which purpose an appropriation of $48 is necessary.

No attempt has been made to establish, in connection with the Library, any representative collection of minerals and metallic ores ; (1) for the reason that our funds are inadequate to provide the space and cases for a suitable collection ; and, (2) because the collections now forming in the new chemistry and mining building at McGill provide such an exhibit, which ours would only duplicate.

At the beginning of its work your Committee adopted the following rules for the government of the Library :—

1. That no books or periodicals should be allowed to be taken from the room, and the bound books should be kept in locked cases under the custody of the Librarian.

2. That the Library should be open each week day from half-past nine in the morning until six in the evening, but owing to the fact that a large number of members sought the privileges of the Library in the evening, your Committee, since October, have left the room open until 12 p.m.

3. Instructions were given to the management of the Hotel that no refreshments were to be served in No. 4, and this rule has been strictly adhered to.

During the eight months that the Library has been open, information has been sought and given to 23 applicants who have visited the headquarters seeking information respecting the mineral wealth of different portions of the Dominion, and in this respect alone your Committee is of the opinion that the grant from the Government has been amply justified. The majority of those seekers for information have been British, although Australians, Germans and Americans are among the number.

The expenses attendant upon the Library have amounted to $702.65, which has been disbursed as follows :—

Rent	$300 00
Purchase of books	259 00
Mounting of maps, photos, etc.	28 60
Book-cases	59 05
Librarian	40 00
Express, postal and other charges	16 00
	$702 65

With the recommendation that ample provision be made the ensuing year for the binding and housing of the increased collection, and also for the purchase of the additional volumes required to increase the efficiency of the Library, your Committee offers this report.

(Signed)

Committee { J. Stevenson Brown.
H. W. DeCourtenay.
Geo. E. Drummond.

The Secretary—A number of the members, noticed by the Treasurer as being in arrear with their subscription, had since paid up, so that the actual membership in good standing was about twelve in excess of the number mentioned in the report.

The report was unanimously adopted.

British Columbia Meeting.

The President announced that the council had determined to hold the next meeting of the Institute in British Columbia, and arrangements were under consideration for an excursion to Rossland, Sandon, Trail, Ymir, Greenwood and other centres in that province.

After some discussion the following committee was appointed to make suitable arrangements: The President, Mr. George E. Drummond, Mr. Eugene Coste, Mr. A. W. Stevenson and the Secretary.

Scrutineers.

Messrs. DeCourtenay, Peacock and Lewis having been appointed scrutineers for the election of officers, the meeting adjourned.

WEDNESDAY—AFTERNOON SESSION.

The President took the chair at three o'clock. He intimated an invitation from Dr. Bovey of the Faculty of Applied Science and also from Dr. Porter of the Faculty of Mining Engineering, to visit and inspect the new mining laboratories at McGill University. It was agreed to visit these laboratories on Saturday morning.

Papers Read by Title.

The following papers were read by title:

On Mine Costs, by the President.

Notes on the Development of the Iron Ore Industry, by Mr. John Birkinbine, Philadelphia.

Across the Pitch v. Up the Pitch, by Mr. O. E. S. Whiteside, Authracite.

On the Occurrence of Cinnabar in British Columbia, by Mr. A. J. Colquhoun, Savonas, B.C.

On the Establishment of Science Classes in Mining Centres, by Mr. A. H. Holdich, Nelson, B.C.

Electric Transmission and Electric Drills, by Mr. F. Hille, Port Arthur.

Smelting Conditions in British Columbia, by Mr. R. C. Campbell Johnstone, Nelson, B.C.

On the Occurrence of Free Milling Gold Veins in B.C., by Mr. W. Hamilton Merritt, Toronto.

On the Lillooet Gold District, by Mr. F. Cirkel, Vancouver, B.C.

On the Driving of the Simplon Tunnel, by Mr. Leopold Meyer, Ottawa.

A Notable Canadian Deposit of Chromite, by Mr. J. T. Donald, Montreal.

On the Petrographical Character of the Ore from the Republic Camp, by Dr. Frank D. Adams, Montreal.

Adjustments and Control of the Stamp Mill.

Prof. W. G. Millar presented a paper by Mr. Courtenay DeKalb on this subject (reproduced in page 149 of this volume).

The President—This paper is particularly interesting at the present time, in view of the rapid development of milling operations in Canada, owing to the discovery of free milling ores in British Columbia and to the expansion of gold milling in Ontario and in Nova Scotia. The members who are interested in the gold milling question will read Mr. DeKalb's paper with a great deal of interest, and will use it to check against their own notes. I have been doing that while Professor Millar has been reading the paper, and it struck me that Professor DeKalb has gone over the situation carefully. Of course, to old mill-men many of his remarks are well known, and I am not going to discuss them at the present time, when we have a number of gentlemen present who are past masters in gold milling.

Mr. G. W. Stuart—As the paper treats not only of the mortar as a crushing machine, but an amalgamating machine as well, it has struck me as singular that the important question of the quantity of mercury to be used has not been dealt with.

Mr. F. T. Snyder—In the matter of the weight of the stamps we find that the question of weight per square inch of area of shoes is more important than the question of total weight, and by changing that we have been able to modify the results in a manner that the total weight does not give us. With respect to the distribution of water and the old method of putting the water into the top of the mortar, it does not matter whether you put it in five times in the one place, it practically all seeks the same level. I had occasion to use a mortar where we had no screen. We adopted freely the principle of sizing the pulp and putting it out of the mortar by means of a water column within the mortar, and the result was that we could get any amount of pulp we wanted in clean distribution, but we could not get enough stuff through. As to the woven wire screens, the quartz breaks into tetrahedrons and the consequence is that while the screen originally has an open area, after it has been running a few hours it has an open area of much less than the bunch screen. It has been found of advantage to regulate the height of the discharge rather than the chuck box, by putting different heights of false bottoms in the mortar.

Mr. Obalski—What is the meaning of "150 meshes"?

The President—I fancy you will find most mill men will evade that question. In South Africa they have a preferable system by which they speak of a screen of "400 or 600," meaning the number of apertures in the square inch of surface. The 400 measurement is that which has 20 meshes on one side of the inch and 20 on the other. I take it that the 150 meshes referred to by Mr. Obalski means 150 meshes to the lineal inch made out of this very fine bolting cloth. With regard to Prof. DeKalb's paper, he said that the width of the mortar and the depth of the mortar are fixed matters, that the depth is adjustable by means of the chuck box but the width cannot—possibly it cannot in one sense of the word, and in another it can. About fifteen years ago I got hold of one of the old vertical screen Nova Scotia mortars. I was disgusted with it and endeavored to convert it into a mortar which would be much narrower at the base and also where I could get a screen having an angle of about twelve degrees. It is true it was only a makeshift, but by putting in wooden blocks and covering them with sheet steel, I succeeded in getting a mortar which gave a test of about as much value as if I had had a mortar of the modern style. I do not mean to say that would have been sufficient to crush a thousand tons, but it was sufficient to crush the sample lots of from ten to fifty tons and to give practically the same results as a modern mortar. In regard to the banking of the ore to which Professor DeKalb alludes, I think most men of large experience will say that that banking is due rather to the order of the drop, than to the manner of feeding through the central slot which extends across the whole width of the mortar. In 1891 I put up a ten stamp mill in which one mortar had a central feed of only about 17 or 18 inches. The other mortar standing alongside it had the whole width of the mortar as a feed slot, and I cannot say that there was the slightest particle of difference between the two as regards the banking or as regards the wear and tear on the shoes and dies. But there was a great trouble in starting that mill from the fact that the mill man had put his cams on in the accepted order of 1. 4. 2. 5. 3. We found there was a tendency for the ore to leave No. 1 and to accumulate under No. 5. The mill man attempted to remedy that by the very bad practice of giving his stamps different heights of drop ; No. 1 was about 5 inches and No. 5 about 12 inches, so you can fancy the effect of that upon your cams and upon all the rubbing surface. When the order was changed to 1. 5. 2. 4. 3., the distribution of pulp was made even and the machine worked smoothly. In regard to the feeding of water, we have with us Mr. Bernard MacDonald who is contributing a paper on an improved method of feeding water to stamp mill mortars, and he possibly may contribute in that paper something of what I would like to say regarding Professor De-Kalb's paper. I think a great deal may be done in that direction, to justify the remarks of Mr. Snyder, by eliminating a great portion of the wear and tear that occurs in ordinary screens, and as far as die cupping is concerned, in my experience, the cupping of the die has been due to improperly feeding too low or too high rather than to anything else.

Metallurgical Standards.

Mr. F. T. Snyder presented his paper on Metallurgical Standards (reproduced on page 3 of this volume).

Mr. Hardman—Mr. Snyder has perhaps expressed himself differently from what some of us would do on this question, but still he has given expression to the need felt by everyone engaged in metallurgical work during the last decade. I do not feel myself competent to express any opinion regarding his sizing methods or his micrometer, but I can sympathize with him in the desirability of having a standard unit of weight which shall be fixed for all operations.

A New, or Hitherto Unrecognized, Geological Formation in the Gas and Oil Producing Regions of Ontario.

Dr. Henry M. Ami of the Geological Survey of Canada, presented his paper on this subject (reproduced on page 186 of this volume).

Mr. Coste—Dr. Ami mentioned in his paper that if the "Trenton" was ever reached by any of the prospectors, they would surely be rewarded by striking large quantities of oil. I regret to say that that has not been our experience. We have just reached the "Trenton" in one of the wells in Essex County, and I am sorry we have not been rewarded yet. We struck the "Trenton" near Lake Erie, about four miles south of the village of Harrow. We started on the lower Heldezberg limestone. We found considerable gypsum down to 910 feet. We had one bed of gypsum 10 feet thick at 865 feet, and another bed at 450 feet of about 5 feet thick. There is a great deal of gypsum all the way through from 110 feet where we struck the first rock down to 910 feet. At 910 feet we struck the "Guelph" and "Niagara" and found water in it. That is where we strike the gas in other parts of the same county between Leamington and Kingsville. It was thought by myself and by others until lately that it was in the "Clinton" where this gas was struck, but that is not so. We had never struck the shales before, and I could not tell exactly where we were until about a month ago, when we drilled down through this salt water and got to the "Medina" shales at 1,300 feet, about 400 feet below the first salt water. I am positive now that the "Guelph" is the stratum where we struck the gas at Kingsville and all through that district. At the Coste well No. 1 we struck the gas at 1,020 feet, or 50 feet below the gypsum bed, and we have the same gypsum bed in borings which I made in different parts of the county, some of them 20 miles distant from each other.

DR. AMI—At what depth?

MR. COSTE—At 1020 feet in the first well is where the gas was struck, or about 50 feet below the gypsum bed. In this last well south of Harrow it was 910 feet where we struck the top of the "Guelph" and "Niagara" formation. We found the "Guelph" and "Niagara" formation to be a very open porous limestone with water in it. We found we had to go through in the wet hole from 910 to 1295 feet and finally we got the 6¼ casing in when we got to the Medina shale at 1298 feet. We struck the "Trenton" at 2,150 feet. I went about 300 feet in the "Trenton" and we got just a little gas and oil—enough for a sample. At Stratford, Ont., where the "Trenton" has also been reached at 2346 feet, they went 40 feet in the "Trenton" and got salt water at 2,384 feet. I have no doubt that other explorations in certain parts of Ontario will lead to the discovery of oil and gas in the "Trenton" formation. The negative result in the boring of two wells means nothing, but the fact of striking a little indicates that a good deal more should be found. I agree with Dr. Ami as to the geology of this part of Western Ontario. A great deal of drilling has been done, but no correct logs of the wells have been kept, so that it is a difficult thing to know what formation would be obtained in different localities and at what depth. It is only lately, since we got more correct logs of the wells, that we can tell just what the series of strata are in Western Ontario. It is mostly covered with drift, and unless you drill and keep a correct account of it, there is no satisfaction to be obtained.

DR. AMI—What do you think of diamond drill?

MR. COSTE—I do not think it is necessary to drill a well with a diamond drill to get a good log of it if you are on the spot and wash each screw of the drillings or cuttings as it comes up. You have to be there most of the time and wash the cuttings carefully every five feet, and if you do that, you can get a very correct log of what you are going through.

MR. INGALL—Have you found any trouble in that respect by rock falling in from above?

MR. COSTE—We have no caving at all in these stratas, as they are very solid; too much so sometimes. In the coniferous limestone, for instance, there is a great deal of flint, and it is very hard rock, as well as the "Guelph" and "Niagara" and the "Clinton." Sometimes we could only make 10 feet in 24 hours. There would be some little chips falling in, but not enough to bother a geologist or paleontologist.

MR. BELL (Secretary)—Perhaps Mr. Obalski could give us some news about the Gaspesian oil wells?

MR. OBALSKI—They are still drilling in Gaspé, but it must be remembered that Gaspé is a new country and that it has not developed to the same extent as Ontario. We expect some time to get oil at Gaspé.

MR. BELL (Secretary)—Has the refinery been put up yet?

MR. OBALSKI—No; they are putting in a pipe line, I understand.

DR. AMI.—It would be a splendid thing if the records of the borings of these wells were systematically kept by the Government, and when a practical man like Mr. Coste reaches the "Trenton" he should let us know all about it at Ottawa. I was fishing for information when I ventured to put that clause in my paper, and I am delighted to know that the "Trenton" has been reached. I beg to tell Mr. Coste that I did not state absolutely that when the "Trenton" was reached the company would be rewarded by finding petroleum, but I ventured to hope that they would, and I suppose it comes to the same thing in the long run. I am delighted to think that Mr. Coste expressed the same hope as I did, that some day we will find petroleum in Ontario in the "Trenton" formation. We all know that in Ohio the "Trenton" formation has afforded large quantities of oil of great value indeed.

THE PRESIDENT.—Do you not think it would be of great interest that the Government should keep these records?

MR. INGALL.—It would decidedly be in the interest of the public and the Government, and a start has been made. Great assistance would be rendered if my friend Mr. Coste would collect these boring record and send them to us. This might be an opportune time to enter a plea on the part of the mining section of the Geological Survey that these gentlemen who have these records should extend to us a larger measure of co-operation in the future than in the past. Had we a large staff in the Survey we might be able to do that ourselves, and I think the mining community of this country should urge the Government to increase the Geological Survey appropriations instead of cutting them down. If we had a larger vote we would be able to put one man on to this work alone, who would keep track of the borings that are going on and persuade the borers to let us have their logs. I appeal to all gentlemen engaged in this business in Canada to voluntarily send us their logs so that we may have a useful record. Of course, sometimes people are not prepared to give away information, but they could use their own judgment on that. There is no doubt that the under-ground geology of the peninsula of Ontario is little known because of paucity of our records in that respect, and although we have a great many logs in the Geological Survey they do not represent a fraction of what has been done.

MR. COSTE.—They are no good.

MR. INGALL.—You will agree with me that it would entirely take up the time of one man who would necessarily have to go on the ground and get correct samples. We have had a great many records sent in, but some of them are perfectly useless. It is a branch of the Geological Survey work which might be developed and would pay to have a man to devote his whole time to it.

MR. COSTE.—We did strike some gas in the "Trenton" limestone in Welland county at a depth of 2,940 feet. We struck a paying well which we have had connected on the lines to Buffalo for several years. We struck the "Trenton" at 2,340 feet, and the find was made 600 feet in the "Trenton." We have tubed the well and closed it in, and it registered a rock pressure of exactly 1000 pounds to the square inch. After several years use that well will yet register 800 or 900 pounds pressure. That was just about 100 feet from the Archean rocks in strata in which I do not think paleontologists would expect to find many fossils ; I would not. This brings up the question of the gas being generated from fossils, and I am quite prepared to say that it is not so generated.

MR. INGALL.—You never got any gas or oil in the Archean ?

MR. COSTE.—That is the nearest I have come to it.

DR. AMI—Applications are constantly made to the Geological Survey Department for information regarding the lay of the formations in Western Ontario, and the only reliable section we have is the Attrell well which is a diamond bored well in the Goderich region. In Europe, as well as in the United States, three or four typical standard sections have been bored by the diamond drill, and it would be of great value if that were done in Canada so that we could have an exact knowledge of the various kinds of strata that are traversed. This Wallaceburg log is a very good one and we have some excellent ones from Petrolia. Our Bureau is supposed to be one of definite information and this is certainly a point on which we should have accurate and definite knowledge. The presence even of organic remains of fossils is of no value. The day before Mr. Coste struck his ten million cubic feet of flow well, he came to my office with samples, and in them we found a very pretty "leptocelia intermedia" from the "Niagara" group which showed just where we were, so the next day he struck the oil.

MR. INGALL.—Mr. Coste is a man of great experience and I would like to have his view on diamond drill boring. I take it that while such boring would be useful as fixing certain horizons, yet I would ask him if it has not been his experience that the question of gas and oil to a certain extent depends on the working of the local folds. Of course that would have to be supplemented by careful selections from other borings so as to get the local features of the under-ground geology. Does Mr Coste consider it has anything to do with the folds?

MR. COSTE.—It has all to do with the folds. I do not think it is necessary to use the diamond drill. Of course, the diamond drill would be altogether for experimental purposes, because the bore would be too small to use for a well. I may say that in our operations boring in the ordinary way, we have never had any trouble in getting samples or a good log of the well.

MR. INGALL.—May I take it that in the future your company would consent to send samples to us?

MR. COSTE.—Yes. Every five feet we clean the well and we take out samples of the ground we are in. Of course, sometimes a few chips fall in from above, but we can easily recognize them and take them out.

MR. INGALL.—If you do that it will assist us in carrying out our work.

MR. COSTE.—You will have to send a man there to attend to it.

MR. INGALL.—You could not send them in yourself?

MR. COSTE.—I would be very happy to go to the wells with your man, and I do not think it would be necessary to be watching the borings all the time. You could make arrangements with the contractor, but you certainly would have to send a man every day or every second day.

MR. INGALL.—How many borings would be going on in Ontario during the season?

MR. COSTE.—More than twenty important ones as to records.

MR. INGALL.—It would keep a man busy all the time for four or five months in the year?

MR. COSTE.—Yes; we are drilling in the winter too. I may say that ten years ago, at St. Catharines, Ontario, the "Trenton" was entirely drilled through at 2,185 feet and the gas was found under the Trenton. At that depth there were 15 feet of very clean sand. They stopped at 2,200 feet, and the last 15 feet was in clear white sand and that is where they got the gas. I do not suppose that was 25 feet from the Archean.

DR. AMI.—Almost everywhere in Ontario, underneath the limestone you find a white sand.

MR. COSTE.—The case at St. Catherines was a new one then; but large wells have since been struck in New York State, also, under the Trenton. It was in the calciferous about 20 feet from the Archean that the gas was found, and where you got the fossils that produced that I do not see.

WELCOME TO DR. DOUGLAS AND DR. LEDOUX.

MR. BELL (Secretary).—Before this session adjourns, I am quite sure I am only expressing the sentiments of every member of this Institute when I express to Dr. Ledoux, and to our brother-member Dr. James Douglas, the eminent president of the American Institute of Mining Engineers, who is so well known to us by reputation—I say I voice the sentiment of every member of the Institute in extending to these eminent gentlemen a very hearty welcome to our meetings. It is a great compliment to Canada to know that a Canadian is President of the largest, and strongest, and possibly most representative Institute of Mining Engineers in the world. It is a great pleasure to us, Dr. Douglas, to see you again in the Province of Quebec. Both Dr. Douglas and Dr. Ledoux will contribute subjects of great interest to our evening session, and we are very much indebted to them for their exceedingly kind co-operation towards the success of this the first meeting of our reorganized Institute. (Applause.)

The session then adjourned.

WEDNESDAY EVENING SESSION.

The President took the Chair at eight o'clock.

MINERAL PRODUCTION 1898.

MR. E. D. INGALL.—I am authorized by the Director of the Survey to place at the disposal of the members the Summary of the Mineral Production of the Dominion. The total showed (subject to revision) :—

Non-metallic minerals	$15,884,596
Metallic	21,622,601
Products not returned	250,000
	$37,757,197

CHAUDIERE GOLD.

MR. J. OBALSKI, Inspector of Mines for Quebec, exhibited several bottles showing very handsome specimens of alluvial gold obtained from the Chaudiere district during the past year, and explained that satisfactory progress was being made in mining in that district.

SWEDISH IRON METALLURGY AND ITS APPLICATION TO CANADA.

THE PRESIDENT.—We are distinguished by having with us two gentlemen, Dr. James Douglas and Dr. A. R. Ledoux, officers of the American Institute of Mining Engineers. These gentlemen have not only been kind enough to come to our meetings, but they have consented to place their views before us on subjects which are certain to be of great interest to our members. (Applause.) I desire to re-echo some of the words which fell from the lips of our Secretary, that in the President of the American Institute, the largest body of Mining Engineers in the world, we have a representative Canadian ; a Canadian by birth and one who remains a Canadian by choice, because I believe Dr. Douglas has never become a naturalized American citizen. It is unnecessary to tell any Canadian mining man of the immense services Dr. Douglas has rendered to the profession, for as a mining engineer and metallurgist his record cannot be surpassed. (Applause.)

DR. JAMES DOUGLAS of New York, addressed the meeting as follows:—

MR. PRESIDENT AND GENTLEMEN—I feel abashed by such compliments as have been passed upon me. I hope you will consider that the honour which has been shown me, a Canadian,—and I consider it a great honour—by electing me President of the American Institute of Mining Engineers, is not only a recognition of my very humble services to the profession, but likewise an acknowledgment that the Institute is a Pan-American Association, and is expressive of the feeling which exists between the two peoples, one in actuality, who divide almost the whole continent between them. But while one in many respects, their interests are not identical. Yet believe me, there is nothing will excite the admiration and esteem of my friends in the United States for Canada so much as downright honest rivalry in trade and manufactures between yourselves and them. The most important branch of industrial life in the United States is the iron and steel trade in all its ramifications. You will excuse me, gentlemen, if I say that I think Canadians should be ashamed of themselves that this industry occupies such an extremely insignificant position in their commercial life. I am quite aware that one reason which will be given for this state of affairs is the absence of coal in Central Canada. This is undoubtedly a cogent reason, but coal is not absent everywhere and iron ores are said to abound in all the Eastern and Central Provinces. The subject that I am merely going to suggest to you this evening, is, the parallel between Canada and Sweden, and it may be taken as an answer to these Canadians who would excuse themselves for the extremely impotent position which the iron industry occupies in Canada, on the score of the absence of fuel.

In Sweden we have a country bearing many analogies to Canada, and yet, Sweden has always stood high in iron and steel work. Some two centuries ago, Sweden ranked probably as the largest producer of iron and steel in the world, and to-day it occupies the proud position of being the producer of the highest grades of iron and steel made anywhere. The question for you to solve is, whether in Central Canada, you can become a competitor with Sweden in this valuable industry. Of course, the question can be resolved only by primarily determining whether you really have iron ores which will compete in purity and quality with those of Sweden. In quantity you probably have them, for in central Sweden, the quantity of iron ores is small; but their quality is incomparably high. Whether you really have iron ore as free from phosphorous and sulphur and as high in iron, it is not for me to say. When we look over the records of the Geological Survey, and the records of the American Institute of Mining Engineers, we find analyses of extremely pure iron ores said to exist in considerable quantity, but whether they really exists in these quantities and in that purity I cannot say. If they do, I see no reason why in Central Canada an industry should not be built up that would compete with that of Sweden.

In Sweden we have two great groups of iron ores. In the extreme north, away in the Arctic Circle, it is estimated that there are at present exposed about 1,250,000 square yards, in superficies of high grade iron ore. In the report of Dr. Lundbohm, who was commissioned by the Swedish Government, to make a close survey of the iron ore deposits of Luassavari, in the Province of Norlän, he gives figures and estimates showing that in that one iron deposit alone, there are 218,000,000 tons of high grade ore above water level running from 60 and 70 per cent. I do not know that in Canada we have anything comparable to that within easy reach of tide water, but according to Dr. Bell of the Geological Survey, you have enormous deposits of fairly good manganiferous iron ore in Hudson Bay, and on Ungava Bay you have on the same authority very large deposits of high grade iron ores. In Newfoundland there are admittedly large deposits. Are all these deposits despite the Arctic surroundings more unfavorably situated as regards the markets of the world than are the northern deposits in Sweden, and would not more precise information if they are worthy of it, attract attention and capital to them? In central Sweden the parallel with Canada is very marked. In central Sweden the deposits are small and the country is reticulated by water ways and is covered in great measure by forests. In round numbers, about 10 per cent. of central Sweden is covered by water and about 80 per cent. is still covered by forests; a condition which prevails in Canada. In that central region of Sweden there is a large development of Huronian rocks carrying these iron ores (and to a certain extent copper ores) which for the last seven or eight centuries have been the main wealth of Sweden. Now, gentlemen, as conditions have altered in the iron trade of Europe, Sweden has adjusted herself to these conditions, and therefore, she is still enabled to maintain a high position. This she has done by sacrificing quantity absolutely to quality. If we we take the quantity of iron turned out in Sweden it is comparatively insignificant. All the furnaces in Sweden together do not annually make as much iron as one of the Carnegie furnaces makes, and yet the iron industry of Sweden is to-day a source of great wealth to the country. Sweden turns out a product of great value. Take the one item of Hollow Ingots shipped to the United States for making bicycles. They are worth to-day in the United States $129 a ton. You can see that if you can make such a product you are doing something which raises iron from being an inferior to a superior metal. The question for Canadians to solve is: Have you got the ores of a quality which would enable you to make a product of that kind? The other conditions necessary to success you certainly have, moreover, it is well to recollect that when you enter the market with a product worth $129 a ton, you are producing a material that is sure not to enter into destructive competition with any thing else, for the quantity of the only other competitor Swedish iron is small, and the world's demand is large and ever growing larger.

I do not pretend to say you have the raw material, but it should be easy to determine whether you have it or not, and if you have the raw materials you surely have the brains and energy with which to utilize them. Now how does Sweden do this? She does it by combining a group of industries for the prosecution of which she possesses the natural ingredients. Iron making and lumbering are in Sweden intimately related. Every large iron company in central Sweden owns a large tract of forest land subsidiary to its iron furnaces. The great company of Kopparbergs has over 700,000 acres of forest lands. This lumber is cut scientifically. They do not sweep it all down recklessly as we do on both sides of the line, both in Canada and the United States. This large company practiced scientific forestry so carefully that this 700,000 acres will last perpetually for the manufacture of the 55,000 tons of high pig iron and the specialized articles in which it is converted as well as large quantities of dimension lumber and wood pulp that the Company makes. This timber land is cut over annually. As far as I could ascertain, when I was in Sweden, they consider forty years the most profitable life of the coniferous tree. This gives timber of eight or ten inches. You never see a large tree in Sweden or Norway. They do not use as a rule coniferous wood for fire wood, but take the aspen or birch for household consumption, and devote the more valuable woods to commercial purposes. All these large iron works have their saw mills attached. As I said they cut their forests scientifically, and they use the product as scientifically. The highest grade is used for making their high grade paper pulps. The next grade is used for dimension timber and what we would call the worthless lumber is used for the manufacture of iron and steel. All that is large enough is made into charcoal for furnace purposes. Inferior wood, and sawdust and twigs and stuff that is too small to be turned into charcoal is all converted into gas and used as gas in open furnaces, and in manufacturing specialized articles, for the Swedish iron works do not confine themselves simply to making crude pig or crude steel ingots. They nearly always devote themselves to making likewise the finest articles in iron and steel that the science of metallurgy can produce. Thus they turn their crude product into the most valuable forms which such high grade material can be converted into. For instance, you never see Swedish rails. The rails used in Sweden are imported. Swedish iron and steel can be much more profitably manufactured into tools and watch springs and other articles which bring the highest prices. The Swedes discovered long ago that they must absolutely retire from the business if they entered into competition with Mr. Carnegie or any of the great works that turned things out by wholesale. But they found that they can by special methods and by infinite care turn out iron and steel which brings these special prices. They find that if they are to retain their conspicuous position in the world it is by abandoning the object of making quantity and confining themselves to making quality. If you look back at their statistics of iron and steel you will be surprised at the changes that have taken place. It demonstrates conspicuously this marvellous facility the Swedish metallurgists have shown for adapting themselves to shifting circumstances. As soon as they are driven from one market by competition they look around to find another for some other articles not made elsewhere. They are undaunted and unquenchable.

When you go through Sweden you cannot help being struck by the difference which their mills exhibit to any of your modern mills. In Sweden they turn out an ingot and that ingot is almost examined by the microscope. Every bit of scale is removed by the chisel. When it is perfect, it it passed to be turned into watch springs and articles of a kind which bring of course enormous prices, give employment to a great many people, and make Sweden the happy and prosperous country which she is to-day.

Now, then, we have very much these conditions in Canada. On the Ottawa, as far as I can ascertain, there goes to waste daily between seven and eight hundred tons of what is called waste lumber and which is costing the lumber men a very considerable amount of money to dispose of. That quantity of wet lumber would yield say 400 tons of dry lumber and that would be sufficient to make 50 or 60 tons of high grade charcoal pig iron, and to convert that iron into an equivalent quantity of very high grade steel—that is assuming that the iron ores are what they are believed to be. This waste lumber to-day is simply used for defiling the water and killing the fish in that grand river. Nevertheless that sawdust and that waste lumber, twigs and every thing that will smoulder could be turned into valuable fuel, and that fuel used in the manufacture of the most valuable iron and steel. (Applause.) It seems to me that is the direction in which Canadians should work. I have been on a Swedish river on which there were 50 or 60 saw-mills and that river was as unpolluted and as full of fish-life as if there were not a mill on its banks. Remember, gentlemen, that is the case, not because it is against the law to throw their refuse into the river, but because the Swedes think it is unmitigated and scandalous waste, and no Swede would think of doing it. We are guilty of this sinful waste in the United States as well as in Canada. I think we are more blamable in the United States, because we do things on a larger scale, and therefore our sins are in proportion to the scale on which we work. I believe, gentlemen, that every intelligent metallurgist on both sides of the line should work in the direction of preventing this waste and at the same time improving our iron industry. (Hear, hear.) It is with that purpose that I have put together these notes on Swedish Metallurgy. I do not think it has ever been proven that in Canada you have got these very high grade ores, nor do I think it has not been proven. But I do say that you have waste lumber enough here to make your iron and steel production equal to at least one-tenth of the total iron and steel production of Sweden. If you have the iron ore you have the lumber, and I believe you have the ore, and you can turn your attention to no more useful purpose than using the one to redeem the other. (Loud applause.)

(See the paper by Dr. Douglas on page 38 of this volume.)

THE PRESIDENT—We are not only indebted to Dr. Douglas for his technical instruction, but we are indebted to him for the lesson which he has given us on national economy. (Hear, hear.)

DR. DOUGLAS—I will suggest to the members present that it would be well worth their while to examine the report of Dr. Lundbohm. He has illustrations in his book which are very interesting.

THE PRESIDENT—We have received a communication from Mr. E. A. Sjostedt, himself a Swede, who has done iron smelting in Alabama and Nova Scotia. Mr. Sjostedt has sent his remarks to the Secretary with reference to the paper of Dr. Douglas.

Mr. BELL, the Secretary, then read the following communication from Mr. E. A. Sjostedt :—

" Your favor of the 23rd, with enclosed advance sheet of Dr. Douglas' paper on " Swedish Iron Metallurgy and its application to Canada " reached me this morning, and as I am away from home at present, busily engaged on some experimental work here, I can spend only a few moments now in an effort to meet your wishes in " taking a hand " in the discussion of Dr. Douglas' admirable paper.

Allow me, then, first to congratulate the writer on his correct conception of the conditions governing the Swedish iron industry, which I have followed closely ever since my college days, and the advancement and wonderful vitality of which both of us, it seems, were fortunate enough to have an opportunity to observe and admire at the Stockholm Exhibition in 1897—a finer display of high quality iron and steel (I feel confident Dr. Douglas will be but too glad to admit with me) there never was. I wish also to thank the writer for his thoughtfulness in giving us, Canadians, such a timely reminder of " the way we should walk "—which also happens to coincide so entirely with my own views on the subject, as presented to this Institute a couple of years ago in my paper on the " Utilization of the Mill Refuse and Peat Mosses of Ottawa." For young Canada, and especially the Provinces of Quebec and Ontario, can indeed, and with profit, follow the example of plucky old little Sweden, with which they have so many similarities in common—such as an abundance of iron ores and other valuable minerals, vast forests, extensive peat bogs, and hardy men, besides the lack of good mineral fuel—and the sooner the lesson is taken to heart, the fewer mistakes will be had to repent, and the sooner will this vast Dominion attain its proper place among the mining and industrial nations.

" Economy of fuel " and " quality before quantity " are the two watch words of industrial Sweden as well as the secret of its success. The zealous care of the forests, the utilization of every kind of waste material of a combustible nature (in the gas generator for fuel purposes), and the untiring care bestowed on every detail of the manufacture, have also enabled Sweden to pursue a most important iron industry in all its branches, for centuries, and this without possessing any mineral fuel of consequence. Neither does the success of this industry depend altogether on exceptionally pure and rich iron ores (for the celebrated *Persberg* and *Dannemora* ores, for instance, do not average much over 50 per cent. metallic iron, and some of the latter contain over 1 per cent. sulphur), but on the infinite care with which the furnace material is prepared, and on the purity of the blast furnace fuel (charcoal). Besides being carefully sorted and sized, the ores are here nearly invariably roasted, not in a indifferent and hap-hazard manner, but most thoroughly and intelligently (in a Westman gas roasting kiln), with special consideration to the different objects aimed at in treating the various kinds of ores. It must, however, be admitted that all the Swedish ores used at home are extremely low in phosphorous, and these ores are most carefully reserved for home consumption, while only the phosphoretted ores—such as those from *Gellivara* and *Grängesberg*, for instance—are exported. This old "protective" policy among the great corporations, holding the purest ore mines, gives them practically a monopoly of the best pig iron and steel billet trade, and enables them to obtain a price for their products, in and out of Sweden, that would make a Canadian ironmaster feel quite envious—although, as I have stated before, he might not be disposed to take all the innumerable small precautions used here, which are indispensable for attaining such results.

To what an extent these precautions sometimes are taken, and to what expense the Swedish iron master is willing and ready to go, in order to gain in even the slightest degree in quality of product, you can get an idea from an instance that came to my personal knowledge only two years ago, while making a tour among the iron works of Sweden, when at *Söderfors* they were actually killing out their birchwood growth, and in its stead were planting pine and fir trees, solely on account of that shade of difference in the amount of phosphorous present in the hard wood, over and above that in the soft wood. Here they used *Dannemora* ores, with only .001 to .007 per cent. phosphorous, please remember, and still to avoid the additional .001 or .003 per cent. of this objectional element, they preferred to add some 50 per cent. to the cost in fuel—and it paid them to do it! For, questioned if he honestly believed that this minute difference in phosphorous really in any measurable degree affected the strength or other quality of the steel produced, the manager admitted that he was not very certain, but as the trade gave the preference to those showing the absolutely lowest percentage of phosphorous in their steel (even to the extent of .001 per cent.) it was not for him to argue this point, but simply to study out how, and do everything in his power, to reduce this element to the lowest possible figure—cost what it may, so long as the importers were willing to pay for it.

In my articles from the Stockholm Exposition (written for the *Iron Age*) I also pointed out how few of the Swedish iron works confine themselves strictly to any one particular branch, and how many convert their own raw material—pig iron, ingots or billets—either into a half finished product, or into even the smallest articles of trade, some also going into the manufacture of other material, such as wood pulp, paper and lumber (as also stated by Dr. Douglas). The reason for this is evidently to avoid being dependent upon the price fluctuations of the raw material, and to enable them to throw the bulk of their working force on that branch, among the different ones pursued, which at the time promises the largest profit.

As regards the high charcoal consumption at the Swedish furnaces, dwelt upon by Dr. Douglas, it is only necessary to remember that the charcoal is made from softwood slabs and ribs from the saw mills—a material which the Canadian lumberman wastes, and our furnace men despise, accustomed as we are here in America to consider only the best of hardwood fit for this purpose. That, measured by weight, instead of bulk, however, the Swedish practice is as good and economical as that of any country, in corresponding size furnaces, is needless to say.

As Dr. Douglas gives you so many facts and figures from the large *Domnarfvert* Works, I beg leave to point out that in respect to quality of goods produced, Sandviken Iron Works (as plausibly illustrated by its exhibit at the said Stockholm Fair) stands second to none in the world. As samples of their special skill in cold rolling long iron bands, for instance, they displayed one that measured 8 inches wide and 2,293 feet long, of 1,155 lbs. weight, also a "light weight" champion of 4,205 feet in length and 2⅜ inches in width, but only 43 lbs. in weight. The thickness of this band cannot be measured in the ordinary manner, as it is only .03 mm. (about .0012 inch); but a still thinner one, measuring .02 mm. (.0008 inch) was also among these unique exhibits. Here was also a hot-rolled band, 290 feet long, 8 inches wide and $\frac{5}{32}$ inch thick, weighing 1,241 lbs., made in one heat, and which is believed to be at the same time the heaviest and longest band ever produced in a similar manner in any part of the world.

In conclusion I will give you the latest published statistics of the Swedish iron industry for 1897:—

Pig iron	538,197	metr. tons.
Blooms	189,632	"
Bessemer steel ingots	107,679	"
Siemens-Martin steel ingots	165,836	"
Crucible steel	691	"
Blister steel	922	"
Bar iron and steel	155,991	"
Plates, tubings, etc., etc	176,568	"
Total	1,335,516	"

Iron ores mined		2,087,166 m. t.
Of which Magnetites	1,854,821 m. t.	
" Red Hematites	231,295 "	
" Brown ores	1,047 "	

The President—We have also present to-night one of the ex-presidents of the Federated Institute who is well posted on the iron business of Canada, and I am sure we will all be glad to hear what Mr. George Drummond has to say.

Mr. Geo. E. Drummond—I have listened with much interest to the eminently practical address of Dr. Douglas. For some years those of us who are interested in the manufacture of iron have been trying, by papers read at our meetings, to awaken an interest in the minds of the Canadian people in the vast natural resources possessed by this country for the manufacture of the most useful of all metals—iron. The great drawback in Canada hitherto in this enterprise, as in a good many others, has been want of confidence in ourselves and our resources, and it is certainly very gratifying to have one of the most eminent metallurgical authorities in the United States come here to-night to publicly recognize the value of these resources and to endorse in regard to the same what we, in this Institute, have so frequently brought to the notice of the Canadian public. Canada's natural fitness for the manufacture of charcoal iron is, I believe, quite as great as that of Sweden. We have vast forest stretches, from which the pine and other merchantable timber of like nature have been removed, and upon which exist a growth of hard and soft woods more extensive perhaps than that possessed by any other country, and just such wood as will make the finest class of charcoal fuel. In the matter of ore, the researches of the officers ot our Geological Survey, and the practical work accomplished by the pioneer furnace-men of this country, although as yet amounting to little more than a "scratching of the earth's surface," have amply proved that we have ores within our borders at least equal to the average ores of Sweden, and in some cases possessed of qualities unrivalled by those of Sweden or any other country. We have in the past lacked confidence, and that necessarily meant also a lack of the "sinews of war," without which this or any other great industry cannot be made thoroughly successful. Dr. Douglas, at the commencement of his paper, states that in the matter of iron-making Canada is certainly "not conspicuous for energy," and he speaks very truly of our "backwardness," but we may be pardoned in reminding him that in Canada we have as yet only some five million people, and while we admit that we are not producing anything like the quantity of iron that we should, yet our exploits in that particular direction of national development compare very favorably with what the American people had accomplished at the same period in their existence. In the year 1810 the U.S. had a population of 7,239,903, and according to a statement of the "Arts and Manufactures of the U.S. of America," as they existed in 1810, prepared by Tenche Coxe, under the authority of Albert Gallatin, secretary of the treasury (a record of which will be found on page 509 of "Iron in All Ages," by Swank), with a population more than one third larger than that of Canada to-day, the U.S. only produced some 53,908 gross tons of pig metal, in addition to which she produced some 44,485 tons of finished, that is to say, wrought iron products. Canada with five million population produced in 1898 about 65,000 tons of pig iron, and in addition to this she produced in the rolling mills, steel works and wire nail factories of the country, a further 125,000 tons of material such as bar iron, wire nails, etc., the whole of which was made either from scrap metal or imported raw material, and not a ton of which was made from the pig iron produced in Canada. In addition to these finished goods about 24,000 tons of steel was made in Canada from the product of Canadian furnaces.

It will naturally be urged that iron was not consumed at the same rate per capita in 1810 as it is to-day, but on the other hand, the American iron producers had the natural protection of being separated by some 3,000 miles of ocean from their only possible competitors, viz, the iron masters of Great Britain, and it must be remembered that in those days ocean freight rates amounted to something, and afforded a splendid natural protection to American iron makers.

The best American authorities unite in agreeing that one great reason why their industry made such slow progress in the early days was that the iron masters were not protected by customs duties against the more fully developed industry of Great Britain. This same argument can be made in defence of Canada's tardy progress with ten times greater force when it is considered that our country lies along the borders of the U.S., the greatest iron producing country that the world has ever seen, and in this connection it might be well to remind Dr. Douglas that it was only in 1887 that the Government of this country saw fit to introduce a fair measure of protection to the native industry, and it is only some two years (or in 1897) since Canadian tariff questions were placed upon a settled basis that gave confidence to our iron producers and to capitalists generally. It can therefore be fairly said that we have just started upon our career of development. The present year will see at least two additional furnaces in blast in Canada, and within the next two years at least we will probably have four more furnaces in addition to those now in blast. The first stage in the progress of the native industry will have been passed, and the products of our furnaces will over-lap considerably what we can readily absorb for ordinary foundry practice, to which we are at present largely limited, and we will have to find a market for the over-plus stock in the manufacture of all forms of finished steel and iron. All that is wanted to accomplish this is that the Government shall maintain a steady settled policy for a few years, and give those now interested, and those who will join them, an opportunity to get the business on a solid modern foundation.

Dr. Douglas' most interesting description of the intelligent way in which the Swedish iron masters have "adjusted themselves to new conditions and new requirements," and have learned to utilize their own pig metal for the manufacture of finished iron and steel, thus securing to themselves and Sweden the maximum value of the labor required to bring the products to the highest stage, and to do it profitably, should be of great encouragement to Canadian charcoal iron producers, who will probably find a more permanent success in building up an industry where quality of product rather than the matter of price is paramount.

It would necessarily be a difficult thing for Canadians to seek to rival the established American producers in the matter of cost of production in coke irons, but in charcoal irons, possessed of unlimited raw matetial, the Canadian producer ought (once thoroughly established) to be abie to compete with Sweden and the U.S. or any other country, and the history of the Swedish industry, as set forth in Dr. Douglas' admirable paper, indicates a profitable course for Canadian producers to pursue.

Certainly the first requisite of charcoal iron should be quality, leaving to the coke iron producers the wider field afforded for cheap products.

The Swedes have certainly succeeded wonderfully in the building up of their iron industry, but a somewhat recent investigation of a few of even their larger plants, viz, in 1896, by a member of my own company, Mr. John J. Drummond, would indicate that the Swedes at that time, had not reached perfection in their methods of operation, and I will mention some of the impressions formed by him as a guide to Canadians generally.

Coal.—He says, speaking of a visit to one of the largest works. "In the making and handling of coal we have nothing to learn from them. I consider our ordinary kiln system (I do not refer to modern by-product plants) far ahead of their largely used Meiller system, but their coal is more uniform in size than ours, some of which is too large. Their system of storing coal for some months before using is, I think, a good one, and well worth following, as it tends to regularity of moisture throughout the whole, and would give steadier running of furnace."

Ore.—In the matter of ore Mr. J. J. Drummond places the Swedish methods very high. He says: "They are much more careful than the usual American or Canadian furnace-men in the handling of their ore from the time it leaves the mine till it is used at the furnace. They handle only well known and thoroughly tested grades of ore, the properties of all of which are well known to them. They are particularly careful in the roasting, breaking to walnut size, and the proper and thorough mixing of their ores and flux as they are charged into the furnace. Nothing can be better looked after than this department."

Furnaces.—"Their furnaces, and furnace plants generally, are not so modern as ours, and their furnace work proper is poor. For instance, each of their furnaces has (according to the superintendent of the plant I refer to) 2,660 cubic feet working capacity, and the two combined 5,320 feet in which they make 28 gross tons per day, with roasted ores yielding 64 per cent., or a gross ton to every 190 cubic feet." This struck Mr. Drummond as peculiar in view of the fact that in his own practice, working on lean ores in a very moderate sized furnace, he was able to secure one gross ton on about 50 cubic feet.

A point that he was very much impressed with at nearly all the works visited was the large number of managers, superintendents and clerks employed about the different works, much more numerous than would be necessary about American or Canadian plants. He says: "I observed extremely large staffs at every plant visited."

Speaking of one of the large works he says: "Compared with American works this place is not run to advantage. There is a lack of system and push, and men take work easily as a rule. The whole place looks a trifle slovenly and generally out of shape. Furnaces are not "up to date" being built of brick from top to bottom, and banded with iron.

Labor.—He refers to the great advantage enjoyed by Swedish producers in point of cost of labor, and says: "I find good engineers and machinists are paid 2½ krona per day, or equal to from 65 to 70 cents of our money. Good miners also receive the same rate of wages, and ordinary laborers only 1½ krona per day, or 40 cents. The system of work is one shift of 8 hours, then one of 16, which seems to work well among the men. Evidently 12 hours constitutes a day's work."

Educated Labor.—In the matter of education, technical and ordinary, I think they have a great advantage over us, as nearly all their working men have the benefit of a fair education. The officials generally seem to have been specially educated in their various lines (the outcome of a long established business) special facilities being provided for their education. Sons follow their fathers in their special lines of work in old and well established concerns, and the Swedes will thus, for a time at least, enjoy a great advantage in this respect over Canadian iron producers establishing a new business in a new country.

Capitalization.—The larger of the Swedish works are heavily capitalized, a most important consideration in the successful building up of the iron industry.

On the whole there is no reason to doubt but that the Canadian iron industry can, in due time, be brought to such perfection that, in point of quality of product, it can compete in the European markets (as the product of at least one of its furnaces does now to some extent) with the first rank brands of Swedish charcoal iron.

With the introduction of more modern methods in our new plants, and with such splendid natural resources as Canada possesses, we should be able to compete most successfully with the Swedes in the matter of price, and gradually take our proper rank among the charcoal iron producers of the world, but the line indicated by Dr. Douglas, that we should first seek quality and then carry our product to the highest form of manufacture, is, in my estimation, the proper course to pursue.

MR. DWIGHT BRAINERD—I am beginning to think that in Canada we have depended too much on government protection and government assistance, and made too many excuses to ourselves for not being more advanced in many lines of industry. Dr. Douglas spoke about the waste lumber on the Ottawa, and without wishing to tread upon anybody's toes I may say that there is a waste in almost every manufacturing concern in Canada.

PROF. MILLAR—Perhaps Dr. Douglas will give us some idea of the details of the iron-producing industry in Sweden.

DR. DOUGLAS—I do not think that the Swedish works will in any way compare with our modern works. Sweden suffers, as they suffer in England, from low wages, and wherever wages are low people become extremely wasteful of labor. On the other hand, wherever wages are high, the people economise and try to supplant the labour by machinery, and that is one reason why the United States occupies her high position to-day. I am not an ironmaster, but I am working in the west where we have to pay $3.50 per day for certain kinds of skilled labour. Well, we cannot afford that, and therefore we reduce labor to the minimum and employ machinery to the maximum. That has been the case all through the United States, for we have been driven to do it and have done it. In Sweden labor is cheap; technical labor is cheap and good, and there is plenty of it. Sweden employs hand labor, and six men are working where one man is employed by us. You could adopt Swedish methods and make Swedish products, and yet not swallow Swedish practices. I do not mean to imply that we should select Sweden as an example and adopt all her methods, but we could adopt the best of her methods and improve upon them. Some of Mr. Drummond's remarks are very pregnant, but when he goes back to the revolutionary times and compares what the United States was without steam, to what you, in Canada, are doing with steam, he is not complimentary to Canada.

MR. GEO. E. DRUMMOND—I made allowances. I gave the United States one-third more population and I cited the fact that you were 3000 miles from your nearest competitor. I wanted to emphasize the point that, competing as we do with the American people, the biggest iron producers in the world and the greatest hustlers in the world, the cases were somewhat analogous.

MR. DOUGLAS—So they are. I read a paper before the Society of Arts in London and I tried to stir up my English friends on this subject. If you go back to 1837, the commencement of Her Majesty's reign, you will find there were in the United States 800 blast furnaces, mostly scattered over the wild west, in Michigan and Wisconsin. There was good transportation even then in Canada. In fact there were more blast furnaces in Canada then than there are to-day, or in the United States either. For want of the transportation facilities we now have, wherever there was a little wood and iron they were obliged to have a little blast furnace and to make iron for their local consumption. Gradually these little furnaces were eliminated and we have to-day the iron production centered in favorable centres. At that time these 800 furnaces made about what one big furnace produces to-day. The conditions are entirely changed. In Sweden they are extremely primitive in their methods and their furnaces are extremely small, even the biggest of them only turning out 40 or 50 tons a day, which is a mere trifle. At the same time they set a very high aim before themselves to produce the very finest of iron and steel, and that is an object we also should aim at.

MR. BURLEY SMITH—Could the sawdust be used without being dried?

DR. DOUGLAS—If it smoulders at all it will do. I may say that I do not think peat would do to make a high grade iron. I think peat has one per cent. of phosphorous, and that would be fatal.

MR. BURLEY SMITH—Coniferous woods do not contain so much phosphorous as the hard woods.

DR. DOUGLAS—So it has been stated.

MR. INGALL—One feature that is encouraging in Dr. Douglas's paper is the fact that notwithstanding there may be a good deal of sulphur in our iron ores, yet by careful selection they can use these ores. That is important news for central Canada. The difficulty in the past has been that from that portion of Canada they have looked to selling their ore to American smelters, and I think they have devoted their attention to producing quantity instead of quality. Instead of selecting the best ore, they have produced a good deal of the unselected material, and the percentage of iron ran low and the percentage of sulphur high. Titanium was markedly absent except in a few cases. I think that these deposits were found to be somewhat similar to the Swedish deposits. The trouble we have had is that there has been so little information to be obtained as to the average analyses of our shipments of ores. In many cases we could not take the averages of large bodies of ore, and all we could do was to take the best ore we could get and see how it ran.

MR. COSTE—There is no doubt that some of our ores in the Madoc district are full of sulphur and would have to be roasted.

MR. INGALL—While that may be true, my experience is that in some deposits there would be a large body of good ore fairly free from sulphur, and in another part of the deposit it would be high in sulphur, so that it comes to a question of selection.

DR. DOUGLAS—When you get a less quantity but higher prices for your final product, it would pay to make a selection.

MR. GEORGE DRUMMOND—Everything rests on that. We can afford to roast our ores and to select them carefully if we get the price.

MR. INGALL—It appears to me that if we enter into competition with the Swedish ores, the market being limited, we would be more or less cutting our own throats.

MR. GEO. DRUMMOND—I do not think it well that we should go away with the idea that all our ores require to be roasted, because as a matter of fact, we have in Canada iron ores that are very free from sulphur. Deprived of access to the American market by Custom imposts, our iron ore producers have been compelled to leave their mines in a more or less undeveloped state up to the present. We are now creating our own market by the erection of Canadian furnaces at various points throughout the Dominion. For instance, my associates and myself are just now engaged on an enterprise that will mean the erection of a new charcoal furnace during the present year, commencing with an output of 80 tons of pig metal per day, the ore supply for which, we intend, shall be taken from Canadian mines. I believe that this creation of a home market will soon develop important mines of high class iron ore in Canada.

MR. INGALL—What is the average run of the mines on Kingston and Pembroke Railway?

MR. GEO. E. DRUMMOND—We are using very little of the magnetite ores in in our present furnace, but what little we have required we have been able (after proper investigation) to get from the Kingston and Pembroke district of a quality comparatively free from sulphur. I am aware from personal investigation that in the

Kingston and Pembroke, and Madoc districts the ore is often very high in sulphur, and the question is whether can we afford to roast such ores. If, however, we build up an industry here such as they have established in Sweden, and secure prices for our products anything like what the Swedes have been able to obtain, we can very well afford to roast at least a portion of our ores.

Dr. Douglas—I do not think that Mr. Ingall need worry about the limited market. The world is growing so large that there is no danger of your surfeiting the market.

Mr. Burley Smith—I should think there is sufficient of ore in this country to make it unnecessary to use magnetic ores.

The President—I venture to think that Dr. Douglas deserves the hearty thanks of the Institute for his paper, which has been not only a lesson in political economy, but has been productive of a discussion which certainly enhances the knowledge of some of the members as to what their own native country is capable of. (Applause.) We have had occasion before to thank gentlemen who came from the other side of that invisible line which divides but does not separate the two countries, and we are under obligation to them again to-night. (Applause.) We have with us Dr. Ledoux, also from New York, who has won for American sampling and American ore sellers a standing in the markets of the world which was not possessed before. Dr. Ledoux also occupies the position of a vice-president of the American Institute of Mining Engineers, and I beg to introduce him to the members of The Canadian Mining Institute. (Applause.)

On the Sampling of Argentiferous and Auriferous Copper.

Dr. Ledoux, of New York, who was received with applause, then read a paper on "The Sampling of Argentiferous and Auriferous Copper" (reproduced on page 108 of this volume).

The President—This paper of Dr. Ledoux's will be found of great importance to the people of British Columbia. Has Dr. Ledoux sampled the anodes coming from the Hall mines?

Dr. Ledoux—I think I have sampled all of them.

The President—These anodes, as you know, carry a large amount of silver as well as gold.

Dr. Ledoux—Yes.

The President—You said in your paper that the casting of this blistered copper into the anodes is of decided advantage.

Dr. Ledoux—It is.

Dr. Douglas—If you can say so without betraying professional secrets, would you give the range in gold and silver in copper as carried in anodes as compared with copper running in pigs?

Dr. Ledoux—Material of that kind certainly contains the five-hundredths of an ounce. We have bored 18 holes in the anodes and assayed every one separately and the extreme variation was less than three ounces.

Dr. Douglas—I may say that the whole question of buying and selling furnace products in the United States has undergone a great deal of change. In the early days England was the arbiter and everything had to be sold in the United States and Canada to English sample and assayed by what they call the English method. From a certain point of view, that was a very sensible procedure. The English assayer put it through the same series of intricate operations that the English furnace man put it through, and he got some result, but what that result was the shipper had not the faintest anticipation of; it might be two, or three, or four per cent. under his assays. Long ago, the United States sellers kicked against that and at home everthing was sold on the arbitrary deduction of one and three-tenths per cent. But for a long time England absolutely refused to take any of our furnace products unless we would allow them to sample and assay them their own way. That went on until England could not do without them, and then, of course, we had our own way, and our way is to sell them subject to Dr. Ledoux's weights and assays. (Applause.) However reluctant, the English people have been obliged to submit to that. I do not think *they* suffered, and I know *we* have not. We sell a great many thousand tons of copper bar every year subject to Dr. Ledoux's weights and sizes, and so Dr. Ledoux has become a by-word and a proverb on both sides of the Atlantic. (Applause.)

The President—I have great pleasure in conveying to Dr. Ledoux the thanks of the Canadian Mining Institute for the very valuable and interesting paper which he has just read.

The meeting conveyed its thanks to Dr. Ledoux amid applause.

Acetylene Gas as a Mine Illuminant.

Mr. Andrew Holland, of Ottawa, addressed the Institute on the above subject as follows: When in the innocence of my heart I accepted your worthy Secretary's invitation to address this Institute on the subject of "Acetylene Gas as a Mine Illuminant," I had not calculated on the fact that I was to appear before an assembly of gentlemen eminent in their professions, well read on the scientific developments of the age in which we live, and no doubt more familiar with the technical and scientific questions involved in the production of calcium carbide and acetylene gas than I can possibly be. Having recklessly pledged my word, however, if you will bear with me a few minutes I may be able to say something of the practical application of acetylene that will be of interest to you as mining engineers. As you are aware, calcium carbide is a product of lime and coke, caused by their fusion in the intense heat of an electrial furnace. I am proud to say the invention or discovery of how to produce calcium carbide is the work of a Canadian, Professor Wilson, of St. Catherines. The discovery was brought about by an attempt, in 1892, by Professor Wilson to reduce lime to its metallic base by heating it with charcoal in the electric furnace. Instead of obtain-metallic calcium, as he had expected, he produced a hard crystalline substance now known as calcium carbide. This substance is infusible except in the electric arc. The gas is permanent in the calcium in a dry atmosphere, but carbide slacks like quick lime when exposed to moisture. Treated with water it decomposes violently and gives oft acetylene, a gas having a strong odor and powerful illuminating qualities. The utilization of this gas as a mine illuminant is a subject of vast importance to the mining industries. More powerful than electric light, it is portable, requires no expensive plant or expert knowledge, and what is probably more important than all to the workmen in underground work, it removes less oxygen from the air and produces less carbon dioxide than any other known mine illumimant, the electric incandescent light excepted. Its heating effect is practically the same as that of coal gas burned with the incandescent mantle. Miners can readily see the importance of having a lighting element that is at once

Simple in operation,
Economical to use,
Powerful as an illuminant,
That does not rapidly consume oxygen, or vitiate the air with smoke or noxious gases, and at the same time is safe and portable, and requires no expert knowledge to operate it.

My first experience with acetylene as a mine illuminant was in the Grand Calumet Silver Lead Mine in the vicinity of Ottawa. A small generator containing a pound charge of carbide was used to light a shaft 10 x 12 at the 60 foot level. The burner was a Bray, consuming only half a foot of acetylene per hour. When the gas was lighted the shaft was so brilliantly illuminated that the smallest piece of rock could be distinctly seen from the top of the shaft. The manager of the mine, Mr. McC. Ritchie, reported as the result of the first week's experience with the new light, that his men had made an increase of three feet in sinking, over the best week's work that had been done in the shaft—a gain sufficient to pay for the lighting plant and carbide to run it for six months. He added that the health of the men was better than it was while mining with oil or candle light. Acetylene light is now in use in many mines as an illuminant. The carbide is packed in galvanized steel cans containing 100 lbs. fastened with screw covers. It is easily portable, and needs only to be kept dry to be perfectly safe. It does not leak and contaminate everything it comes in contact with as oil does, and it can be taken into the roughest mining country without difficulty. There are scores of generators on the market, adapted for all kinds of lighting. I am myself the inventor of, I believe, the only successful acetylene head-light for locomotives. It is now running on the Pontiac and Pacific, Gatineau Valley, and Canada Atlantic Railways. The engineers declare that acetylene gas has greater diffusive power than any other illuminant that they have ever used in a headlight. Engineer McFall of the Ottawa and Gatineau Railway says that he would rather buy carbide out of his own wages than go back to oil light for his locomotive.

The popular impression that acetylene is dangerously explosive is due principally to the terrific explosions which took place in the Jersey City Works, where ordinary low pressure acetylene gas was converted into liquid acetylene under high pressure. Of course anyone can readily understand that 400 cubic feet of gas subjected to a pressure that reduces it to one cubic foot, when it becomes a liquid, creates a dangerous element. Ordinary atmospheric air compressed in the same way under one temperature, when subjected to a rapid change in temperature would also develop a tremendously expansive force. It is believed by some authorities that the explosion of liquid acetylene at Jersey City was due more to impure carbide used in its production than anything else. Pure acetylene is not explosive. It requires a mixture of air to render it so. I have been unable to trace any explosion of acetylene gas generators to any cause but gross carelessness and ignorance, and in no case have I ever heard of a spontaneoms explosion of acetylene or a destructive fire being caused by an acetylene explosion. Vested interests in coal gas, electric light and oil companies have made the most of the explosions that have taken place to create distrust in the public mind. They might as well, however, try to roll back the ocean tide or the flow of the St. Lawrence River as to prevent the developments of this progressive age. Acetylene has come to stay. We have only touched the edge of the market for it yet. I expect to live to see the day when locomotives and Atlantic liners will be propelled by steam generated from carbide. The possibilities of our immense water powers, the development of the electric furnace and by its means the conversion of what we have hitherto looked upon as waste products will, in the near future, create a wonderful industrial development in Canada, not the least of which will be the manufacture of Calcium Carbide. The industry is yet in its infancy. It stands to-day in the same relation to coal oil that coal oil did half a century ago to the tallow candle. I have probably followed the practical application of acetylene as an illuminant, more closely than many of you gentlemen have done, and my advice to mining engineers one and all, is to keep posted on its development, for the product of the electric furnace will as surely be in the 20th century the poor man's light as the product of the petroleum well has been in the latter half of the 19th century.

THE PRESIDENT—There are, no doubt, some members present who would like to ask Mr. Holland some questions.

Mr. HOLLAND—I shall be happy to answer any questions to the best of my ability.

THE PRESIDENT—Might I ask you what is the danger, if any, in using acetylene?

Mr. HOLLAND—As far as my experience goes there is positively no more danger in the use of acetylene as an illuminant, when generated in small quantities in proper apparatus, than there is with any other illuminating element—in fact there is less danger with it than there is with coal oil.

THE PRESIDENT—I presume that carbide will be extensively manufactured in Canada?

MR. HOLLAND—I am satisfied that the manufacture of carbide will within a very short time become one of the important industries of Canada. At present there is only one factory—that of the Willson Company, at St. Catherines, Ont. Its capacity is only 3½ tons per day. In a conversation with Prof. Willson to-day, at the Russell House, Ottawa, he gave me to understand that he had about concluded arrangements with a number of Ottawa capitalists, owners of large water powers there, to manufacture under a royalty to his company. In fact one factory has commenced operations and already has two furnaces in operation turning out carbide. Other furnaces will be installed as rapidly as possible. The demand for carbide during the past winter was so great that it could not be supplied, and two-thirds of the generators installed for house lighting had to be shut down. The carbide famine existed all over this continent.

MR. LEWIS—Is it not a fact that in the United States there were several accidents reported as caused by acetylene explosions?

MR. HOLLAND—Yes, that is a fact, but in every instance they were due to carelessness or the same sort of reckless ignorance that causes accidents with coal oil by filling lamps while lighted, pouring oil into a cook stove to hasten the getting of the breakfast, or with coal gas by prospecting for a leaking pipe in a cellar with a lighted candle. Such accidents will always occur with any lighting element that is explosive, where ordinary care is not exercised. As I said before, the explosions that caused such death and destruction of property in Jersey City, were not of liquefied acetylene, an element so dangerous under all circumstances in its present stage of development that Professor Willson will not sanction its manufacture in Canada under his patents.

THE PRESIDENT—Is not acetylene more explosive than oil or ordinary illuminating gas from coal?

MR. HOLLAND—I have not found it so in practical use. Professor Lewis, of London, England, in his interesting experiments, finds that it requires a smaller quantity of acetylene in a given quantity of air to cause an explosion than it does of ordinary gas. But acetylene has this advantage. An ordinary Bruy burner of 16 candle-power consumes 7 feet of ordinary illuminating gas per hour. An acetylene burner of 25 candle-power consumes only half-a-foot of gas per hour. Consequently if an acetylene gas burner were to remain open for ten hours in an ordinary room the proportion of gas to air would not make an explosive mixture. You must also bear in mind that there is no such thing as spontaneous explosion of low pressure gas. You must have an air mixture and fire or flame to produce it.

THE PRESIDENT—I would like to ask Mr. Holland what kind of lamps he used in the Calumet mine?

Mr. HOLLAND—It was a small generator made of galvanized iron, about the size of an ordinary water pail. It carries a charge of one pound of carbide, which is sufficient to run a 25 candle.power gas jet for five to seven hours, according to the purity of the carbide and the care used in preventing leaks. The generator is stationed in the most convenient place in the shaft and the gas is conveyed through a ⅜ rubber tube to a short bracket and ell cock and burner that can be stuck anywhere in a crevice in the rock where it will throw the light to the best advantage. When the holes are drilled and loaded for a blast, the generator and bracket are taken up out of the shaft until the blasts have been made, and then taken down again and replaced.

THE PRESIDENT—Is that the only form in which it has been used underground?

Mr. HOLLAND—I have not heard of permanent plant being installed in a mine. Of course a large generator and regular piping could be put in where no blasting was being done. Acetylene must be burned as an open flame, and could not be used in coal mines or where explosive gases are developed.

THE PRESIDENT—I asked you that question because to be used successfully in a mine an acetylene light must be in such a practical form that it can be used in any part of the shaft or stopes.

Mr. HOLLAND—In that case you could use small hand lamps, such as you see in bicycle headlights.

THE PRESIDENT—And they are perfectly safe?

Mr. HOLLAND—Yes, perfectly safe. The quantity of acetylene generated in a lamp at one time is so small that if it did explode it would not be as dangerous as a fire cracker.

Mr. COSTE—How do you get your water pressure?

Mr. HOLLAND—In all these small generators there is a reservoir and regulating value for the water feed.

Mr. COSTE—Not with the small lamp?

Mr. HOLLAND—Yes, the acetylene lamp is a generator and lamp combined, no matter in what form you get it. One fact about the acetylene light is its wonderful diffusive power. Mr. Murphy, engineer on the Pontiac Pacific Railway told me this winter that the acetylene headlight pierced through fog and falling snow in a way that no other headlight can.

Mr. ANDREWS—Is there any way of overcoming the disagreeable odor of acetylene?

Mr. HOLLAND—There is no odor from acetylene when it is burning; the odor is from escaping gas, and the gas itself is not injurious to health until it is in such quantity as to displace the air, and then it kills by asphyxiation.

Mr. ANDREWS—Is there any way of preventing the escape of gas when refuse is taken from the generator.

Mr. HOLLAND—No, a certain amount of gas will always escape when the generator is opened, but the smell soon disappears. In some generators the refuse carbide is drawn off from the bottom like milk of lime. It is called the wet process.

Mr. ANDREWS—In taking the ashes out is there not always some carbide in them that contains a certain amount of gas that would cause danger from fire?

Mr. HOLLAND—Not where ordinary precaution is used. Before cleaning out the refuse, if sufficient water is allowed to enter the generator to decompose the carbide the ashes will be damp and and will give up all its gas, and while they will throw off a strong odor of acetylene there is not sufficient gas left to light with a match.

Mr. ANDREWS—Mr. Holland has referred to the advantage of being able to carry carbide with provisions in taking supplies to a mining camp. Does he refer to carbide in sealed cans or loose?

Mr. HOLLAND—Carbide must always be carried in air-tight cans or drums. Like quick lime it readily absorbs moisture from the air and slacks, giving off its gas. The safest place to keep carbide would be alongside a furnace, or in a furnace for that matter. It will keep for any length of time in a dry atmosphere.

Mr. ANDREWS—What do you calculate the cost to be of lighting with acetylene?

Mr. HOLLAND—At the present price of carbide, $76 per ton, a 25 c. p. light costs about half a cent per hour. Of course this varies with the quality of the carbide. If Prof. Emmerson's process of utilizing sawdust as a source of carbon supply is a success, carbide of a superior quality can be produced and sold at such a low price that coal oil cannot compete with it in any sense. It is calculated that at Ottawa from 700 to 800 tons of sawdust are thrown into the river daily from the sawmills. During the coming season Prof. Emmerson proposes to convert that vast quantity of waste material into marketable products, one of which is carbon. The carbon is rendered chemically pure in the process of producing it, and used in connection with a high-grade lime the carbide made from it is of a superior quality. Prof. Emmerson believes that he can make carbide with it that will yield from 8 to 9 cubic feet of gas per pound, as compared with 5 feet from carbide made with coke and lime.

THURSDAY MORNING SESSION.

THE PRESIDENT took the chair at 10.30 a.m.

AN IMPROVED METHOD OF FEEDING WATER TO THE STAMP MILL MORTAR.

MR. BERNARD MACDONALD then addressed the members on this subject (see pp. 54 and 102 of this volume).

THE PRESIDENT—Those of you, gentlemen, who have had anything to do with milling, especially gold milling, will appreciate Mr. Macdonald's paper. I wish simply to say that the device in its present application may be new, but that so long ago as 1882, I saw practically the same thing in use in a stamp mill in South Carolina. It is not a new device in the sense of the introduction of water below the level of the pulp discharge, it having been tried in California (according to Mr. Hobson,) in quite a number of places, but the details of it are certainly to my mind new, and I know that some of the gold men are anxious to say something about it.

MR. C. F. ANDREWS—This method of feeding water would certainly facilitate rapid crushing ; but it would, to some extent, interfere with the complete amalgamation of the gold. I thing that the strong current would indeed clear away a great part of the ore from around the die ; but, in doing so, it would be likely to carry through the discharge the light particles of very fine gold before they had remained in the mortar long enough for amalgamation to take place. This, at least, was the conclusion at which I arrived after experimenting with this style of feeding water.

A reference to Fig. No I will show that the pulp in the mortar will have a tendency to bank up in a rather solid mass under the discharge. A current of water flowing into the mortar near the bottom under the feed side, and following the direction of the arrow "H," would be likely to wash fine gold immediately from the bottom of the mortar out through the discharge.

I find it an improvement on this method of bottom water feed, to introduce the water through six jets from the opposite, or discharge side of the mortar. These jets are placed in a wooden chuck-block, about in the position indicated by the bottom of the block in Fig. I. The jets point downwards between the dies. The current of water from them flows in almost the opposite direction to that indicated by the arrow "H," downward across the battery, and, being deflected in its course by the bottom and back of the mortar, finally reverses its direction, and flows out through the discharge along the line "F" "F."

The advantages of this method over that described by Mr. MacDonald are these, the pulp, instead of banking up below the discharge, is here at its lowest point, forming a pocket or receptacle into which the fine gold may settle, and be retained in the mortar. Moreover, the mercury, on being introduced into the mortar, will gravitate towards this lowest point. The current of water, in its course as before described, conveys directly to the surface of the mercury the fine gold which it may carry, allowing it to become amalgamated ; instead of sweeping it directly out of the mortar as was the case when the water was introduced in the manner described by Mr. MacDonald.

In examining the surface of the water where the bottom feed method has been used, while the stamps were hung up, I have frequently observed small bubbles of air coming to the surface. I think there is room for considerable doubt as to whether these bubbles of air will not attach themselves to particles of fine gold, causing this fine gold to float away on the surface. If my memory serves me rightly, this theory of air attaching itself to fine gold, and thereby causing a certain portion of the so-called float-gold, was pretty freely discussed some time ago in the American Institute of M. E.

Another disadvantage which I find in connection with bottom-feed, where the water is introduced as in Fig. 1, is that the current of water makes a V shaped trough which would be roughly illustrated by using the side of the mortar at "E" as one side of the trough, and the line of the arrow "H" as the other side; the material forming the "H" side being composed of such sulphurets and heavy material as would be contained in the ore. This, as I previously stated, has a tendency to bank up under the discharge in a rather solid mass. Thus, as it will be seen, the lowest point in the mortar at which the mercury can settle is where the current is flowing directly against it in such a manner as to lift the mercury, causing too much of it to be thrown out through the discharge upon the outer plates. The pulp in the bottom of the mortar, particularly during a run of any duration, is inclined to pack so solidly below the line where this up-cast jet of water enters the mortar, as not to be readily penetrated by the mercury, which will consequently be retained in a solid body in the trough made by the current till a portion of it has been blown out by the up-cast jet of water. In my experience with mortars where the water has been fed into the bottom, I have found that a larger percentage of the heavier portions of the ore has been retained in the mortar, than has been the case where water has been fed into the top. This heavier material, such as sulphurets, waste steel, etc., packs more solidly in the bottom of the mortar, than is the case where a lighter material is retained.

Mr. STUART (Truro)—I have had some experience in this matter myself and I wish to say a few words as to this new system which we are indebted to Mr. MacDonald for bringing before us. One of the most important matters in connection with this has not been mentioned in Mr. MacDonald's paper. As all practical mill men know, it is a very important thing to introduce just the required amount of mercury into the battery in order to give us good amalgam. If we use too little, the fine gold is allowed to escape for want of amalgamation, and if we feed too much it is thrown out of the battery and passes down over the plates; whereas, by the method under discussion, that of introducing the water below the level of the top of the dies, it has been proved that though an excess of silver is used, no bad results follow, as the recesses between the dies created by the water jets provides ample room for the silver to rest. Some few years ago this method was introduced at one of the Waverley mills by Mr. O'Shaughnessy in rather a crude way compared with that now presented to us by Mr. MacDonald. On the whole I may say that the experience of Mr. O'Shaughnessy of running two batteries side by side on the same material, one with this method and the other with the old method of introducing the water was eminently satisfactory. He got about 90 per cent. of his gold in the battery by the old method, and in the new he got 98 per cent. He obtained in the various tests he mad eat least 1 per cent. more gold by the new method.

Mr. MACDONALD—You do not believe, Mr. Stuart, that it destroys the effect of the mortar as an amalgamating machine to have the water injected from below?

Mr. STUART—There can be no question about it improving it.

Mr. MACDONALD—In that you do not agree with Mr. Andrews?

Mr. STUART—I cannot from the experience I have had.

Mr. MACDONALD—That is my experience, too. May I ask Mr. Andrews how the air got into the water?

Mr. ANDREWS—By various methods. Water contains a certain percentage of air. The water, being introduced under pressure below the water line in the mortar, would liberate a part of this air, which would immediately find its way to the surface of the water.

Mr. MACDONALD—I should think, Mr. Andrews, that the water falling over the top at a distance of three feet would have a far better chance of being aerated than in flowing through a pipe under good pressure.

Mr. ANDREWS—Possibly; but there would also be a possibility of the water liberating the air, and at least there would not be the same percentage of air arising through the water from the bottom of the mortar. I think that, to a certain extent, my remarks have been misunderstood by Mr. MacDonald. I do not for a moment maintain that bottom water feed is not as beneficial to amalgamation as top feed; though I cannot deny that it has some disadvantages. The special disadvantage of Mr. MacDonald's plan of bottom feed, I have found, as previously stated, to be that the swift current flowing directly from what is, practically, the lowest point in the mortar, up to the discharge, sweeps away the fine gold before it becomes thoroughly amalgamated.

Like Mr. MacDonald, I found that with the bottom feed I obtained a large percentage of the total collection of amalgam from the inside of the mortar; but I also found that with the feed-water entering from the discharge side of the mortar, rather than from the feed side, as is advocated in his paper, a still smaller proportion of amalgam was deposited upon the outside plates.

Assays of the tailings from the mill in which the water is introduced to the mortars under the discharge, show that the mill is saving from 95 to 97½ per cent. of the total value of gold contained in the ore; and this in spite of the fact that the concentrates from these tailings assay at $33 per ton. However, it is apparent that the percentage of concentrates is small. This result, I should think, would go to prove that bottom water feed, properly applied, cannot be detrimental to amalgamation.

Mr. MACDONALD—If the amalgam was got on the outside of the plates it would be equally as good?

Mr. ANDREWS—We prefer to have the amalgam in the mortar, if possible.

Mr. MACDONALD—Unless your assays prove to the contrary it really made no difference if it was found on the outside plates.

Mr. ANDREWS—There is always a chance when the amalgam gets on the outside plates that it may be swept away with the pulp. It may be a small lot at a time which might not show in the assays, as it might not happen to go at the time the samples were taken.

Mr. MacDonald—There would be danger of the inside plates scouring and the amalgam coming through the screens and being washed off the plates.

Mr. Andrews—Since I have introduced the bottom feed under the discharge, I find that I have less amalgam on either inside or outside plates, and find nearly the entire lot between the bases of the dies

The President (communicated)—Having been absent from the room during this discussion I would like to say that one or two points of interest have been omitted. In the first place the agitation of the pulp in the stamp mortar under ordinary conditions (that of stamps dropping from 95 to 100 drops a minute) is such that water fed over the top of the mortar is very thoroughly mixed and agitated with the crushed rock before it escapes through the screen, and I think that the "short cut" of the water along the line I. G. is theoretical rather than actual ; the settling effect of the clear water thus introduced on top of the pulp is minimized, and possibly entirely absent, by reason of this churning action of the stamps.

I have alluded at the opening of this discussion to the fact that a similar device was in operation in North Carolina some sixteen years ago ; the effect in the particular case then noted, as also in those cases where it has been tried in California, was to wash away the finer particles of the pulp from the side of the mortar on which the water was introduced and to produce a corresponding increase of wear on that side of the dies. This was accentuated to such a degree that the dies had frequently to be changed or turned about to prevent an oblique blow of the shoe which is the frequent cause of fracturing stamp stems. While admitting that theoretically the introduction of water below the level of the top of the die may be advantageous it would appear that the chief result in practice is the washing away of the fine material from the back of the mortar and the deposition of the heavier parts of such fine material in the front part of the mortar. In the case of Nova Scotia ores one would expect to find a concentration of arsenopyrite and the other metallic sulphurets just along and below the screen ; I would like to ask Mr. MacDonald if this has not been observed. Mr. MacDonald says—"the effect of the inflowing water is to wash away all the fine material, leaving in these spaces only the coarser grains of ore."

As regards the influence of this device upon amalgamation I may say that my information regarding the results of the Waverley mill does not agree with the statement made by Mr. Stuart. In correspondence with both of the amalgamators at that mill I have learned that the experiments on being continued for some length of time were not satisfactory, one paragraph reading—"I do not think we got any more amalgam in the mortar than we did without the jets, nor is the mortar cleaned up any more easily." There was also a good deal of difficulty at Waverley in keeping the jets open, one or more would get blocked with sand so that water had to be fed from the top to insure the proper constituency of the pulp going over the plates.

Another point in this connection is that in order to dispense with feeding in the water at the top of the mortar the water coming through the jets would have to have sufficient force not only to prevent them being choked up with with sand but to furnish a sufficient quantity to properly thin the pulp, in which case one might run against the opposite horn of the dilemma by feeding in too much water and thereby making more or less of a scouring action, thereby causing the loss of the fine gold alluded to by Mr. Andrews.

While this device is worthy of investigation there are many reasons why it should be adopted with caution by the mill man; where the slimes of the contained sulphurets carry high values its introduction may be advisable but in the case of ores where the contained sulphurets are of low grade it would be questionable whether the device would pay for itself.

I must plead, being old-fashioned, in entertaining a dislike to creating any possible aperture in a mortar below the level of the discharge. Every such opening is a weakness and unless the counterbalancing results are clearly greater the safe way is to leave the mortars intact; the introduction of these bore holes at the rear of the mortar is weakening theoretically, although practically it may not be sufficient to affect the life of the mortar.

Gold Medal for Students.

Mr. Bell, the Secretary, announced, that as last year, a gold medal would be offered for competition among Canadian mining students for the best original paper contributed to the Transactions of the Institute during the current year.

The object of this competition was to encourage observation and original work, particularly during their summer vacation. Last year the award had been made to Mr. Percy Butler, a graduate of McGill, now with the Guggenheim Smelting Co. at Perth Amboy, N.J. (Applause.)

Description of the Sultana Quartz Lode and the Sinking of the Burley Shaft on Bald Indian Bay.

Mr. J. Burley Smith, of Winnipeg, presented his paper on the above subject (reproduced on page 87 of this volume).

Dr. G. M. Dawson (who occupied the Chair.)—We are all interested in the sinking of this shaft, under somewhat unusual circumstances, and I dare say there are several here who would like to ask questions about it.

Mr. Andrews.—Mr. Smith spoke of the borings there as testing the lead. Were these tests made to find out whether the lead continued there, or the value of the lead?

Mr. Burley Smith.—To find whether the lode continued there.

Mr. Andrews.—Would that be of any value for assaying?

Mr. Burley Smith.—They were all assayed.

Mr. Andrews.—I have no experience in that line and I was thinking of trying it myself. Would you consider it valuable at all as an indication of the value of the lead?

Mr. Burley Smith.—If you get a sufficient number of borings, I should think it would be. The same applies to the sampling of these borings as to sampling in the pigs and copper. The greater number of borings you have the more likely you are to arrive at the correct estimate of the value of the ore.

Mr. Andrews.—Could you give any idea as to the cost of sinking these borings?

Mr. Burley Smith.—The cost of most of these borings was a little increased on account of the ice there. They had to be put down from the surface of the ice and as the weather there often goes to forty degrees below zero we had trouble with the freezing of the motor. All through the grouud is very hard there and it cost us about $3.55 per foot on the average.

Mr. Andrews.—There was no very deep boring.

Mr. Burley Smith.—No; the deepest boring was a trial bore of 300 feet to test the ground generally.

Mr. Coste.—I have heard that my name was mentioned in connection with this matter, and that a remark was made about a report I made on that district in 1883, and I understand Mr. Smith has stated that I condemned the district.

Mr. Burley Smith.—Oh no.

Mr. Coste.—As I understand it, you stated in this paper that I said in my report there was no gold in that particular mine.

Mr. Burley Smith.—Your report so stated with regard to the quartz as not being auriferous.

Mr. Coste.—Well, I have the report here and it will speak for itself as regards that. I may say that the report was written before we had the result of the assays and before they were made, but I will now quote from the report in order that there may be no misunderstanding about it :—

"This vein, called the Sultana lead, is about 30 feet wide. Its strike is 70°, and its dip south at an angle of 72°; the quartz is yellowish, hard, and devoid of minerals, I do not think it is auriferous. It reappears 500 or 600 feet to the east on another bay of Indian Bay; and also a quarter of a mile to the west, on the Island directly west of Quarry Island. In the foot wall of this quartz vein at 12 feet or thereabouts is another little vein with softer and whiter quartz, which is auriferous and contains mispickel, iron—pyrites and galena—probably argentiferous. The thickness of this little vein varies from 6 in. to 1 ft. The gneiss at the foot wall of this second vein, and between the two veins, is also changed into hornblende schist.

"'Pine Portage Mine' (shaft vein), ten miles south-east of Rat Portage, Lake of the Woods.

"A dark greenish schistose rock, intersected by numerous seams of calcite and containing a good deal of iron pyrites. The sample which consisted of a single fragment weighed two pounds nine ounces. Assays showed it to contain :—

"Gold .... Trace.
"Silver.... .... 0·117 ounces to the ton of 2,000 lbs.

"'Pine Portage Mine' (shaft vein), one mile from the bottom of Pine Portage Bay, Lake of the Woods.

A greyish translucent quartz, associated with a little coarse crystalline calcite and containing, in parts, a trifling amount of iron-pyrites, weight of sample, a single fragment, one pound one ounce. It was found to contain :—

"Gold .... 9.916 ounces to the ton of 2,000 lbs.
"Silver.................. 15.371 " " " "

"Maiden Island—small island three quarters of a mile east of Heenan Point, Lake of the Woods.

"The sample consisted of three fragments—the first a greyish, translucent quartz, associated with a small quantity of greyish green chloritic mineral, in parts coated ferric hydrate and containing here and there a little copper pyrites—the second a fragment of quartz much stained with ferric hydrate, contained in parts a little copper pyrites—the third, a soft greyish-green schistose rock, associated with a little quartz, it was in parts coated with ferric hydrate, and contained here and there a little copper pyrites, weight of sample two pounds fifteen ounces. It was found to contain :—

"Gold .... 1.225 ounces to the ton of 2,000 lbs.
"Silver.................. 0.175 " " " "

"Sultana lead (little vein), east shore of Indian Bay, eight to ten miles south-east of Rat Portage, Lake of the Woods.

"A very fine greyish white quartzite, holding here and there, a few specks of pyrrhotite and iron pyrites. The sample, a single fragment, weighed two pounds nine ounces. It was found to contain :—

"Gold .... 0.992 ounce to the ton of 2,000 lbs.
"Silver .... 0.467 " " " "

"Sultana lead (big vein), east shore of Indian Bay, eight to ten miles south-east of Rat Portage, Lake of the Woods.

A greyish sub translucent quartz, in parts coated with ferric hydrate. The sample, a single fragment, weighed two pounds one ounce.

"'Keewatin mine,' west vein, eight to ten miles south-east of Rat Portage, Lake of the Woods.

"A white quartz, in parts very much honeycombed, the cavities at one time most likely contained iron pyrites, which has been removed by weathering; it was, here and there, stained with ferric hydrate, and contained a little iron pyrites; minute specks of native gold were observed adhering to the walls of some of the cavities. The sample, a single fragment, weighed one pound three ounces. Assays showed it to contain :—

Gold................	9.917	ounces to the ton of 2,000 lbs.
Silver	0.525	" " "

Mr. Smith will therefore see that I only mentioned one as not being auriferous, and that was proven afterwards by the assay.

Mr. BURLEY SMITH—I qualified that in my paper. I stated that the actual boring tests made lately at this particular place had shown that the quartz is not auriferous or contains the smallest trace of gold. Opposite the Crown reef there is a vein of about 14 feet wide which yielded a splendid mass of quartz and has really fine walls. I imagine you alluded to that, because it is patent you must have seen it. I must say at the same time that I feel myself very much indebted to Mr. Coste's report because it was owing to that report I first got the idea of following that lode up. I was pointed out to me by a man named Jake Hennessy. I trust Mr. Coste does not think that I cast any reflection on his report, because, on the contrary, I am much indebted to it.

Mr. COSTE—Far from this district not being rich in gold, I think it is quite the contrary. Although in 1883 there was very little work done, still there was enough to show, and the assays proved, that some of the veins were very rich in gold. For instance, one of the places that was open about a mile or so on the other side of the little peninsula—the Pine Portage mine—the vein was about 70 feet wide, with very little iron pyrites or any other mineral, and you could not see any gold in it, yet when it came to taking samples of the white quartz the assay has proved by analyses 12.77; another one assayed 9.68; another assayed 9.91; showing that some of the veins in the Pine Portage mine were very rich. Also in the Keewatin mine, one assay gave 4 95 ounces, another 9.91 ounces. My report cannot be said to condemn that district, but on the contrary it shows that some of the veins are very rich.

Mr. BURLEY SMITH—Your report was the best I read on the subject, and it led me to further exploration on that lode. With regard to that position, where the quartz re-appeared on the island, we got assays there quite 6 ounces. We have sunk a shaft slightly beyond that place and the lode was 25 feet wide, and there is gold visible.

Mr. COSTE—I think it is a most promising district. Some of the veins are very strong, well defined, and quite rich.

Mr. INGALL—I am glad Mr. Coste is here today, because I know that on several occasions allusion has been made to this report. People do not seem to have read it carefully or understood about the assays being published in another part of the volume separate from the report. It is well that Mr. Coste has made an explanation so as to clear up mistakes. I have heard it said that Mr. Coste stated there was no gold in the Sultana veins, whereas is was another vein altogether to which he alluded.

Mr. BURLEY SMITH—Anyone who reads the whole of Mr. Coste's report will see that he states that very clearly. There was not sufficient work done at that time to show up, but he mentioned many veins where there was gold. At that time it would be impossible for any one to judge by appearances.

Mr. COSTE—Even then my report went to show that the district was rich, and the assays proved it afterwards.

Mr. MACDONALD—I would like to ask whether that large body of auriferous quartz occurs at a vein paralleling the auriferous vein or as an isolated body.

Mr. SMITH—It is a vein parallel with it and over it. They are really lenses.

Mr. MACDONALD—Vertical?

Mr. BURLEY SMITH—They have the general dip of the other lenses.

Dr. DAWSON—It seems to me the most singular thing about that whole district is that it should have been opened up more than 15 years ago and reported on and known to be auriferous, and a good deal of excitement started about that time and it dropped through for years and years and has only been taken up again quite lately. It appears to have arisen entirely from the work having fallen in the first instance into the hands of people who are not versed in that sort of business and who made it purely a speculative matter. As far as I can make out that was the whole trouble at first, and only for that these mines might have been producing for the last fifteen years.

Mr. INGALL—It must be remembered, however, that there was difficulty as to the title of these lands and a dispute as to whether they belonged to Manitoba or Ontario.

Mr. BURLEY SMITH—That had an important influence in delaying their development. For instance, it was not known who could give the title to the Sultana Island, and it was only recently that the owner obtained his patent from the Ontario Government. The Ophir mine was opened by the John Taylor Company, and it was partly because of a disputed ownership, and also the prior timber limit rights of Mr. John Mather, and others, which caused the mine to be closed down. That mine will open some day and will, I believe, be one of the richest mines in the world.

Mr. INGALL—Was there not some difficulty also with the Indian Department?

Mr. BURLEY SMITH—The Indian Department at that time gave only such a patent as they were able to give. They did not guarantee it was a valid patent, but it was taken as being the best we could get.

Mr. LATIMER—Sixteen years ago I spent some time in the neighborhood and examined the locations and I can say that the great difficulty in connection with the development of that country was that a sufficient satisfactory title could not be obtained. The Sultana vein showed little gold, except on one side, at that time; we could get only from $1.00 to $3.00, except on one side, where it was very rich. I recommended it at the time, and when they commenced to develop it they found the title was not satisfactory and they were afraid to make an investment. The title was a great difficulty, and then there was also a little want of confidence and want of capital.

Mr. BURLEY SMITH—Mr. A. W. Fraser, of Ottawa, who is present, is fully cognizant of all the legal difficulties of this case, and as the question has a strong bearing on the development of that district, I trust he will state the facts to the meeting.

Mr. A. W. FRASER—A difficulty regarding the title arose in the first instance because this was disputed territory. The Dominion issued patents to a portion of the island for the Sultana mine and also for three locations called the "Ophir Property." When the litigation between the Province of Ontario and the Dominion was decided in favor of the Province, it was then claimed that the Indian Reserve on the main land included Sultana Island, and that the Dominion had power to deal with the island as forming part of the reserve. In the precious metals case the Privy Council decided that the precious metals are vested in the Province. There are a number of cases dealing with these questions which are fully summarized in the very able judgment of Mr. Justice Rose, in the case of "Caldwell *v.* Fraser," and the judgment of Mr. Justice Rose was confirmed by the divisional court. This case sustained the title granted by the Province to the defendant, and from this time forward I expect there will be no further difficulty about titles. Regarding the Indian reserves, as I understand it, the Province has to confirm the reserves set apart by the Dominion before they become actual reserves, but this has not yet been done. So far as the precious metals are concerned, the authorities have decided that the Province only has the power to deal with them, and if the patents are granted of the mining rights it carries with it the right to work the mines. Even should it be held that Sultana Island formed part of the Indian Reserve, the Indians having surrendered their title the Province has full power to deal with the minerals.

THE PRESIDENT—With all due respect to the men from Ontario who may be here, I have never seen so many examples of bad management in the same territory as I have seen in the Province of Ontario. How much that has to do with retarding the progress of the country, perhaps I am not posted enough to say, but I can say that when you put men who are accustomed to hew timber, to hew rock, you make a mistake. The great trouble that has been in Ontario that they seem to think that a blacksmith can make boots and shoes for people to wear. They have had a class of management there which has been, to put it very mildly, thoroughly ignorant of the subject of mines. Of course there are exceptions, and I make exceptions in the case of several men. In June or July last I was in the Rat Portage country and I was informed that of all the number of stamps in the Lake of the Woods district, only three were running, viz: Regina, Mikado and Sultana. I know from my own experience of twenty years, in several districts, that for every one property that is intrinsically poor, and is a failure, there are at least a dozen good ones that are turned down simply because of incompetent management. I think the failure of the Lake of the

Woods country to produce more bullion than has been produced during the last three or four years is due chiefly to the bad management which has prevailed, and not to the poverty of the country.

Mr. INGALL—Apart from the question of mismanagement that question of disputed title is very important it seems to me. No matter what representations may be made about a property, the first question asked you in New York or London when you go for capital is why have you not worked the district? It is all very fine to tell us about the district, but why was it not worked? Consequently it is of great importance that it should be known that this district was not worked because of the disputed title. The gold district of Beauce, in Quebec, has not been worked so well as it ought to have been for the reasons that the titles were not perfect and the people gave up in despair.

Mr. BURLEY SMITH—It is undoubtedly true that there has been mismanagement of mines, but it must be remembered that mismanagement always occurs in developing new fields of industry, and it occurs especially in mining because of the class of men who go into prospecting. Men who prospect are not supposed to be good mine managers, and it is only after the mines become developed that really good management is necessary.

Mr. B. T. A. BELL, Secretary—While admitting that the question of title had been a great factor in keeping back the development of the Lake of the Woods, that was a thing of the past, and hardly explained why the whole gold production of Ontario did not, so far, exceed $300,000 per annum. Hundreds of companies had been incorporated in Ontario during the past three years ostensibly to carry on mining, but I am afraid the disposition has been to speculate in undeveloped lands and to gamble in ten cent stocks rather than to produce bullion. In that new country there naturally had been ignorance in mining practice and costly mistakes had been made, but it was gratifying to observe of late substantial indications of progress and the gold output, not only of the Lake of the Woods, but of the Seine, and other sections of the Province would be considerably increased this year. The curse of gold mining in Ontario, and for that matter of other portions of the Dominion nearer home, was that our people had yet to realize that mining was a business, requiring skill and experience and economy, and to be successful must be managed on the same lines as other industrial undertakings.

A NEW DEVICE FOR THAWING DYNAMITE.

Mr. DANIEL SMITH, Kingston, exhibited a patented device for thawing dynamite which his company, the Ontario Powder Works, has recently had on the market. The idea is that of a miniature boiler, and consists of a series of horizontal tubes of galvanized iron, fixed in a square water tight box of similar material; so that, when the dynamite cartridges (fifty at a time) are placed in the tubes, horizontally, and not on end, and the box filled with water at about 115 to 125 degrees

Fah. each cartridge is completely surrounded by the water, being thus warmed safely, uniformly and quickly to the temperature most suitable for use with the best results. This method of thawing dynamite, laying on the flat in tubes surrounded by water, and not on their end, is safe, and much more effective than any other and I advise its use. Some may think I attach too much importance to thawing dynamite. I would say, thus far you have escaped damage by thawing before a fire, around a blacksmith's forge, or in the leg of your boot. You may the very next time pass over the danger line and be torn to atoms. Dynamite freezes ten or eleven degrees sooner than water, and is practically unexplodable by ordinary means, and every winter in this country brings a fresh crop of accidents while attempting to thaw it in an improper way. A very safe plan outside of our thawing box, on large work, is to have a frost proof room with means of keeping it heated to 70 or 80 degrees and have the dynamite placed around on shelves laying down flat, and not standing on end where it can thaw slowly through and through and about summer heat maintained.

The session thereafter adjourned.

THURSDAY AFTERNOON SESSION.

The President took the Chair at three o'clock.

Mr. J. W. Evans presented his paper describing some work done on "The Gold Bearing Sands of the Vermillion River" (reproduced on p. 105).

The Gold Measures of Nova Scotia and Deep Mining.

Mr. E. R. Faribault, C.E., of the Geological Survey, next presented a paper on this subject (reproduced on p. 119).

The President—Mr. Faribault is well and favorably known to most of the members of the Institute, and especially to the gentlemen from Nova Scotia, in which Province he has spent eighteen years in mapping out the gold fields. You will agree with me gentlemen, that this paper is one of the most valuable which will be recorded in our transactions. I may say further, that considering that the Geological Survey of Canada is primarily an economic Survery, there is no department of its work which will give better results to the tax payers of Canada than that which is being done by its agents in the Province of Nova Scotia. I have a desire to discuss this paper as I spent ten years in the development of some of Nova Scotia's gold properties, but I give place to the many gentlemen who are present and who have equal or better experience than I have in that Province. I first of all would like to hear from the distinguished Director of the Geological Survey who, although he has earned more fame in calling Western Canada to the attention of the public, has of late years done the Eastern part of the Dominion no little service in proclaiming its similarity with the very famous Bendigo fields of Australia.

Dr. G. M. Dawson—I have great pleasure in endorsing what the President has said, particularly with regard to the work of the author of this paper on that very complex subject which he has been studying in connection with the gold fields of Nova Scotia. It is most pleasing to find that his calculations are all coming out in a clear and easily understood way ; you might almost say with mathematical precision. I dare say some day some one will attempt to work out equations with regard to the relation of the folds and domes. I will leave practical mining men to deal with this question. I appreciate the remarks of the President on this particular phase of the work of the Geological Survey, and I will leave him to call upon those who are practically familiar with the region.

THE PRESIDENT—I shall call upon a gentleman who has had experience in the gold fields of Nova Scotia second to no man. I mean Mr. G. W. Stuart, the Mayor of the town of Truro, who is with us to-day, and who may be said to be one of the pioneers of the Nova Scotia gold mining industry.

Mr. STUART—Mr. Chairman and Gentlemen,—I am a practical man and I regret very much I have not the ability to place these questions before you with that eloquence for which your worthy President is noted. I must first say that Nova Scotia owes the Geological Department of the Dominion of Canada a debt of gratitude for sending a gentleman like Mr. Faribault to that Province, and Nova Scotia will never be able to repay Mr. Faribault for the work he has accomplished. I trust that the Government will see their way clear to have Mr. Faribault remain in Nova Scotia, so as to bring to a completion the work he has commenced. In order to appreciate Mr. Faribault's work and the manner in which he does it you have to be with him and follow him in the field ; a more indefatigable worker I have never seen. It would, perhaps be useless for me to go over the whole ground of the gold industry in Nova Scotia with you this afternoon, and it will no doubt, be more interesting if I read to you a few excerpts from an article which I contributed to the last number of the CANADIAN MINING REVIEW.

[After reading the article in question and dwelling on the marked progress in mining and milling practice, notable of recent years in Nova Scotia, and the satisfactory increase in its gold production, Mr. Stuart said :]

You will see, gentlemen, from these statistics, that we are beginning to learn something about mining in Nova Scotia, although I am bound to say we are yet far behind the methods adopted in some other countries. For instance, in the last report of John Hayes Hammond on South Africa, he reports an average sinking in what they call their deeps between three and four thousand feet. The average sinking per month for each shaft is from 150 to 260 feet, whereas, we have never yet succeeded in getting a depth of over 80 feet per month in Nova Scotia. I do not know what you have been able to do in Quebec and Ontario, but I fancy you have not beaten the Nova Scotians very much. When you come to contrast the difference between 80 feet per month and that of from 150 to 260 feet per month in South Africa and that chiefly done by native labor, you will see that we have yet a good deal to learn.

THE PRESIDENT—The excitement of recent years, so far as mining in Canada is concerned, has been confined to British Columbia and portions of Western Ontario and as Mr. Stuart has said Nova Scotia has suffered somewhat by reason of that. Mr. Faribault made reference to the Dufferin mine, or the Salmon River mine, and we have with us to-day the manager of that mine, Mr. Bernard Macdonald, an American citizen whose experience has been, not in Canada, but Montana and the Western States, where they are supposed to be very active and abreast of the times. We should be obliged to Mr. Macdonald if he would give us his experience in Nova Scotia.

MR. MACDONALD—My experience in Nova Scotia has extended over a period of only about a year and I am perhaps not competent to pass judgment after such a short acquaintance with the Province. As to the rapidity in mining I know that the Nova Scotians cannot compete in speed with the people of the West. My experience goes to show that there is no means of making that speed and progress which Mr. Stuart has stated they make in South Africa. I assume that South Africa is like Australia and all the western places, British Columbia included, where they work Sunday as well as Monday in mining work, and that is not so in Nova Scotia so far as I am aware. For my part I would as soon stop a ship in mid-ocean to rest her over Sunday as to stop a mine or mill. I think this will answer to some extent for the slowness of the progress in Nova Scotia, but it certainly does not give the full reason.

THE PRESIDENT—We have with us our youngest, but not least experienced, member, Mr. Andrews, and we would like to hear from him. He was formerly manager of the Richardson mine of which you have heard Mr. Faribault speak.

MR. ANDREWS—I was quite interested in Mr. Faribault's comparison between the leads in Bendigo and the leads in Nova Scotia, especially with regard to their development in depth, and it was rather surprising to me to find that our leads compare so favorably with them. My limited experience has principally been in connection with some of the large bodies of ore in Nova Scotia, and particularly with those coming in close proximity to the anticlinal formation. I have watched Mr. Faribault explain all these formations and I find that his conclusions coincides almost exactly with my own experience. For instance at the Richardson mine, at the time of the discovery of that reef, the anticlinal formation was not much of an accepted theory. The lead was first discovered on the south dip, and it was developed by tunnelling eastward. The tunnel following the lead curved gradually northward, and then to the westward, forming a horseshoe, proving that the vein was on the eastern pitch of a dome. One reason why at that place we were enabled to obtain our quartz so cheaply was on account of the location of our shaft house, which was eventually located at the turn, there already being a shaft dipping to the southeast; and, after some expensive work, there were three shafts sunk on the turn of the anticlinal, all of which came to the surface at one big shaft house, so that all the rock was handled at the one place. The proper way to develop such a district, would be, as Mr. Faribault suggests, to sink a perpendicular shaft on the anticline through the lead or belt and carry it deeper to other saddle reefs lying one beneath the other in the same fold. I know there are a great many people who are under the impression that mining operations in Australia are confined to one lead, whereas, as a matter of fact, the larger mines have extended their operations in depth to a number of leads; but after all then, the large and numerous saddle-reefs and veins, which have been worked to such great depths in Australia, would be but one-twentieth as extensive as those likely to be met with in depth in the Nova Scotia formation. This fact in regard to mining in Nova Scotia is a matter of great encouragement. I for one, though not born a Nova Scotian, but one who has spent a great deal of time there, believe that Mr. Faribault is deserving of a great deal of thanks for the work he has done in that Province.

Mr. FARIBAULT—Mr. Andrews has just brought out a very interesting fact. In Bendigo the saddle-reef veins seldom extend more than 50 or 100 feet below the cap, while in Nova Scotia veins have been worked 700 feet in depth, and theoretically they should be about twenty times as extensive as in Bendigo, giving an extreme limit of 1,000 or 2,000 feet. There has been a tendency in Nova Scotia, on account of the great extent of the veins, to confine the developments to individual veins, while in Bendigo the limited extent of the veins has led to development by means of perpendicular shafts and cross-cuts, new saddle veins being thus opened up one under another to depths of over 3,000 feet.

Mr. STUART—In proof of what Mr. Faribault has said I may mention that in the district of Goldenville there has not been over 400 feet of cross-cutting done in the whole district.

Mr. FARIBAULT—That is a noteworthy statement. Nova Scotia has had too few mining engineers capable of understanding the complex nature of the quartz deposits, and to this cause may be attributed most of the failures and the slow progress made by gold mining in the province.

Dr. LEDOUX—If there are very few good mining engineers in Nova Scotia, it occurs to me that the most of the good ones must be here to-day, for I have listened with the greatest of interest to these papers and I have been specially interested in the paper of Mr. Faribanlt. I am one of those who took occasion to complain of the fact the United States geological survey is constantly publishing very learned geological treatises and nothing very practical for the miner. I have recently been in Montana on which the United States survey has recently published a pamphlet, but that pamphlet is full of technical and geological terms, and it contains nothing as practical for the miner as this paper of Mr. Faribault. There is nothing in the United States work which the practical mining engineer could take hold of with a view of prospecting and getting a good return. I believe that Mr. Faribault's paper is going to make a record, and that it will be of immense value not only to this particular district, but to many others where, in all probability, the same vein formation occurs. Might I ask whether the granites ever show in gold at all—or in other words, were the veins which have followed these fissures segregated close to the granites?

Mr. FARIBAULT—Some of the districts, like Forest Hill, Mooseland, Country Harbour and Cochran Hill, are in close proximity to granite masses, but most of them are at some distance from them. At Forest Hill and Country Harbour I have observed granite dykes and veins cutting quartz veins which were worked, showing conclusively that the granite intrusion is later than the segregation of the auriferous quartz veins, and has not affected the richness of the veins in any way whatever.

Mr. STUART—At Forest Hill, near the shore of a lake, granite dykes were found to run parallel with quartz veins and in several places it is shown very clearly and conclusively that the granite is of later origin than the gold formation, because of the fact that in several places where tongues of granite have shot out from the main body, they have either carried a section of the gold formation with them, or, in some instances, parted the formation only, the intrusion is quite apparent.

Dr. F. D. ADAMS—Mr. Faribault's paper embodies one of the best pieces of work which the geological survey of Canada has ever produced, and the survey is to be congratulated in having upon its staff men, who like Mr. Faribault, possesses the ability and perseverance required to unravel such complicated geological problems as those presented by the region under discussion. The director of the survey is also to be congratulated in that notwithstanding the various calls made upon the time of his staff, he has been able to keep Mr. Faribault at work in this region for several years, and has thus made it possible for him to carry out the work in the detail necessary to achieve such valuable results. Studies such as this show the enormous and direct practical value of accurate and detailed geological work in any ore-bearing region, as indicating in the first place where the ore is to be found, and in the second place how it may be most economically mined. The resemblance of the Nova Scotia gold field to that of Bendigo, as described by Rickard and others, is most remarkable. In both fields we have an ancient series of sandstone and shales in both cases the same anticlinal folds with the transverse pitches, and in both cases an association of the ore-bearing rocks with granite intrusions. The fact, pointed out by Mr. Faribault, that the structure of the Nova Scotian field is on a larger scale than that of Bendigo, the anticlinal axes being further apart, the saddles larger and the "legs" longer, is a fact which must be a source of satisfaction to the fortunate possessors of claims situated on the domes of the Nova Scotian folds. The origin of the gold is in both cases a question of much interest, and the presence of great masses of intrusive granite in each case, would seem to point to the heated waters which always accompany or are given off by such masses on cooling as the source of the precious metal. It is evident from Mr. Faribault's map that the whole gold field in Nova Scotia is underlain at no very great depth by granite, so that if this rock be the ultimate source of the gold, there should be an abundance of the latter. The question, however, is one which can only be decided by close observation and study of the veins and their relation to the surrounding rocks and it is hoped that with the progress of deep mining in the district, additional light may be thrown upon this very interesting and important subject.

Mr. B. T. A. BELL—This very excellent paper of Mr. Faribault's reminds me of the splendid service, he and other members of the Staff of our Canadian Geological Survey are rendering the country, and that the occasion is appropriate to express our appreciation as mine owners and mining engineers of their work. It is deplorable to think that gentlemen who possess their skill and ability and high technical training and whose investigations and reports are so valuable to the development of the mineral wealth of the country are so poorly and inadequately recognized by the Government. The appropriation made by the Dominion Government annually to this work is altogether insufficient to meet the growing necessities of the country and it is not surprising, therefore, to find, from year to year, many of the best men leaving the service for more remunerative professional work. Going no further than this room, I notice my old friend, Mr. Coste, at one time in charge of the Division of Mineral Statistics, who has since become rich in practical work done in our natural gas territory. Dr. Lawson, Mr. J. B. Tyrrell, Mr. W. A. Carlyle and many others have resigned and now occupy positions yielding them salaries more in keeping with their high professional attainments. We ought, as an Institute, to impress upon the Government not only the necessity of maintaining the Survey in a proper state of efficiency by paying its officers better salaries, but the imperative need of more suitable quarters to house the magnificent collections of the Survey, worth many millions of dollars. The present building, besides being altogether too small, is unsafe and may tumble about the ears of the staff at any time. With respect to the gold mining industry of Nova Scotia my views are too well known to require repetition. I can only reiterate what I have said many times before at these meetings, that the gold measures of that Province will amply repay investigation. The returns last year showing a gold production of over $600,000 on an invested capital of about half a million dollars must be considered distinctly creditable. One can readily realize what results may be expected when adequate capital is invested under competent and skilful administration. Until last year, when the Montreal-London Company started work on the Dufferin, comparatively little foreign capital had found its way into the Province, but the results from that enterprise under the skilful administration of my friend Mr. MacDonald, may be relied upon to give a fillip to mining enterprises in the Province.

Mr. INGALL—It seems to me that Nova Scotia gold mining can stand a very large investment of capital which will develop it into a much larger industry. If it does so, it will be very gratifying to me to have the statistics put together so as not to have B. C. have the heavy end of the log.

THE PRESIDENT—We should like to hear from Dr. Jas. Douglas, for, if I am not very much mistaken, he has seen one or more gold districts in Nova Scotia.

DR. DOUGLAS—My knowledge of gold mining in Nova Scotia is so perfunctory that I cannot form a conclusion with regard to it. This paper of Mr. Faribault's puts a new face upon the whole question. It will encourage those who have invested money in Nova Scotia and who have been discouraged by the work they have done to extend their operations. It has determined me to point out to my friends the high and better hopes they ought to have, if they would only put back a little of the money they have already taken out.

THE PRESIDENT—We have still to hear from Mr. Coste, who was formerly connected with the Geological Survey, and who is now a distinguished mining engineer.

MR. COSTE—I have listened to the paper of my friend Mr. Faribault with the greatest interest, especially as it points out a condition in Nova Scotia, which is somewhat different from the general conditions that exist in the districts of British Columbia and Western Ontario. In these districts you have veins and you follow your veins always the same between the two walls. It was only by very careful work that it could be brought out in such a clear manner as it has been brought out by Mr. Faribault. I believe, like Dr. Ledoux, that this will be a record paper, that it will tend not only to the fame of the Geological Survey, but to the reputation of our Institute to have such papers in our Transactions.

THE PRESIDENT—I shall allude to one point which Mr. Faribault made and I think it is an important one. Mr. Faribault alluded to the similarity between the Silurian rocks in Nova Scotia and those of Quebec which underly the alluvial gravels of Beauce County. After experience in both sections of the Dominion, I think that the effect of the geological work which Mr. Faribault has been doing in Nova Scotia will very materially aid that search for the gold veins in Quebec which has been illusive hitherto. We know there is gold in the gravels, but we do not know there is paying gold in the quartz which occurs under precisely similar conditions. This part of the paper ought to be very valuable to those in Quebec. Reference has been made to sinking to determine whether these saddles really do occur in Nova Scotia. In 1891 I was in charge of a property in Nova Scotia in which I had an opportunity given me by my directors of sinking an experimental shaft to determine the question. Unfortunately I was only allowed to go 253 feet. We commenced on the anticlinal axes, but in sinking that shaft we opened nine different veins which never came to the surface. As to their auriferous qualities each of them showed a value, but out of the nine there were only two considered sufficiently rich to constitute milling ores. This is apart from the question ; but there has been for the last eight years a decisive conviction that what I did in 250 feet could be done in 2,530 feet in proportion. Another feature which must be remembered is the very high quality of the Nova Scotian gold. Mr. Stuart gave you some figures as to the number of tons crushed and the number of ounces of gold, but I fancy many in the audience do not know that an ounce of Nova Scotia smelted gold rarely runs below $19.50, while an ounce of Yukon gold averages from $14.00 to $16.00, and in Grass Valley, Cal., $16.00 is a high price for an ounce of gold. When you have an ounce of Nova Scotia gold you have an article that is worth two dollars more than an ounce of any other gold in the world, except that of Victoria, Australia. The session then adjourned.

THURSDAY EVENING.

Exhibition of Lantern Projections.

The evening session was entirely taken up by lantern projections, Dr. George M. Dawson exhibiting a large number of slides showing prominent mining works in Canada, from Nova Scotia in the East to British Columbia in the West. He was followed by Mr. A. C. McCallum, who exhibited a number of diagrams illustrating his paper on the Designing of Metallurgical Machinery. Mr. James F. Lewis, of the Canadian Rand Drill Co., terminated the session by exhibiting a magnificent series of views showing the work done in constructing the celebrated Chicago Drainage Canal.

FRIDAY MORNING SESSION.

The President took the Chair at 10 a.m. After a number of new members had been elected, the Secretary read a petition respecting the Yukon Mining Regulations which had been forwarded by the Incorporated London Chamber of Mines and after having been considered by the Council of the Institute, had been referred to this meeting for action.

The Secretary—I do not think any action we may take respecting this question of royalty will affect in any way the decision of the government in the matter. The Hon. Minister of the Interior, had emphatically stated that he would not make any rebate of the royalty. Every mining man in the country would sympathise with the efforts of the Yukon miners to have the royalty reduced or repealed, but nothing would be done by the Government at present.

Mr. Stevenson—It is a question of policy with the Government.

Mr. Fergie—It is a question that we should not interfere with at all.

The President—In view of what the Secretary has stated as to the expression of sentiment on the part of Hon. Clifford H. Sifton, perhaps it is as well that this communication should be laid on the table.

Mr. Stevenson moved, seconded by Mr. Fergie that the resolution be laid on the table.

ELECTION OF OFFICERS AND COUNCIL, 1899.

Mr. Jas. F. Lewis, on behalf of the scrutineers, reported that 83 votes had been cast, two ballots being rejected, with the following results :

President:

Mr. John Hardman, S.B., Consulting Mining Engineer, Montreal, Que.

Vice-Presidents:

Dr. George M. Dawson, C.M.G., Director Geological Survey of Canada, Ottawa.

Mr. W. A. Carlyle, M.E., General Manager British-America Corporation, Limited, Rossland, B.C.

Mr. Hiram Donkin, C.E., General Manager Dominion Coal Company, Glace Bay, C.B.

Mr. George E. Drummond, Canada Iron Furnace Co., Montreal, Que.

Secretary:

Mr. B. T. A. Bell, Editor CANADIAN MINING REVIEW, Ottawa.

Treasurer:

Mr. A. W. Stevenson, C.A., Montreal, Que.

Council:

Mr. S. S. Fowler, S.B., M.E., London & B.C. Gold Fields, Limited, Nelson.

Mr. John B. Hobson, M.E., Consolidated Cariboo Hydraulic Mining Co., Quesnelle Forks, B.C.

Mr. Elliot T. Galt, Alberta Railway & Coal Co., Lethbridge, N.W.T.

Mr. Robert R. Hedley, Metallurgist, Hall Mines Limited, Nelson, B.C.

Mr. Archibald Blue, Director of Mines, Toronto, Ont.

Mr. James McArthur, Metallurgist Canadian Copper Co., Ltd., Sudbury, Ont.

Mr. Eugene Coste, M. E., Provincial Natural Gas & Fuel Co., Limited, Toronto, Ont.

Mr. Charles Brent, M.E., Rat Portage, Ont.

Mr. George R. Smith, M. L. A., Bell's Asbestos Co., Limited, Thetford Mines, Que.

Mr. J. Obalski, M.E., Inspector of Mines for Quebec, Quebec.

Dr. Frank D. Adams, McGill University, Montreal.

Mr. R. T. Hopper, Anglo-Canadian Asbestos Co., Montreal.

Mr. Wilbur L. Libbey, Brookfield Mining Co., North Brookfield, N.S.

Mr. Clarence Dimock, Wentworth Gypsum Co., Windsor, N.S.

Mr. C. A. Meissner, Londonderry, N.S.

Mr. J. R. Cowans, Cumberland Railway & Coal Co., Springhill, N.S.

GOVERNOR-GENERAL AND PREMIER BECOME PATRONS.

THE SECRETARY intimated that His Excellency Lord Minto, Governor-General, and the Right Hon. Sir Wilfred Laurier, M.P., had graciously consented to become patrons of the Institute. (Applause.)

An Executive Committee.

Mr. George E. Drummond suggested the addition of two names to the Library Committee to work in conjunction with the Council. It has been found difficult sometimes to get a quorum of the Council together. He therefore moved that such an Executive Committee be appointed, to consist of Mr. H. A. Budden, Mr. H. W. DeCourtenay, Mr. Stevenson Brown and Mr. Meredith, together with the officers and Council *ex officio*.

Mr. Lewis seconded and the committee was appointed.

Messrs. S. J. Simpson and J. J. Riley were elected auditors.

CANADIAN MINING AND METALLURGICAL EXHIBITION.

Mr. B. T. A. Bell suggested that it would be desirable at an early date to consider the advisability of holding a first class Canadian Mining and Metallurgical Exhibition in Canada, preferably in Montreal, where suitable accommodation could now be obtained. Such an exhibition would be a laborious undertaking and could only be successfully carried into effect by the co-operation of the Federal and and Provincial Governments. Other countries are showing the world what they produce and are advertising their natural wealth and in another year or two Canada would be in a position to make an exhibition that would be an eye-opener to outside capitalists. The year succeeding the Paris Exhibition would be a favorable time to hold it.

Mr. Snyder—I thoroughly approve of the suggestion made by Mr. Bell and I believe the Canadian Mining Institute should take the matter up enthusiastically.

Mr. Bell—I would move that this meeting endorse my suggestion and recommend to refer it to the Council for future consideration. Carried.

THE GEOLOGICAL SURVEY.

Mr. B. T. A. Bell again referred to the small grant given to the Geological Survey by the Government and the wholly inadequate remuneration paid to its officers.

Mr. A. W. Stevenson—I am sure that we all heartily approve of the suggestion made by Mr. Bell and in order to put it in practical shape I move, seconded by J. Burley Smith, the following resolution: "That the Canadian Mining Institute herewith places on record its appreciation of the services rendered to the mining interests of Canada by the work of the Geological Survey, and would urge on the Government the necessity of giving further financial support to that Department, with a view to the increase of its work in the mining districts.

"The Institute views with regret the various losses sustained by the Geological Survey of late years, in the resignation of so many of the experienced members of its technical staff, and would urge that steps be taken to give remuneration more in keeping with the professional standing and valuable services rendered by these gentlemen, so that it may be possible for the future to permanently retain their services and thus ensure a continuance of the valuable work already done."

The motion was adopted unanimously.

Mr. J. BURLEY SMITH—Let us hope that when the Hon. the Minister of the Interior collects his revenue from the Yukon royalty he will devote a portion of it to increasing the salaries of the staff of the Survey.

The following were appointed a deputation to present the resolution to the Minister of the Interior:—Messrs. G. E. Drummond, Eugene Coste, A. W. Fraser and Lt.-Col. Wright.

INCREASED EFFICIENCY OF PROVINCIAL MINING BUREAUS.

Mr. W. H. GALLAGHER, Vancouver, suggested that a resolution be passed empowering the Council to communicate with the executive in the various Provinces with a view of securing more attention from the Provincial Governments to mining interests.

Mr. ANDREWS—I do not know how this suggestion would work in the other Provinces, but so far as Nova Scotia was concerned it would accomplish nothing. Our local Society in that Province is now keeping the Government up to its utmost capacity and any further work in the lines indicated might do harm.

Mr. FERGIE—I can endorse what Mr. Andrews has said. We have been driving the Provincial Government of Nova Scotia pretty hard for some years and they are beginning to think that we are pushing them a little too tight.

Mr. GALAGHER—If the Nova Scotia Government is doing its work the local Committee would not require to act. The present Government of British Columbia has advertised throughout the Province for suggestions as to mining regulations, not only from the Mining Associations; but from anybody who wishes to offer them. Whilst I am willing that the Provincial Association should take the initiative, yet I think that they should be backed up by the influence of this Institute.

Mr. OBALSKI—Any suggestion made to the Quebec Government by this Institute will, I am sure, be well considered. I do not see any objection to the local associations making suggestions to the Provincial Governments to improve the proficiency of the Bureau of Mines.

Mr. ANDREWS—If a motion could be passed without interfering with the Nova Scotia Government I can see no objection to it. Our local Society in Nova Scotia has been before the Government very frequently. We have some matters now under the consideration of the Government and I do not think they would be expedited by any outside interference.

Mr. FERGIE—I do not want to see any outside matter brought before the local Government of Nova Scotia at the present time or otherwise we might get less than we expect.

Mr. Coste—The money spent by both the Dominion and local Governments in connection with mining has been so far thoroughly inadequate. The local Society might push the matter in any Province where it considered it necessary to do so.

The Chairman—I am of opinion that these matters should be left to the discretion of the Council of the Institute.

Mr. Bell—The question as to the publication of mining statistics is a vital one. As a matter of fact no uniform standard exists for making out these statistics. The Geological Survey and the Provinces of Ontario, Quebec and British Columbia make up their statistics to the end of the calendar year ; Nova Scotia makes them up to the 30th of September, its fiscal year, and the Trade and Navigation Report gives figures up to the 30th of June, the Dominion Government fiscal year. It is impossible now to arrive at any fairly correct idea of the aggregate value of our mineral products.

Mr. Gallagher—My object was to pass a resolution to instruct the Council of the different Provinces to take all these matters into consideration.

Mr. Drummond moved the following resolution, which was adopted :

"*Resolved*, That the Council of the Institute be authorised to instruct its Executive in the various Provinces to take whatever steps may be necessary to impress upon the Provincial Governments the necessity of maintaining their Mining Bureau in a high state of efficiency and the desirability of adopting a more uniform standard of compiling mining statistics."

Civil Engineer's Bill.

Mr. B. T. A. Bell—Mr. Snyder has handed me a copy of a Bill concerning Civil Engineers, being promoted by the Canadian Society of Civil Engineers, which will come up at the present session of the Legislature of Ontario. As many of the members would recollect, Bills promoted by the same Society had been successfully opposed by the Federated Canadian Mining Institute in Quebec and in Nova Scotia, inasmuch as if enacted they would infringe on the rights and practice of the mining engineer and mine manager. While the present Bill, unlike its predecessors, omitted mining in its definition of a civil engineer, it was still open to serious objection, as would be seen from paragraph *(d)*, which read :

"*(d)* The expression 'civil engineer,' means any one who acts or practises as an engineer in advising on, in making measurements for, or in laying out, designing or supervising the construction of canals, aqueducts, drains, harbors, docks, lighthouses, river improvements, dykes, dams, railways, bridges, power plants, waterworks, sewerage works and all hydraulic, municipal, sanitary, electrical, mechanical *or other engineering works*, when the estimated cost of such work exceeds one thousand dollars."

That clause, if made law, would compel every mining engineer and mine manager in Ontario to become a member of the Canadian Society of Civil Engineers. After it became law every young man seeking to practice as a mechanical or electrical engineer, irrespective of his practice or his technical training, would be compelled to pass an examination provided by this Society. Mine managers would also be debarred from constructing any electric, mechanical or hydraulic plant at their works when the cost exceeded $1,000, and they would be compelled to employ in such work the services of a member of the Canadian Society of Civil Engineers. The Bill was an impertinent intrusion upon the rights of the mining engineer and mine manager and should be vigorously opposed by the Institute. (Applause.)

Mr. ANDREWS—Would that Bill prevent a person who is managing a mine from constructing a dam?

Mr. SNYDER—I believe it would. I think he would have to join the Canadian Society of Civil Engineers in order to keep out of the police court and be fined $50.

The PRESIDENT—I have been informed that this is just a preliminary attempt to pass a similar act in all the Provinces. A mining engineer is a mining engineer pure and simple and he is not an hydraulic engineer or a sanitary engineer or the thousand and one things enumerated in this Bill. I trust this Institute will take action to defeat the purposes of this Bill in so far as it relates to mining engineers.

Mr. BELL moved that the Council of the Institute be authorized to take immediate action with a view to having the objectionable clause expunged from the Bill.

Mr. COSTE—I have great pleasure in seconding the motion.

Mr. SNYDER—While mining engineering is unquestionably a profession of itself, yet there is an immense amount of civil engineering in connection with it. In my own line, which is a mixture of mining and mechanical englneering, I have to do with the mechanical side fully as much as with the mining side, so that I would suggest that Mr. Bell's motion be changed so as to include any kind of engineer. We don't want to be forced into any kind of societies in order to make a living.

Mr. ANDREWS—This is the third year we have had to fight this Bill in our Local Legislatures, and if we have to go on fighting this thing every year would it not be better to compromise with these people and let them have their own way if they let us alone.

Mr. BELL—We fought them last year to a standstlil, and I believe we will beat them again.

Mr. FRASER—This Bill undoubtedly contemplates including mining engineers within its scope.

Mr. FERGIE—When it came before the Nova Scotia Legislature the clause referring to mining engineers was struck out.

Mr. OBALSKI—In the Quebec Legislature the word "mining" was struck out in the English version of the Bill, but through a clerical error it was not struck from the French version, and so the Government is introducing a Bill this session to remedy that defect.

Mr. BELL—Was there an Act passed in British Columbia?

Mr. GALLAGHER—They tried to, but they never got it before the House.

The following amended motion was then passed unanimously:

"That the Institute authorize the Council to take whatever steps it may deem necessary to defeat the object of this Bill in so far as it effects or relates to mining interests."

After a vote of thanks to the President the session adjourned.

FRIDAY AFTERNOON SESSION.

The members re-assembled at three o'clock.

The following papers were read :—

"Test of a Two Stage Compressor" by Mr. John Preston, Montreal.

"Notes on the West Kootenay Ore Bodies" by Mr. R. W. Brock, Geological Survey.

"On Some Peculiarities of the Ore Bodies of West Kootenay, B.C." by Mr. J. D. Sword, Rossland, B.C.

"Palaeontology in its Relation to Mining" by Dr. H. M. Ami, Ottawa.

A CANADIAN MINT.

Mr. W. H. GALLAGHER (Vancouver, B.C.) moved, seconded by Mr. J. D. SWORD (Rossland, B.C.) the following resolution : Whereas the Establishment of a mint in Canada would be a great benefit commercially and otherwise. Be it resolved: That the President and Secretary present a memorial on behalf of the Institute urging upon the Dominion Government the desirability of establishing a mint in British Columbia at the earliest possible opportunity.

Mr. BELL—This is a most important question open to a good deal of discussion and it is unfortunate that it has been brought up so late in the day. So much can be said on both sides of the question that it would not be fair to the Institute to commit itself to this resolution without a full consideration of the question.

Mr. GALLAGHER—I am willing to adopt that suggestion but for the benefit of the members present I would like to say that we in Western Canada consider that a Canadian mint is an absolute necessity. The fact that there is $15,000,000 or more, of Canadian gold sent to the American mints annually should be at least a sufficient inducement to the members of this Institute who reside in the Eastern Provinces and especially in Montreal and Toronto to support such a resolution. As well as being mining men I presume we are more or less commercial men, at least I am, and I can say that the sending of this bullion to San Francisco results in a great deal of business being done there and robs our own country of its legitimate trade. Living in Vancouver, as I do, I know that millions of gold were sent to American cities last year and that a great trade was done with these American cities in consequence. Our Provincial Government is doing all it can in this direction. The Boards of Trade and other institutions on the Coast, have passed a similar resolution. I feel confident that it is high time that we had a Canadian mint.

Mr. BELL—This is a commercial question and any resolution of the kind at this late stage of our meetings would open up a large field for discussion. The resolution should be left with the Council.

Mr. COSTE—Is not the Bank of Commerce going to keep some of the gold in Canada? I understand they have established agencies at Skagway and Dawson.

Mr. GALLAGHER—Yes; but they have no way of refining the gold.

Mr. COSTE—Yes; but if it is kept in bullion I do not think it can be said it goes to the United States.

Mr. Gallagher having agreed to the Secretary's suggestion the discussion ceased. The meeting then adjourned.

ANNUAL DINNER.

At eight o'clock over 100 members and their friends sat down to dinner in the Ladies Ordinary, Windsor Hotel, Mr. John Hardman, S.B., presiding. The Hon. W. S. Fielding, M.P., Finance Minister, who is an Honorary Member, and Mr. H. M. Whitney, President of the Dominion Coal Company, occupied seats at the head of the tabler The dinner was an unqualified success in every sense.

The toast list was a short one, including "The Queen," "The President of the United States," "Our Mineral Interests" aund "Our Guests," all the speeches being conspicuous by their brevity, no one exceeding the time limit of five minutes. Songs and recitations of which an exceedingly generous programme had been arranged by the committee, were then in order, the members enjoying themselves hugely until midnight. Dr. Drummond, the well known author of "The Habitant," contributed a number of selections from his writings which were greatly enjoyed. All the vocal and instrumental numbers were above the average, and the choruses were joined in very heartily, Mr. James D. Sword, as usual, adding greatly to the enjoyment with his songs and banjo accompaniments.

COUNCIL MEETING.

MONTREAL, 6TH APRIL, 1899.

A meeting of the Council and Library Committee was held in the Library of the Institute, Windsor Hotel, Montreal, on Thursday evening, 6th April. The President took the chair at 8.30 p.m. Present:—Messrs. Hardman, Adams, Stevenson, Bell, Stevenson-Brown, Hopper, Meredith and DeCourtenay.

The Secretary presented the minutes of Council Meeting held on the 28th of February, and these, on motion, were confirmed.

CIVIL ENGINEERS' BILL.

The Secretary reported that in accordance with resolution of Annual Meeting, he had, in conjunction with Mr. Coste, appeared before the Legal Committee of the Ontario Legislature in opposition to the Bill respecting Civil Engineers, promoted by the Canadian Society of Civil Engineers, and that the Bill had been given the twelve months' "hoist."

GEOLOGICAL SURVEY RESOLUTION AND ANNUAL GRANT.

The Secretary reported that the resolution adopted at the Annual Meeting respecting the Geological and Natural History Survey of Canada had been forwarded to the Hon. the Minister of the Interior. He also reported having made formal application to the Hon. the Finance Minister for a renewal of the grant to the Institute.

PUBLICATION OF PAPERS IN THE CANADIAN MINING REVIEW.

The President read a letter under date of 14th March from Mr. Lionel H. Shirley, Montreal, pointing out that papers read at the meetings of the Institute in 1898 had been published in the CANADIAN MINING REVIEW prior to their publication in the Journal of the Institute. Mr. Shirley also called attention to the publication of advance proof copies of several papers in the same publication of February, 1899, some of which contained statements which could not be substantiated. He complained that the publication of these papers before discussion was detrimental to the interests of the Institute.

The Secretary in reply explained that he had followed a precedent established by the Provincial organizations for many years. The publication of the papers in the REVIEW was beneficial inasmuch as it gave publicity to their proceedings and was conducive to more liberal discussion. Mr. Shirley's statement that proofs of papers had appeared in the REVIEW before having been received by the members was incorrect. The papers were sent out to members with the second notices two weeks in advance of the Annual Meeting, whereas the REVIEW was published in Ottawa on the 28th of February and could not have been delivered to any of the members before the 1st of March, the date of the Annual Meeting. His reference to Paragraph IX. of the Constitution was also inaccurate, as it only had reference to the power vested in the Council with respect to publication in the Journal of the Institute. The point raised by Mr. Shirley as to whether it was advisable to publish their transactions solely in the Journal of the Institute was worthy of consideration.

The President explained that the publicity given to their papers and proceedings was one of the grounds upon which they had based their application for the Dominion grant.

Dr. Adams pointed out that the advance proof copies to which Mr. Shirley referred had been sent to members distinctly marked "Subject to Revision," with a request for discussion.

The sense of the meeting being favorable to the widest publicity being given to the papers and proceedings of the Institute, the Secretary was authorized to so communicate with Mr. Shirley in acknowledging his letter.

British Columbia Excursion.

The Secretary reported having had an interview with Mr. McNicoll, General Passenger Agent of the Canadian Pacific Railway, with respect to the proposed excursion of the members to British Columbia. Mr. McNicoll had expressed his desire to co-operate with the Institute on the most favorable terms and he promised to quote the lowest possible rate for transportation, sleepers and dining cars as soon as he had an opportunity of conferring with Mr. Shaughnessy on his return from England.

The President read letters from Messrs. S. S. Fowler, Nelson; R. R. Hedley, Nelson; Wm. Blakemore, Fernie, and Mr. Elliott Galt, Lethbridge, discussing various details concerning the excursion.

After some discussion the President, Secretary and Mr. Meredith were appointed to confer further with Mr. McNicoll.

Grant to Library.

On motion the sum of two hundred dollars was voted for the immediate necessities of the Library.

The Secretary was authorized to purchase the volumes of the American Institute of Mining Engineers necessary to complete the sett of these publications in the Library.

The President was authorised to purchase an additional book-case.

The Library Committee was authorized to bind such volumes of exchanges and periodicals as were complete for the purpose.

Renewal of Library Lease.

The President was authorized to renew the lease of the Library premises for another year on the same terms.

New Member.

Mr. Walter Ross, Rat Portage, was proposed by Mr. J. Burley Smith, seconded by Mr. R. G. Leckie, nominated for membership.

Dinner Deficit.

Mr. Robert Meredith, Secretary of the Dinner Committee, reported a deficit of $72.55 in the receipts of the annual dinner.

On motion the Treasurer was authorised to pay the amount.

A vote of thanks was passed to the Dinner Committee.

After arranging for a meeting of the Library Committee to be held on Saturday afternoon, the 8th instant, at 5 o'clock, the Council adjourned until Saturday evening, 15th instant, at 8 o'clock.

MEETING OF LOCAL EXECUTIVE COMMITTEE.

MONTREAL, 6TH MAY, 1899.

A meeting of the Local Executive was held in the Library of the Institute, in the Windsor Hotel, Montreal, on Saturday, May 6th, at 8 p.m.

Present—The President, the Treasurer, R. Meredith, J. S. Brown, H. W. DeCourtenay.

A letter from Mr. McNicoll to the Secretary, giving information and rates concerning the proposed British Columbia meeting was read by the President, and the itinerary suggested by Mr. McNicoll was discussed and modified, and it was resolved that the itinerary as modified should be submitted to Mr. McNicoll for his approval on Monday, the 8th May, by the President. The meeting was adjourned subject to the call of the President.

MEETING OF COUNCIL.

MONTREAL, 8TH JUNE, 1899.

Present:—Dr. F. D. Adams, R. T. Hopper, J. Obalski, B. T. A. Bell, and (by proxy) Jas. McArthur and Clarence Dimock.

The Secretary read the notice convening the meeting; also a letter from Messrs. Gemmill & May, Barristers, Ottawa, concerning the legal status of the Executive Committee appointed at the annual general meeting; also letters from Mr. A. Blue and Mr. C. A. Meissner, regretting inability to be present and signifying their approval of the resolutions to be submitted at the meeting as noted in the memo. of business in the circular notice. After some discussion, it was resolved to submit the following letter to the members of Council, and embody it in the Minutes:—

Montreal June 8th, 1899.

We, the undersigned members of the Council of the Canadian Mining Institute, having been regularly called together and being in doubt as to whether we form a duly constituted quorum, two members being represented by proxy, and having agreed upon the following resolutions, desire hereby to submit them to the judgment and approval of the Council as a whole:—

Resolved,—That the Council does not deem it desirable to extend the administration of the affairs and business of the Institute beyond that provided in the Constitution and By-laws.

BY-LAWS FOR THE CONDUCT OF THE MEETINGS AND BUSINESS OF THE COUNCIL AND "THE LIBRARY AND LOCAL EXECUTIVE COMMITTEE."

1. *Resolved*,—That "The Library and Local Executive Committee" shall be a sub-committee of the Council to transact whatever business may be necessary for the maintenance and equipment of the Library and Reading Room, and such matters of a local character as may be referred to it from time to time. The Library and Local Executive Committee shall, through the Secretary, report to the Council all appropriations for expenditure upon the Library, and all business transacted by it shall be subject to the direction and approval of the Council.

2. Notice shall be mailed by the Secretary to each member not less than two weeks in advance of the date upon which it is proposed to hold a meeting of Council.

3. Members unable to be present in person at meetings of the Council may record their votes upon any question, or upon any matter of business of which advice has been given in the notice convening the meeting, by sending to the Secretary, or other officer of the Institute, the following form of proxy duly attested :—

I,.................of.................Province of.................. being a member of the Council of the Canadian Mining Institute, do hereby nominate, constitute and appoint—(here give name of President, Secretary or other member of Council) to vote for me on my behalf at the meeting of Council convened for................., being (here state whether favorable or opposed) to the questions and business enumerated on the notice of the meeting.

B. C. Meetings and Excursion.

The Secretary having presented the report on behalf of the Committee appointed at the Annual General Meeting to arrange for the Excursion to British Columbia, it is resolved that all future arrangements in connection with the matter be left in the hands of the President, Treasurer and Secretary.

Grant to the Secretary's Office.

Resolved, that the Council recommend, if in the opinion of the Treasurer the funds of the Institute will allow of it, that the grant to the Secretary's office for the ensuing year be increased to the sum of Six Hundred Dollars ($600.00.)

(Signed) Frank D. Adams, *Chairman.*
R. T. Hopper,
J. Obalski,
B. T. A. Bell, *Secretary.*
James McArthur (by proxy).
Clarence Dimock (by proxy).
Approved, A. Blue,
" Chas. Brent,
" C. A. Meissner.
" S. S. Fowler.
Approved (excepting resolution relating to voting by proxy) George R. Smith.

The meeting adjourned at eleven o'clock.

MEMBERS.

LIST OF MEMBERS

AT 1st JULY, 1899.

PATRONS.

His Excellency Lord Minto, Governor-General.
Right Hon. Sir Wilfrid Laurier, M.P., etc.

HONORARY MEMBERS.

Birkinbine, John, *Mining Engineer*,
Past President American Institute of Mining Engineers,
Philadelphia.

Fielding, Hon. W. S, M.P.,
Minister of Finance, Ottawa.

Selwyn, Dr., A.R.C, C.M.G.,
Late Director of the Geological Survey of Canada,
Vancouver, B.C.

MEMBERS.

Adams, Captain Robert C., *Mine Owner*,
45 Metcalfe Street, Montreal.

Adams, Dr. Frank D., *Geologist*,
McGill University, Montreal.

Aldridge, W. H., *Mining Engineer*,
General Manager, Trail Smelting Works, Trail, B.C.

Allan, Alex. B., *Ironmaster*,
7 Langside Crescent, Campside, Glasgow, Scotland.

Allan, W. A., *Mine Owner*,
Victoria Chambers, Ottawa, Ont.

Ami, Dr. H M. *Palaeontologist*.
Geological Survey, Ottawa.

Andrews, C. F., *Mining Engineer*,
Isaac's Harbor, N.S.

Archambault, Victor E.,
7 Vitre Street, Montreal.

Bacon, F., *Iron Merchant*,
377 St. Paul St., Montreal.

Bacon, T. P., *Secretary-Treasurer*, *New Rockland Slate Co.*,
377 St. Paul St., Montreal.

Baker, H. C., Ba.Sc., *Mine Superintendent*,
Rossland, B.C.

Bartlett, Edmund T., *Mining Broker*,
31 Imperial Building, Montreal, Que.

Beebe, James C.,
Mine Centre, Ont.

Belcourt, N. A., Q.C., M.P., *Mine Owner*,
Central Chambers, Ottawa, Ont.

Bell, B. T. A., *Editor Canadian Mining Review*,
Ottawa, Ont.

Bell, Dr. Robert, *Field Geologist*,
Assistant Director, Geological Survey of Canada, Ottawa.

Bell, John W., Demonstrator in Mining Engineering, McGill University,
"Cragholm," Westmount, Que.

Blackburn, R. L., *Mine Owner*,
Ottawa, Ont.

Blakemore, William, *Mining Engineer*,
General Manager, Crow's Nest Pass Coal Co., Limited,
Fernie, B.C.

Blue, Archibald,
Director of Mines for the Province of Ontario, Toronto.

Blue, John, *Civil and Mining Engineer*,
Eustis Mining Co, Eustis, Que.

Boas, Feodor,
Managing Director, Asbestos and Asbestic, Limited, Danville, Que.

Bodwell, E. V.,
Victoria, B.C.

Bonner, W. T., *Mechanical Engineer*,
The Babcock & Wilcox Co., Limited, Montreal.

Boss, J. E., *Mine Manager*,
Spokane, Wash.

Bowen, Cecil, *Civil Engineer*,
Cobourg, Ontario.

Braden, Wm., S.B., *Mining Engineer*,
Helena, Montana.

Brainerd, Dwight,
Hamilton Powder Co., Montreal.

Breidenbach, T., *Mine Manager*,
Sirdar Mine, Rat Portage, Ont.

Brelich, Henry, *Mining Engineer*,
Nelson, B.C.

Brent, Chas., *Mining Engineer*,
Rat Portage, Ont.

Brock, R. W., *Geologist*,
Geological Survey of Canada, Ottawa.

Brown, D. A.,
Bell's Asbestos Co., 77 Pearl St., Boston, Mass.

Brown, J. Stevenson,
Box 153, Montreal

Brown, T., *Assayer*,
Nelson, B.C.

Bruce, R. Randolph, B.Sc, C.E.,
Windermere, East Kootenay, B.C.

Bucke, M.A., *Mining Engineer,*
Box. IV., Kaslo, B.C.

Budden, H. A., *Mine Owner,*
New York Life B'd'g, Montreal.

Burchell, J. T., *Colliery Proprietor,*
New Campbelltown, Cape Breton

Campbell, Geo. H., *Mine Owner,*
72 Spadina Road, Toronto, Ont.

Carlyle, W. A., *Mining Engineer,*
British America Corporation, Limited, Rossland, B.C.

Carpenter, C. B. K.,
Manager, Petroleum Oil Trust, Ltd,
Gaspé, Que.

Carrel, Frank, *Daily Telegraph,*
Quebec, Que.

Carriere, C. H., *Mechanical Engineer,*
Levis, Que.

Carry, H. E. C, *Civil and Mining Engineer,*
Barkerville, B.C.

Chambers, R. E, *Mining Engineer,*
Bell Island, Conception Bay, Newfoundland.

Champion, Jas., *Civil and Mining Engineer,*
Barkerville, B.C.

Chewitt, J. H., *Civil and Mining Engineer,*
87 York Street, Toronto, Ont.

Christie, C. J., *Mining Engineer,*
Portland, Oregon.

Cirkel, F., *Mining Engineer,*
Greenwood, B.C.

Clarke, Roy H., *Mining Engineer,*
Box 258, Rossland, B.C.

Clough, C. F.,
Spokane, Washington.

Colby, Hon. C. C., *Mine Owner*,
Stanstead, Que.

Colquhoun, A. J., *Mining Engineer*,
Savonas, B.C.

Cooper, James, *Mine Owner*,
James Cooper Manfg. Co., Limited, Montreal.

Coste, Eugene, *Mining Engineer*,
34 Madison Avenue, Toronto.

Cowans, J. R., *Mechanical Engineer*,
General Manager, Cumberland Ry. and Coal Co., Springhill, N.S.

Cowie, F. W., *Civil Engineer*,
Department Public Works, Ottawa.

Cox, E. Strachan, *Mining Broker*,
Toronto, Ont.

Crawford, J. D., *Mine Owner*,
Westmount, W. Montreal.

Croasdaile, H. E.,
General Manager, Hall Mines, Limited, Nelson, B.C.

Curran, Neil McLeod, *Mine Manager*,
North Star Mining Co., Limited, Fort Steele, B.C.

Davys, M. S.,
Superintendent, Hall Mines, Limited., Nelson, B.C.

Dawson, Dr. George M., C.M.G., etc.,
Director, Geological Survey of Canada, Ottawa.

Deacon, T. R., *Civil Engineer*,
Rat Portage, Ont.

DeCourtenay, H. W.,
476 St. Paul Street, Montreal

Denis, Theo. C., *Mining Engineer*,
Geological Survey, Ottawa, Ont.

Dick, Alexander,
Rossland, B.C.

Dimock, Clarence, *Mine Owner*,
Wentworth Gypsum Co., Windsor, Nova Scotia.

Dingman, A. W.,
50 Wellington Street W., Toronto.

Domville, Lt.-Col., M. P.,
St. John, N.B.

Donald, J. T., M.A., *Assayer*,
112 St. Francois Xavier Street, Montreal.

Donkin, Hiram, *Civil Engineer*,
General Manager, Dominion Coal Co., Glace Bay, C.B.

Douglas, Dr. James, *Metallurgist*,
99 John St., New York.

Douglas, Lord Sholto, *Mine Owner*,
Sault Ste. Marie, Ont.

Drummond, G. E.
Managing Director, Canada Iron Furnace Co., Montreal.

Drummond, Hon. George A.,
New Rockland Slate Co., Montreal.

Drummond, John J., *Mining Engineer*,
Canada Iron Furnace Co., Radnor Forges, Que.

Drummond, Thos. J.,
Montreal Car Wheel Co., Montreal.

Drury, H. A.,
Imperial Oil Co., St. John, N.B.

Eustis, W. E. C., *Mine Owner*,
Eustis Mining Co., Box 2412, Boston.

Evans, John W., *Civil and Mining Engineer*,
Sudbury, Ont.

Fergie, Chas., *Mining Engineer*,
Managing Director, Intercolonial Coal Co., Westville, N.S.

Flaherty, R., *Mine Manager,*
Rat Portage, Ont.

Fleck, A. W., *Mine Owner.*
Canada Atlantic Ry., Ottawa, Ont.

Foley, James,
Managing Director, Petroleum Oil Trust, Limited,
New York Life B'd'g, Montreal

Fowler, S. S., *Mining Engineer,*
New Gold Fields of B.C., Nelson, B.C.

Fraser, Graham,
Nova Scotia Steel Co., Limited, New Glasgow, N.S.

Fraser, A. W., Barrister,
Ottawa, Ont.

Gage, W. J., *Mining Engineer,*
Hotel Cadillac, New York.

Gallagher, W. H., *Mine Owner,*
Vancouver, B.C.

Galt, Elliot T.,
Managing Director, Alberta Railway and Coal Co.,
Lethbridge, N.W.T.

Gaylord, F. B., *Iron Manufacturer,*
Deseronto, Ont.

Gilman, E. W., *Mechanical Engineer,*
Canadian Rand Drill Co., Montreal, Que.

Goodwin, Dr. W. L.,
Director, School of Mining, Kingston, Ont.

Green, George A., *Mine Owner,*
152 Drummond Street, Montreal, Que.

Grundry, Frank,
General Manager, Quebec Central Railway, Sherbrooke, Que.

Guess, George A., *Assayer,*
Greenwood, B.C.

Guess, H. A., M.A., *Metallurgist*,
Ottawa Gold Milling and Mining Co., Keewatin, Ont.

Gue, T. R., *Mine Owner*,
Acadia Powder Co., Halifax, N.S.

Guilbault, Antoine, *Mining Broker*,
11 John St., Quebec, Que.

Gwillim, J. C., Ba. Sc., M.E.,
Slocan City, B.C.

Haley, Dr. Allen, M.P., *Mine Owner*,
Windsor, Nova Scotia.

Hall, P. P., *Mine Owner*,
Quebec.

Hamilton, Wm., Jr., *Mechanical Engineer*,
Wm. Hamilton Mnfg. Co., Peterborough, Ont.

Hammond, Herbert C., *Mine Owner*,
Toronto, Ont.

Hanson, C. C., *Mechanical Engineer*,
Jas. Cooper Mnfg. Co., St. Henri, Montreal.

Hardman, John, S.B., *Mining Engineer*,
Room 3, Windsor Hotel, Montreal.

Harvey, W. Pellew, F.C.S., *Assayer*,
Vancouver, B.C.

Hay, A. M.,
President, Dominion Gold Mining and Reduction Co., Limited,
Port Arthur, Ont.

Hayward, A. A., *Mining Engineer*,
Hollis Street, Halifax, N.S.

Heal, John H., *Mining Engineer*,
44 Cathcart St., Montreal, Que.

Hedley, Robert R., *Metallurgist*,
Hall Mines, Limited, Nelson, B.C.

Hersey, Milton L., Ba.Sc., *Assayer*,
Magog, Que.

Higginson, J. F., *Mine Owner*,
Buckingham, Que.

Hill-Catherine, W. J., *Mining Engineer*,
60 Gracechurch St., London, England.

Hille, F., *Mining Engineer*,
Port Arthur, Ont.

Hill, Leslie, C.E.,
Vancouver, B.C.

Hobson, John B., *Mining Engineer*,
Consolidated Cariboo Hydraulic Mining Co., Quesnelle Forks, B.C.

Hogue, A. E., *Mining Engineer*,
Edmonton, N.W.T.

Holdich, A. H., *Assayer*,
Revelstoke, B.C.

Hopkins, F. H.,
Dominion Wire Rope Co., Montreal, Que.

Hopper, R. T.
Managing Director, Anglo-Canadian Asbestos Co., Limited,
Canada Life Building, Montreal, Que.

Innes, F. C., *Mine Owner*,
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Jenckes, J. M.,
Secretary, Jenckes Machine Co., Sherbrooke, Que.

Jenckes, S. W.,
Sherbrooke, Que.

Johnson, A. S.,
Johnson's Asbestos Co., Thetford Mines, Que.

Johnstone, R. C. Campbell, *Mining Engineer*,
Nelson, B.C.

Jones, R H., F.S A., *Mineralogist*,
The Grange, Gunnersbury, London, W., England.

Kehoe, Henry, *Mining Engineer*,
Canadian Pacific Exploration, Limited, Rossland, B.C.

King, Lt.-Col., *Mine Owner*,
Sherbrooke, Que.

King, James, *Mine Owner*,
Union Bank B'd'g, Quebec.

Kirkgaard, P., *Mining Engineer*,
Canadian Gold Fields, Limited, Deloro, Ont.

LaBeree, Edwin E., *Mining Broker*,
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Latimer, F. H., *Civil Engineer*,
Vernon, B.C.

Law, Charles F.,
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Lawrence, H. D., *Mine Owner*,
Sherbrooke, Que.

Lake, H. Perry, *Mining Engineer*,
Revelstoke, B.C.

Leckie, J. E., *Mining Engineer*,
Greenwood, B.C.

Leckie, Major R. G.,
Sudbury, Ont.

Leckie, Major R. G. Edwards, *Mining Engineer*,
Rossland, B.C.

Ledoux, Dr. A. R., *Metallurgist*,
98 John St., New York, N.Y.

Lenard, R. W., C.E.,
Montreal West, Que.

Lewis, James F., *Mechanical Engineer*,
Rand Drill Co., Chicago, Ill.

Loring, Frank C., *Mining Engineer*,
Spokane, Wash.

Low, Albert P., Ba. Sc., *Field Geologist*,
Geological Survey of Canada, Ottawa.

Macdonald, A., *Mine Owner*,
St. Johns, Que.

Macdonald, Bernard, *Mining Engineer*,
Montreal & London G. & S. Dev. & M. Co.,
180 St. James Street, Montreal.

MacDougall, George,
85 Osborne St., Montreal.

Mann, D. D., *Mine Owner*,
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Mann, W.,
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Marcuse, B.,
Canadian Asbestos Co., Cor. Foundling and St. Peter, Montreal.

Marks, Geo. Thos., *Mine Owner*,
Port Arthur, Ont.

Mason, F. H., F.C.S., *Assayer*,
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Meissner, C. A., *Metallurgist*,
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Mendenhall, F. R.,
Rossland, B.C.

Meredith, Robert, *Mining Broker*,
51 St. Francois Xavier St., Montreal.

Merritt, W. Hamilton, Assoc. R.S.M., M.E.,
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Meyer, Leopold L., *Mining Engineer*,
Grand Calumet Mining Co., Gilmour House Block, Ottawa.

Milbourne, C. Kingsley,
Nelson, B.C.

Millar, Prof. W. G.,
School of Mining, Kingston, Ont.

Millar, Spencer, *Civil and Mechanical Engineer*,
Lidgerwood Manufacturing Co., Liberty Street, New York.

Mitchell, J. S.,
Beaver Asbestos Co., Sherbrooke, Que.

Montpetit, Dr., *Mine Owner*,
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Morgan, C. E., *Mechanical Engineer*,
Northey Mnfg. Co., Toronto, Ont.

Morris, A. W., *Mining Broker*,
St. Francois Xavier St., Montreal.

McAree, John, *Land Surveyor*,
Rat Portage, Ont.

McArthur, J. B.,
Columbia, Yale District, B.C.

McArthur, James, *Metallurgist*,
Canadian Copper Co., Copper Cliff, *via* Sudbury, Ont.

McCall, James T., *Iron Merchant*,
Canada Life Building, Montreal.

McCallum, A., *Mechanical Engineer*,
Peterborough, Ont.

McConnell, R. G., *Field Geologist*,
Geological Survey of Canada, Ottawa.

McConnell, Rinaldo,
Crystal Gold Mining Co., Mattawa, Ont.

McCrae, John Ferguson, *Mine Owner*,
Rossland, B.C.

McCuaig, Clarence J., *Stock Broker*,
Notre Dame St., Montreal.

McEvoy, James, *Field Geologist*,
Geological Survey of Canada, Ottawa.

McInnes, Wm., *Field Geologist*,
Geological Survey of Canada, Ottawa.

McLennan, J. S.,
Treasurer, Dominion Coal Co., 95 Milk St., Boston.

McNaughton, G. F., *Mine Manager*,
New Egerton Mining Co., 15 Mile Stream, N.S.

McNeill, A.,
Metropole Building, Halifax, N.S.

Nelson, Charles,
174 St. James St., Montreal.

Nelson, W. J.,
Intercolonial Coal Co , Montreal.

Nichols, W. H.,
Nichols Chemical Co., 32 Liberty St., New York.

Newman, W. T.,
Box 81, Vaucouver, B.C.

Obalski, J., *Mining Engineer*,
Inspector of Mines, Province of Quebec, Quebec

Parker, Charles, *Mining Engineer*,
Rossland, B.C.

Paterson, H. C. E.,
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Peacock, B. F.,
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Peacock, Francis T., *Mechanical Engineer*,
St. James St., Montreal.

Penhale, John J., *Mine Superintendent*,
United Asbestos Co., Black Lake, Que.

Pigott, J. F.,
St. Francois-Xavier St., Montreal.

Plummer, Frank,
36 Canada Life Building, Montreal, Que.

Porter, John B., *Professor of Mining Engineering,*
McGill University, Montreal.

Preston, W. A.,
Harding P.O., Minn., U.S.A.

Pyke, J. W., *Iron Merchant,*
St. Francois Xavier St., Montreal

Reed, Dr. James, *Mine Owner.*
Reedsdale, Ont.

Riley, James Johnstone,
204 Board of Trade, Montreal, Que.

Robb, D. W., *Mechanical Engineer,*
Amherst, N.S.

Robinson, A. H. A.,
Peterborough, Ont.

Ross, G. J., *Mechanical Engineer,*
Rat Portage, Ont.

Ross, Walter,
Rat Portage, Ont.

Roughsedge, Dr. Wm. H.,
South Edmonton, N.W.T

Rykert, E. G., *Stock Broker,*
Notre Dame St., Montreal.

Sanders, W. A., *Mining Engineer,*
Juneau, Alaska, U.S.A.

Shirley, Lionel H., C. & M. E.
151 Alexander St., Montreal.

Simpson, S. J.,
James Cooper Mnfg. Co., Montreal.

Sjostedt, E. A., *Metallurgist*,
Sault Ste. Marie, Ont.

Smillie, Dr. N. C., *Mine Owner*,
384 Green Avenue, Montreal.

Smith, Daniel,
Ontario Powder Works, Kingston, Ont.

Smith, George R., M.L.A., *Mining Engineer*,
Bell's Asbestos Co., Ltd., Thetford Mines, Que.

Smith, J. Burley, *Mining Engineer*,
Montreal, Que.

Smith, Chas. F.,
President, Montreal Board of Trade, St. Peter St., Montreal, Que.

Snyder, Frederick T., *Mechanical Engineer*,
Wm. Hamilton Manfg. Co., Vancouver, B.C.

Spafford, S. L.,
Nichols Chemical Co., Capelton, Que.

Stephens, W. Barclay,
Granite Creek Mining Co., Montreal.

Stevenson, A. W., C.A.,
Bank of Toronto Chambers, Montreal.

Stuart, George W., *Mining Engineer*,
Truro, Nova Scotia.

Strachan, Wm ,
Wm. Strachan & Co., Montreal, Que.

Sussman, J. H., *Mining Engineer*,
Care of Lewisohn Bros., 81-83 Fulton St., New York.

Sweney, Roy, *Electrical Engineer*,
170 St. George St., Toronto.

Swinney, A. J. G ,
Lorne Villa, Sidcup, Kent, England.

Sword, Jas. D., *Mining Engineer*,
Rossland, B.C.

Taylor, C. H., *Mechanical Engineer*,
Taylor Air Hydraulic Compressor Co., Montreal.

Tibbits, J. H., *Mining Engineer*,
Modstock Gold Mining Co., Forest Hill, N.S.

Topping, E. S, *Mine Owner*,
Trail, B.C

Townsend, George E.,
Castle Mining Co., Rossland, B.C.
Care of Henry Schloss, 552 Broadway, New York.

Tuck, T. J., *Mine Owner*,
Sherbrooke, Que.

Wm. G. Turner,
Imperial Building, Montreal.

Tye, A. T., B.Sc., *Mining Engineer*,
923 E. Adams St., Los Angelos, Cal., U.S.A.

Tyrrell, J. B., *Consulting Mining Engineer*,
Dawson City, Yukon, N W.T.

Waterman, W. J., *Mining Engineer*,
Princeton, B.C.

Wallingford, Edward,
Perkins Mills, Que.

Whiteside, O. E. S., *Mining Engineer*,
Anthracite, N.W.T.

Wilkinson, C. H.,
British Yukon M., T. & T. Co., 53 New Broad St., London.

Williams, J. N. S., *Civil and Mechanical Engineer*,
P.O. Box 641, Victoria, B.C.

Wiley, F. S., *Mine Owner*,
Port Arthur, Ont.

Wilson, Alfred,
Commissioner, Canada Co., Toronto.

Woodside, J. W.,
Sherbrooke, Que.

Wright, Lt.-Col. Joshua, *Mine Manager*,
Hull, Que.

STUDENT MEMBERS.

Ainley, Chas. N., Ba. Sc.,
Almonte, Ont.

Atherton, H. Stanley,
c/o Bank of Montreal, Montreal, Que.

Blaylock, Selwyn G.,
Danville, Que.

Butler, Percy,
Guggenheim Smelting Works, Perth, Amboy, N.J.

Grant, G. Harold,
McMaster University, Toronto.

Kirkpatrick, Stafford F.,
96 Barrie Street, Kingston, Ont.

MacInnes, Mr.,
5 North Park St., Halifax, N.S.

Preston, John C.,
196 Cowen Avenue, Toronto, Ont.

Robertson, Philip W.,
32 McTavish St., Montreal, Que.

Waller, Geo. W.,
Bartonville, Ont.