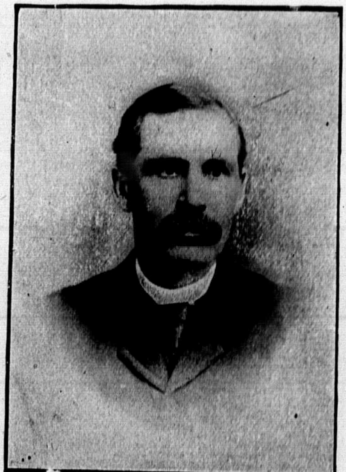
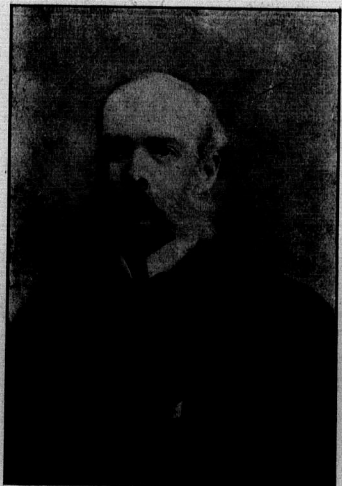
Mossom Boyd Co.
Bobcaygeon, Ont.



JOHN BLUE, C. & M. E.
President, 1894-95.



THE LATE COL. LUCKE, *Vice-President*,
Died July, 1894.

D. Smit
Brown

1895.

nch,
Quebec.

D. Smith, Brownsburg

Burley Smith, Glen Almond.

J. T. Dwyer, Montreal.

Prof. Nicol, Kingston.

E. B. Haycock, Ottawa.

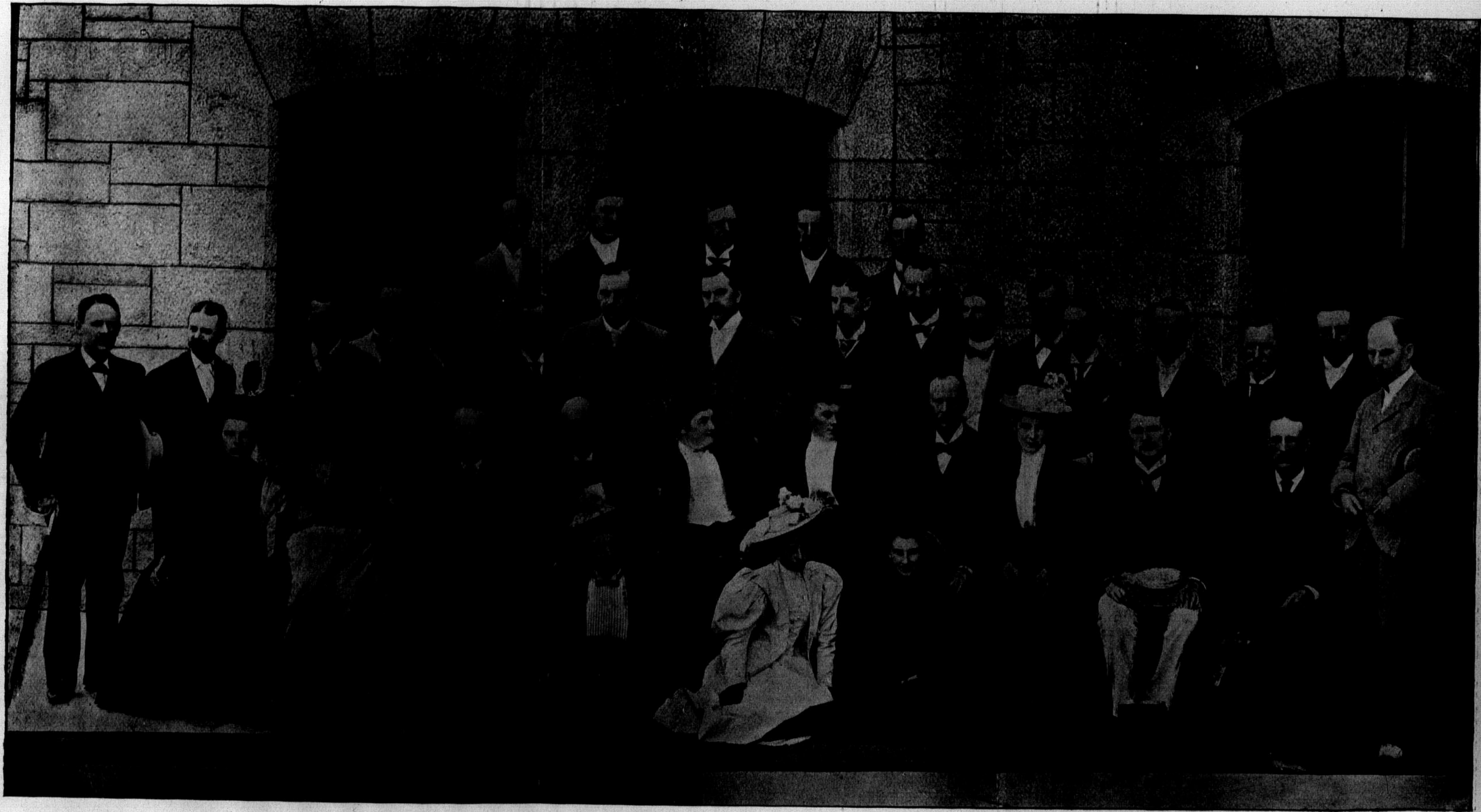
R. W. Prittie, Toronto.

B. T. A. Bell, Ottawa.

R. H. Brown, Sydney, C.B.

Mr. Justice Sedgewick, Ottawa.

GROUP TAKEN AT QUEBEC, 28th JUNE, 1895.



F. T. Shutt, Ottawa. — George E. Drummond, Montreal. — John J. Penhale, Black Lake. — C. W. Morgan, Toronto. — L. J. Lynch, Quebec.

D. Smith, Brownsburg. — T. W. Gibson, Toronto. — L. A. Klein, Black Lake. — J. Obalski, Quebec. — L. Gendreau, Jersey Mills. — John Blue, Capelton. — Jas. Mitchell, Sherbrooke. — G. Y. Chown, Kingston. — A. W. Stevenson, Montreal. — W. T. Bonner, Montreal. — J. Burley Smith, Glen Almond. — J. T. Dwyer, Montreal. — Prof. Nicol, Kingston. — E. B. Haycock, Ottawa. — R. W. Prittie, Toronto.

Hon. E. J. Flynn, Quebec. — Hon. George Irvine, Q.C., Quebec. — Mrs. Klein. — Mrs. Lynch. — Jas. King, M.L.A., Quebec. — B. T. A. Bell, Ottawa. — R. H. Brown, Sydney, C.B. — Mr. Justice Sedgewick, Ottawa.

Miss Lynch.

THE JOURNAL

OF THE

General Mining Association

OF THE

PROVINCE OF QUEBEC.

. 1894-95 .

VOLUME II.

"The Association as a body is not responsible for the statements and opinions advanced in the papers which may be read, or in the discussions which may take place at any of its meetings, or which may be reproduced in any of its publications."—*Constitution and By-Laws, Sec. X., Par. 30.*

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PROCEEDINGS

OF THE

GENERAL MINING ASSOCIATION

OF THE

PROVINCE OF QUEBEC,

FOR THE YEARS 1894-5.

FOURTH ANNUAL MEETING.

—

MONTREAL.

—

11TH AND 12TH JANUARY, 1894.

—

The proceedings opened in new Club Room, Windsor Hotel, on Wednesday at three o'clock in the afternoon. Captain Robert C. Adams, in the absence of the Hon. George Irvine, Q.C., President, in the chair.

The minutes of previous meetings were read and confirmed.

NEW MEMBERS.

The following were elected members of the Association:

J. D. Sword, M.E., Ingersoll Rock Drill Co., Montreal.
W. E. C. Eustis, Eustis Mining Co., Boston.
A. W. Morris, M.L.A., Montreal.

FINANCIAL STATEMENT.

MR. A. W. STEVENSON, C.A., submitted the financial statement for the year, which showed the total receipts to have been $2,406.42, and the expenditure $2,269.55, leaving a balance in hand of $136.87.

THE SECRETARY briefly referred to the marked increase in the membership during the past year, the interest that had been taken in the various meetings and excursions, particularly the proceedings of the International Mining Convention, held at Montreal during the week beginning 21st February, when the Association welcomed as its guests the American Institute of Mining Engineers, the Mining Society of Nova Scotia and the Ontario Mining Association.

THE LATE MR W. HALL IRWIN.

On motion of the Secretary the following resolution was adopted :

"The members of the Association having learned with profound sorrow of the untimely death of Mr. W. Hall Irwin, a valued and highly esteemed member of the Council ; be it resolved : That a minute be entered in the proceedings of this Annual General Meeting recording the sense of loss sustained by the Association and the mining industry of the province, the welfare and interests of which he had done so much to promote and further by his integrity, energy and enterprise."

AMENDMENTS TO CONSTITUTION.

The following amendments to the Constitution and By-Laws were adopted :

Section 10. "The President shall not hold office for more than two consecutive years, but shall be eligible for re-election to that office after an interval of a year."

Section 12. "All officers and members of Council shall retire annually, but shall be eligible for re-election."

Section VII. "When the proposed candidate is elected, the Secretary shall give him notice thereof according to Form 'B,' but his name shall not be added to the list of members of the Association until he shall have signed the Form 'C' in the appendix."

Section XVI. "General meetings for the reading and discussion of papers and for the transaction of business shall be held once in every four months in each year, at such time and place as the Council may determine."

AFFILIATION OF MINING STUDENTS.

THE SECRETARY stated that at one of their Council Meetings the question of affiliating the McGill Mining Society, which was an organization of the mining students attending the lectures at McGill University, had been discussed, and Mr. Carlyle had written to say that the matter had been favorably entertained by the students. On motion it was decided to refer the matter to Council.

A CANADIAN MINING ASSOCIATION.

THE SECRETARY stated there was a very favorable disposition among many of the members towards the incorporation of the existing mining organizations into one strong body, which, while representing the provinces, would be thoroughly representative of the mining interests of the Dominion. Certain prominent members of the Mining Society of Nova Scotia were also strongly in favor of such an amalgamation.

THE CHAIRMAN—The idea is a capital one, and I think that we should make a move towards carrying it out.

MR. F. A. HALSEY was heartily in sympathy with such a move. The Council, he thought, might draw up a proposition and submit it at their meeting on Thursday; it could then be left in the hands of a sub committee to enter into negotiations.

On motion the matter was referred to the Council to report.

ELECTION OF OFFICERS AND COUNCIL.

The meeting then proceeded to elect officers and Council, the various ballots resulting as follows:—

President:

JOHN BLUE, C. & M.E., Eustis Mining Co., Capelton.

Vice-Presidents:

J. Burley Smith, British Phosphate Co., Glen Almond.
George E. Drummond, Canada Iron Furnace Co., Montreal.
F. P. Buck, Dominion Lime Co., Sherbrooke.
Col. Lucke, Beaver Asbestos Co., Sherbrooke.

Council:

James King, M.L.A., King Bros., Quebec.
Capt. R. C. Adams, Anglo-Canadian Phosphate Co., Montreal.
F. A. Halsey, Canadian Rand Drill Co., Sherbrooke.
S. P. Franchot, Emerald Mining Co., Buckingham.
Hector McRae, Electric Mining Co., Ottawa.
R. T. Hopper, Anglo-Canadian Asbestos Co., Montreal.
J. J. Penhale, United Asbestos Co., Black Lake.
George R. Smith, Bell's Asbestos Co., Thetford Mines.
Fritz Cirkel, M.E., Ottawa.

Treasurer:

Mr. A. W. Stevenson, C.A., 17 St. John St., Montreal.

Secretary:

Mr. B. T. A. Bell, 17 Victoria Chambers, Ottawa.

After discussion it was unanimously resolved to hold the next meeting in the city of Quebec during the first week in June.

The meeting then adjourned.

The members re-assembled at eight o'clock, Mr. John Blue, C. & M.E., President, in the chair. The following papers were read at this session:—

THE DIAMOND PROSPECTING DRILL IN MINING CANADIAN PHOSPHATE AND OTHER IRREGULAR DEPOSITS.

By J. Burley Smith, M.E., Glen Almond, Que.

It is generally held that the diamond drill is not of the same utility in prospecting and determining the position of irregular deposits as it is in minerals of more regular occurrence.

This is more from the fact of the great results achieved in determining accurately the area, extent and depth of regular deposits scientifically located, than failure to discover the position of acknowledged uncertain deposits.

However great the service rendered with regard to regular deposits, it will be remembered that the value of the diamond drill as a prospecting tool became first properly appreciated from the remarkable discoveries made through its use in the great hematite deposits of North Lancashire and Cumberland, England.

Deposits, which from their apparent fitfulness and irregularity had been worked only on a small scale, and as mere surface pockets occurring here and there over a considerable area of ground, and abandoned when apparently exhausted, until the boring operations of a few enterprising proprietors taught the lesson that, although the character of the ore seemed irregular, similar deposits occurred at much greater depths, and of much greater magnitude, the irregularity, scientifically considered, being but another form of regularity and the peculiar order in which these deposits were to be looked for.

Subsequently, and chiefly owing to the use of the prospecting drill, these mines have been worked to a very great depth, and much more extensively, turning out annually many hundreds of thousands of tons.

And the great number of successful results of recent years in such deposits, in all parts of the world, appears to indicate that the diamond drill is of even greater utility in prospecting these than in the more regular minerals referred to.

The very irregularity which makes some kinds of mining so uncertain shows the necessity of traversing and searching the zone of occurrence in many directions by some method much more rapid and less costly than by shafts and tunnels, and a tool like the diamond drill, capable of drilling from 20 to 40 feet per day and bringing out cores of the material passed through, seems to fulfil, in a great measure, these required conditions.

Through its use, prospecting of a mineral property can be exhaustively and reliably carried out in a few months, and cross-sections delineated, showing the number and size of the deposits, from the plotted profiles of which the quantity of ore contained may be approximately calculated, showing if the quantity discovered is large and near enough to bear the greater expense of sinking a shaft or driving tunnels to reach it.

Thus, by the expenditure of a few thousand dollars in the prospecting machinery and the cost of the necessary boring operations, the owner of a property is able, figuratively, to cut his property into slices and see what is inside. The accuracy of which depending, of course, on the number of cuts made.

And, instead of risking a large sum in the purchase of a costly permanent plant and machinery to begin active mining operations for a mineral only doubtfully believed to exist, it may be ascertained by a properly arranged system of borings (practically constituting an approximately accurate underground survey showing the extent and location of detached and irregular deposits) whether it is advisable to lay out money in plant at all, or how much, and even if it is advisable to mine a property or not.

If valuable the very best machinery can be laid down without hesitation or risk for the most economic method of sinking or driving to and winning the mineral when reached.

At the same time an approximate knowledge of the quantity, making it feasible to determine in advance all the questions of transport and annual yield, the laying down of tramways and the transport generally and the use of available water or other gratuitous power to the best advantage.

Negotiations for sale or purchase would also be much simplified from the fact of the real value of the mining estate being established, the cores of mineral and country rock, with the accompanying chart and sections, being the best evidence of the character of the property.

In mining phosphate of lime in Canada the prospecting drill is certain to prove of the greatest possible service.

It is now pretty clearly demonstrated by those eminent Canadian geologists who have earnestly investigated the phenomena of occurrence of this peculiar mineral, that it is found, with rare exceptions, in detached masses or pockets sometimes resembling veins, in masses of pyroxene which, originally considered as interbedded portions of the structure of the Laurentian rocks, are now generally acknowledged to be intrusive dykes, probably connected with the basic eruptions of Archean date.

Very recent observations made in the actual mining of phosphate corroborate in a remarkable way these conclusions, and give at once a basis from which to start in searching for the mineral.

The question of irregularity and uncertainty of the phosphates is not disposed of, but the occurrence and form of the pyroxene are shown to be not irregular and it may be easily recognized.

It is well known that these pyroxene zones, belts or bands, or whatever name they are distinguished by, are readily found and their boundaries clearly defined.

Granting this, it will be seen that the field of operations for the diamond drill prospector is not unduly large, and that a comparatively few carefully selected bore-holes will show if the zone is rich in phosphate or not, the character of the deposit, rich or poor, generally prevailing throughout, and if it is desirable to make further and more conclusive tests, or proceed to another field without loss of time or money.

If a number of vertical borings, placed at fixed intervals with their situation carefully recorded on plan are made and a proper register kept, together with the drill cores brought to the surface, a number of accurate profiles may be constructed, showing a faithful section of the ground tested and whatever it contains. And if parallel lines of borings be made at a convenient distance it will be seen that the area of these respective profiles multiplied by the parallel distances apart will give approximately the quantity of material lying between, whether of unproductive ground or a deposit of mineral.

My own experience in diamond boring in phosphate deposits has been confined so far entirely to underground work, *i.e.* in testing the ground in search of deposits lost track of, or cut out, or new ones believed to exist, but I am able to testify to the success attending those borings made and profiles taken which proved the existence of several valuable deposits; in one case fully corroborated by the extension of a drift to it. And knowing the distance exactly, and the kind of rock intervening, we were able to let the driving of this by contract and on very reasonable terms.

I regret, from the fact of our boring operations being yet incomplete, that I am not at liberty to give full figures and details, but hope on some future occasion to return to the subject and publish a full account of this work, which has proved valuable and interesting to me, and may be of use to other phosphate miners.

I will therefore conclude with some description of the machine in use at our mines, which has given the greatest satisfaction, absolutely costing nothing in repairs during the six months we have had it in daily use.

The diamond drill we have in use is the Bullock drill and of the prospecting type, it is capable of boring holes up to a depth of 1,200 feet; in hard rocks such as gneiss or diorite it will bore at the rate of about 20 feet per day of ten hours, and in phosphate, one foot in three minutes, and it requires about four horse-power to drive it efficiently. It bores holes of 1¾ inch in diameter bringing up a core 1 3-16 inch diameter.

The motive power is supplied by a pair of light and compact trunk engines, fitted with slide valves of novel construction, which permit the using of the smallest possible part, and reducing the clearance to a minimum, thus effecting a large saving in the use of compressed air.

It is light and portable and can be used with equal convenience on the surface or underground, and will bore in almost any direction.

It is unnecessary to give further particulars here, and I will therefore refer enquirers for more to the catalogue of the makers.

Finally, however, I desire to express the opinion that the diamond drill is equally useful in prospecting for mica, graphite and all minerals of more or less irregular occurrence.

As a mining tool in every-day operations it is of the greatest value—in testing ground ahead, in sinking, driving or stoping, and it is not infrequently used in boring blast-holes as well.

MINE TUNNELS AND TUNNEL TIMBERING.

By W. A. CARLYLE, M.E., Montreal.

Location.—In the selection of the site for the tunnel-entry care is taken to choose a place (1) as easy as possible of access by trail or road, (2) but chiefly at the lowest point, so that the greatest possible area of the ore deposit may be worked over-head after the tunnel reaches it, and at the same time be drained naturally of water, all geological data having been sought out by surface examination and test-pits. Good and sufficient dumping-ground is also provided for, care being taken by survey if at all doubtful, that the tunnel will be on the right territory and that the waste rock on the dump will not fall so as to trouble other property or block public roads, or by any possible means incur litigation or impede future mining operations.

Often in the early life of a claim to develop the character and value of the ore-body, a tunnel is run at a point high up so as not to be at first of too great length and cost, but afterwards a longer tunnel is driven in at a much lower level after the upper one has proved the claim to be good, and enriched the none-too-plentiful supplies in the company coffers. Again a tunnel may sometimes be profitably driven as from the other side of the hill or mountain, so that its mouth will be in a most advantageous position for connection with an aerial wire-rope tramway, by which arrangement, although the first cost will be more, the cost of transport of ore from the stope to mill or railroad will be so lessened as to quickly repay the extra initial outlay. For this reason it may be wiser to use a tunnel instead of a shaft, even if the latter is much the more preferable for the mining of a deposit, and when work must be done below the tunnel level. This is now rendered very easy by sinking inclines and placing at their head rapid and powerful hoists operated by electricity or compressed air, and, if water is encountered, pumps can now be got that will do, beyond peradventure, most efficient work with either of these sources of power.

In all cases the tunnel must be run right straight for the vein, and for this it may be well to call in the aid of the surveyor, whose directions should be then closely followed, for if even a slight deviation is made, say to work along softer ground, one's course is quickly lost underground and a queerly shaped tunnel is the result. This direction is easily kept by lining in the miners with plugs driven into the centre of the roof and plumb-bobs suspended from them, or using stout screw-eyes in the caps of the timbering.

Dimensions.—In metal-mining tunnels 4½ x 7 feet for single track, and 8 x 7 feet for double will be amply large when no timbers are used, but with timbers, 4 x 6⅔ feet in the clear for single, and 7⅔ x 6⅔ feet for double will permit the easy haulage of much material, but still be none too large. In a small, cheap prospecting tunnel 3½ x 6 feet will suffice.

Grade.—The best average grade in good work is 6 inches per 100 feet, giving a rapid fall for water and equalizing the work of taking out fulls and returning the empties. A 1 per cent. grade common in levels, with a good track, will permit a trammer to ride out, but he will have a heavy push back, especially with iron and timbers. Miners left alone will quickly work in a steep grade, they will never run level, and in good work the grade is easily kept by using a 16 to 20 foot straight-edge cut to the proper inclination and a spirit-level, laid along the mud-sills, and checked with level and rod every 100 or 200 feet, for 6 inches per 100 feet too much grade in 1,000 feet means 5 feet less of stoping ground.

Equipment.—In developing a claim by tunnelling the least amount of equipment is required. If the work is to be done with the very least outlay of money, a small, stout shed or blacksmith-shop is erected over or near by the entry and fitted up with forge, anvil, bench, vises and sufficient appliances to keep all the mining tools in good condition, such as drills, hammers, shovels and picks, and also with such supplies necessary for repairing the cars. Often all the blacksmith work is done by one of the miners working part-time in the shop, but if one man is needed just for this work, during spare hours he may be engaged in building more cars, using bought wheels, or else in cutting out mine timber setts. In more extensive work, where machine drills are used, a simple and not expensive engine-house is built, say 40 x 40 feet, divided into (1) the compressor-room, in which are a 4 to 8 drill-compressor, the receiver and two steam-pumps, one for boiler feed, the other for supplying cold water to the compressor; (2) coal-bunkers; (3) a small store-room, and (4) the rest of the building has a sufficient boiler, a large bench with vises, tools and fittings for repairing the air-drills, etc., and also a small hand-drill. Around near the boilers are benches and books for the miners' use, warmed in winter by the exhaust steam. At a very large tunnel-working in Colorado, often to be referred to, and in which the writer worked, the cost of such an engine-house thus supplied was $8,700, while another $1,000 was spent on two other buildings, a well equipped blacksmith-shop and a timber-shed on either side of the track near the tunnel, which was double-tracked and driven 6,000 feet at a cost of $125.000; with such an equipment, the first 3,940 feet taking exactly two years to accomplish, being delayed by hundreds of feet of tremendously difficult and dangerous ground.

If two drills are being used a third should be kept in the shop, also a good supply of track-iron, piping, sharp drills, etc., trying to anticipate always any wants that otherwise might delay work. If good water-power is available, excellent machines are now made, by the using of which power the cost of this kind of work can be greatly reduced.

As to houses and eating-quarters for the men, I think company money should not be spent on these, as good men can nearly always be got who are willing to work and also to build their own houses or shanties. Even the manager or superintendent should be content with humble quarters if in a new region, until the mine warrants more expense.

Ventilation.—When the tunnel is run a short distance some means of conveying fresh air to the face must be provided:—(1) By hand-blower set up at entry and pipes 4 to 5 inches diameter; (2) by a tight wooden box, 1 foot square, running into the face and having its outer end running up the hill to create a draught; (3) by some regular form of blower or exhaust fan, as the Root or Baker, driven by water or a small steam-engine, using piping 8 to 12 inches diameter, spiral-welded and tight joints; (4) by discharging compressed air at intervals as found so successful in the large Patrolino tunnel, Italy, 3,600 metres long; (5) or, by perhaps the best and cheapest method of all, *i. e.*, using pipes 8 to 14 inches diameter, with tight joints, running nearly to the face, introduce in the pipe near the tunnel-mouth a Koerting exhaust (made in Philadelphia, which is about 3 feet long and the same diameter as the pipe. To this conduct through a ½ inch pipe live steam of 60 to 80 lbs. pressure, or as usually used, compressed air, which is allowed to blow off in the exhaust in a direction towards the mouth, a vacuum tends to form quickly behind the jet and at once a strong current of air begins to flow along the pipe from the heading, and it is surprising how great is the efficiency of this cheap and simple exhaust ventilator. I have often seen in this big tunnel, with the air-hose for two drills open to supply more fresh air, an 8 inch pipe thus have the air fresh and good in twenty minutes after the firing of 25 holes loaded heavily with dynamite. Of course, as the tunnel gets long, the air along it may get sluggish and poor except near the heading, and as soon as possible natural ventilation should be secured through another connection with the surface, or the decay of the timbering will be very much more rapid. In using the drills the exhaust air from them is aiding very materially, but this is not enough in itself after the work is 800 or 900 feet long.

Drainage.—In cheap work, even in very good work, if a large flow of water has not been anticipated, water when struck is allowed to flow out over the floor, planks being laid between the rails to keep the men's feet dry; but this is a wet, dirty way, especially near the entry in winter time. Much better is it, remembering that water is almost a certainty, to prepare to confine it in a trench or small box along the side, or if a large flow may be expected, to put in water boxes from the first under the centre of the mud-sill (Figs. 4-7), at very little extra cost, such a box 12 x 16 inches, with ½% fall, safely carrying 2,000 gallons per minute. I have seen a torrent pouring from a tunnel when it was then necessary to make the timber sett higher to permit the putting in for the tracking of a second sill 12 x 14 inches, above the mud-sill, just such as is seen in the Sutro tunnel of the Comstock.

Illumination.—Around where the miners are at work, as at the face, the paraffine candle is by far the best illuminant, as it can be put anywhere and does not vitiate much air as do the foul-smelling, dirty coal oil lamps or torches that must be used in very wet places. The electric light is of course most efficient for permanent lighting, all wires being well insulated and the lamps usually with a wire mask, but *no* key for turning on and off the current. These protected incandescents can be used at the face, but are not as convenient as the candle in a miner's stick.

Explosives.—In tunnelling only some form of dynamite or giant is the explosive used, giant No. 1 or 75% nitro-glycerine being used in the centre cutting holes, where a concentrated effort is required in blowing out this central wedge of rock, while in the following or side holes when greatest effect is gained by spreading the energy of the blast over more space, giant No. 2, or 36 to 45% strong is used, lower grades being discarded in all such work. These explosives, bought at a cheaper rate when in a considerable quantity, are best stored in a small vault or room excavated from one side of the tunnel near the entry, well boarded up and floored so as to be perfectly dry, with double doors, one locked, and good ventilation. Here it will be safest from any harm, as fire, lightning, or mischief, and liable to freeze only a little. The boss should prepare the cartridges, knowing just about the number of sticks needed, and then take them in at loading time when he sees that this important part is properly executed. In small work the miners usually carry in the necessary powder stuck down in their boot-leg and fire the holes as soon as ready.

In thawing out giant, which by the way should not be kept too long in stock, or over 1½ years, some simple arrangement is easy if there is a steam engine where a small box can be heated by the exhaust or live steam, but if a large amount is being used daily, it may be better to have a small house 6 x 6 feet, with racks for holding the stacks and trays of sawdust beneath, all heated by steam, and with a good supply of powder thus kept ready the cartridges can be safely made on a broad shelf opposite a window, without running the chances of danger always liable if this work is done, say, in the engine-room. With a small Brunton fuse-nippers cartridge loading is done much better and quicker, as with the nippers the fuse is cut square off and compressed so that it slips easily and snugly into the fulminate end of the cap, which is then fastened tightly on by an incircling squeeze from another part of the same tool.

Firing—If the tunnel is being driven by hand-drilling, the shots are always exploded by simply snuffing or igniting the fuses with the candle, but with air-drills the battery is much used, first firing the centre cutting holes and then the remainder, although if the timbering is kept close up to the face, this method is found to be harder on it, and for very good reasons many superintendents prefer lighting the charges by hand, making the fuses of the centre, or over, or undercutting holes shorter, so as to fire first and give the other shots their maximum efficiency. In this large tunnel where the driving was hard and fast, the battery was used for some time, but returning to hand-firing it was found more satisfactory, as the preparations for shooting were quickly made, the rotation of shots was nearly controlled, the timbering not nearly as badly hammered up, and the number of missed shots small. These missed shots were easily set off by carefully cleaning out the hole nearly to the charge by the man who loaded it, and then inserting a small cartridge of a new fuse and half a stick that seldom failed to detonate the original charge, the ventilating exhaust described quickly drawing off the hot, smoky air, thus delaying work but a little. Such shots must be very carefully watched, especially if a large number has been exploded, for should the drill strike one that has been overlooked a bad explosion will ensue. One of the superintendents of this tunnel, afterwards in another mine, was caught in just this way while going his rounds, and on stepping up to the machine just as it struck the charge the man had neglected to notice had not exploded.

Mining—Tunnelling is begun by making a good entrance, if in rock, by putting in a strong well-cut set of timbers and a good door or gate; if in wash, by clearing away at once all loose stuff and timbering or walling up the approach to the opening to prevent caving in of the banks after heavy rains or in spring. For the first 100 feet or so wheelbarrows may be used for taking out the waste which at first is disposed of in levelling up outside and preparing for the tracks to the dump. Timbering will be needed until well into the rock, and usually close lagging, as water working through the wash would otherwise bring much soft stuff into the tunnel, besides the timbers are best kept close up to the face to forestall much unnecessary excavation, and to bar against the accidents liable in this often dangerous material.

The putting in of good solid tracking from the first will soon repay the extra cost, as it is surprising how the progress is increased by the use of good cars and tracks, when the maximum work can be got out of the trammers and the horses or mules, and vexatious and expensive delays caused by cars leaving the rails reduced to a minimum. The rails of at least 16 lbs. per yard, but preferably 24 lbs., are laid on the mud sills or on stout ties 4 feet apart and ballasted between with waste to make a good footway, or else planks are spiked down between the rails that have an 18 or 20 inch gauge carefully set. In this big tunnel 36 lb. steel rails made a firm steady track over which with ½ per cent. grade a 900 lb. mule easily pulls in a train of 12 or 15 heavy steel cars or trots out with the same loaded with 12 to 20 tons of rock or ore, a brake being necessary to control when going out.

Steel cars holding ¾ to 1½ tons of rock and with the wheels running loose on the axles are generally used, but if much wet gritty stuff is being carried out, that, dripping down, quickly cuts the axle-bearings. This rapid and very harmful deterioration can be checked by putting on self-oiling wheels that are now made in a simple manner to protect such bearings. As the bottom of the car-box is the first place to wear out from the constant fall of rock and this is an awkward place to patch or renew, the blacksmith should fit in the new car a false bottom of 1 inch pine and 3-16 inch boiler-plate bolted to the floor of the car, which will protect the car itself and can be quickly replaced when worn out. Such details greatly lengthen the life and also reduce the cost of the rolling-stock besides decidedly improving the efficiency. In a double-track tunnel it is very convenient to use near the face a temporary switch and single-track of light iron that can be lifted up and carried ahead, by which an empty coming in on its track can be run on this single-track in the centre, much more easily shovelled into and worked about, and when filled, be pushed upon the other track to wait until the whole train is ready. On the outside a simple device will save a man's time or the unnecessary stopping of the train when under full way and the otherwise great liability of the cars leaving the track at this point, and this is an automatic or simple spring-switch where the two tracks merge into the one to the dump, that allows the car coming out to pass on to the dump-track, but returning the switch is always and only open to the ingoing truck. As to the motive-power when the tunnel gets long or over 1,000 feet, the trammers should give way to a horse or mule that will soon become accustomed to working in the darkness with perhaps only a lighted candle at the curves. In a completed tunnel not over 1,600 feet in length and a grade of not less than 1 per cent., haulage is made very easy by putting at the inner end where it connects with the deposit a 10 or 12 horse-power motor that will quickly pull in a train of empties that runs out full, dragging the steel cable and is checked at the entry by the motorman at the motor at the inner end.

The majority of tunnels are, perforce, driven by hand-drilling, and good progress is thus made. Comparative tables as to the cost of driving by hand or machine are not available, but in the west with even the very high price for labor it is well understood that the advantage gained in the use of air-drills is in time, but not in cost, therefore I think one should hesitate, before installing such a plant, to count the cost and to decide whether the work had better be rushed with all speed and whether the compressor and drills can be put to real use after mining commences. In some camps compressed air becomes a perfect fad and every superintendent thinks himself behind the times if not using it. In a single track, work 100 to 180 feet per month by hand-drilling is quite possible if the rock is not extremely hard, but with air-drills the rate should be from 250 to 330 feet, 300 feet being good driving. In the big tunnel mentioned with two drills working in shale and afterwards hard dolomite, and breaking as much rock as the shovellers could well handle, the men were allowed pay as for two extra shifts if 300 feet was the month's advance, and it was astonishing to see the way they made the rocks fly and resented any delays, the result being that 320 to 330 feet was repeatedly the month's progress, while the star record for one month in softer dolomite, was 421·5 feet or 13·6 feet per day of completed tunnel.

If a head of 40 to 100 feet of water from a flume is available the compression of air is greatly cheapened by operating the compressors with Pelton water-wheels. The electric percussion drills now in the market have not as yet proved a decided success, but in time technical defects will surely be remedied.

In hand-drilling the placing of the holes depends greatly upon the character of the rock, although this influences but a little machine-drilling, in which two vertical rows of holes are drilled toward one another in the centre for breaking out the central wedge, and then parallel rows of somewhat deeper holes and such squaring-up holes as are required. Again three or four converging holes near the centre, especially in small tunnels, will suffice to make a good centre cut, and concentric rows of holes will complete the work, but all machine-men have their hobbies and a really good man will make much faster progress than one who knows how to handle the drill but not select the position for the holes. It might be said here that greater effect is secured by firing these centre cutting holes by electricity, but the others are fully efficient when snuffed.

Timbering—It is seldom that the rock in the tunnel will stand long without support, excepting some classes of granite, syenite, gneiss or firm limestone or sandstone, and as the primary object of timbering is to *prevent*, not *check*, the movement of the ground, it is generally best to timber up at once if the rock is at all liable to be weak, as so often the rock under strong tension will collapse without any warning or immediately after examination, and timbering will then be far more expensive in the end.

Spruce, pine and hemlock are mostly available for such service in our American mining and then they are best if the trees have been killed but not damaged by fire, and stand straight, dry and strong, as the green wet stuff is very heavy to handle underground. Such timber cut above altitudes of 7,000 or 8,000 feet, was found, in Colorado, to be much inferior in strength to that from lower down, being less resinous and brashy.

Some sketches have been made to show the styles of timbering mostly used in American tunnels, those requiring the fewest cuts and simplest framing while preserving the maximum strength.

Fig. No. 1 shows a cheap sett consisting of cap and posts of round timber and poles split or unsplit for lagging.

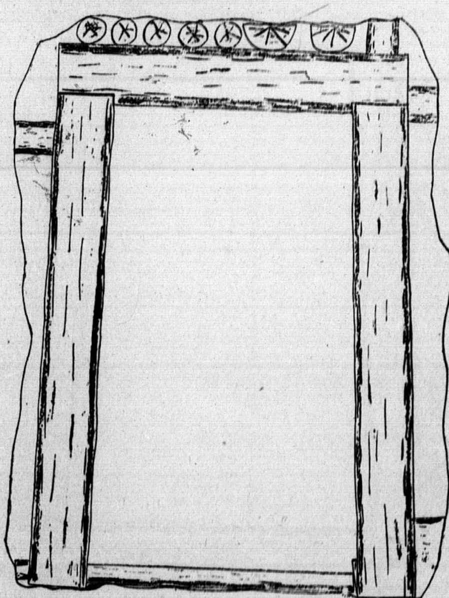
Fig. No. 2 is a full sett of round timbers better framed with or without collar braces.

Fig. No. 3 shows a sett for single track with different kinds of joints, and of timber sawn on two or four sides.

In putting in the timbers every sett is made perfectly firm with wedges and blocks on top and sides, and in lagging up, if the ground is not very wet and loose, the lagging is spread out, not put close together, by leaving out every other piece and filling in between with bits of rock, and to make the most of the lagging's strength it is put in with the round side next to the timbers.

Figs Nos. 4 and 5, show the sett used in the double track tunnel mentioned, with collar-braces and water-box. Before framing, the sticks were squared on two sides by two French-Canadian axemen, at a cost no more than that of the timber squared at the mill, as was afterwards used in the arched setts. This form and size of sett was found to stand very heavy ground, even when spiling had to be used, but finally it was supplanted by the arch sett, (Figs. No. 6 and 7), when the pressure became excessive and as it was better adapted to spiling. This sett was designed to give ample room for working, but in the least possible space and with the simplest form of framing. It withstood tremendous pressure when the cost of progress for some time was $600 per foot, and

I



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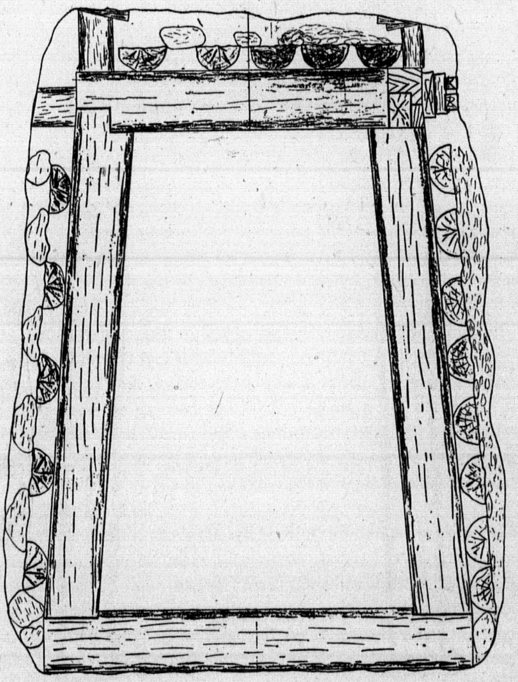

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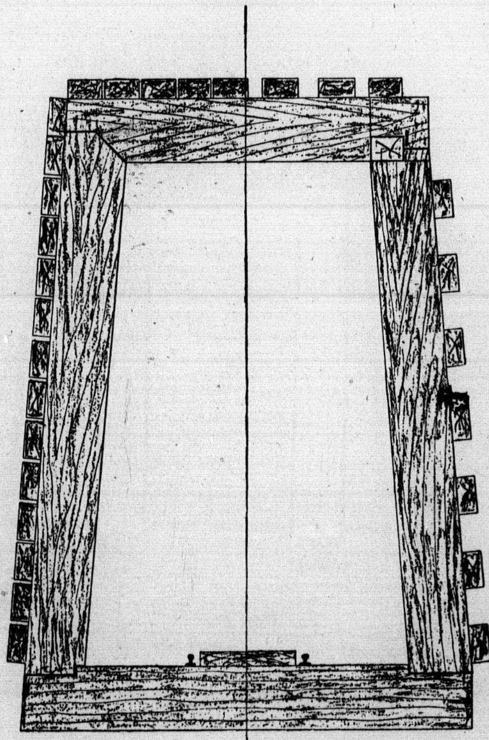
III



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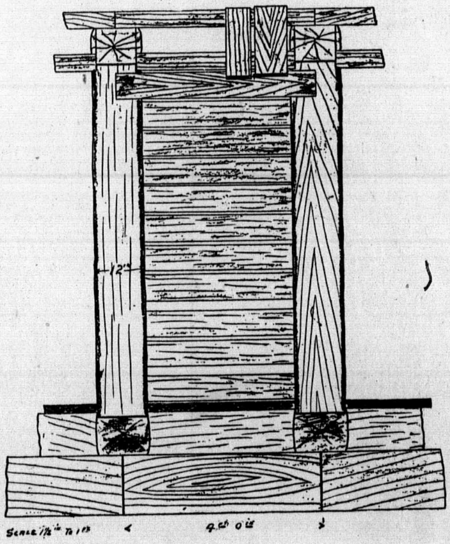

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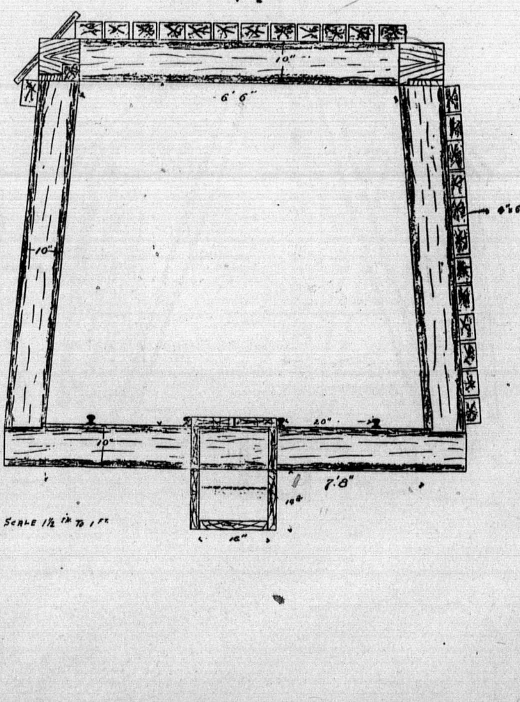

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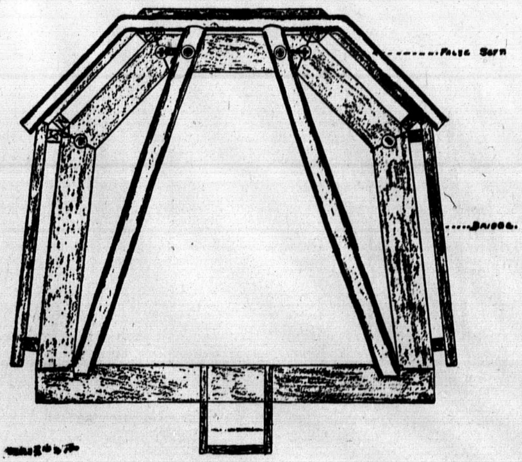
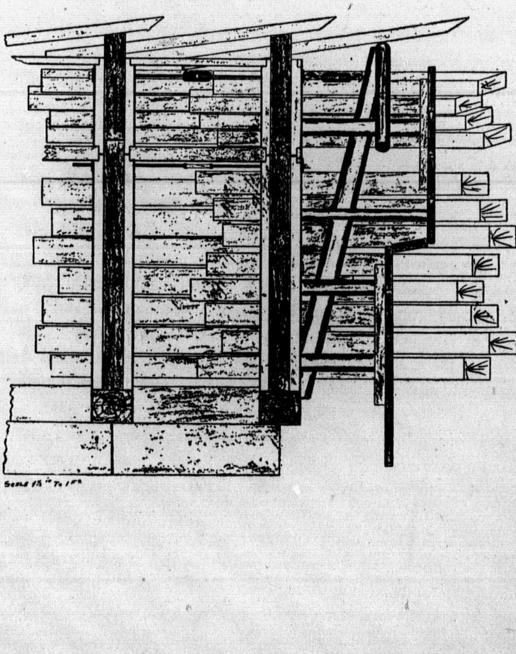


VII.



Scale 1½" to 1 Ft.

only in one place where crossing a bad water-course, were extra intermediate setts needed besides those with four foot centres.

For the framing, good drawings were given the carpenter, who then made very accurate templates, by which the different pieces were quickly marked and cut, so that each sett always fitted together perfectly. If a sett ever did show signs of collapse another was at once put in beside it, and where the tunnel had passed through some porphyry that afterwards swelled and forced the timbers all out of shape, the only relief was gained by every little while working away the rock behind the timbers until this swelling ceased.

When bad running ground is met with, the greatest care is imperative lest the men be suddenly overwhelmed or hundreds of feet of the tunnel filled up in a few minutes. The timbering being right up to the heading that threatens to burst in, this is prevented by slipping in the breast-boards or horizontal planks across the face between the last sett and the rock, then over the cap and behind the posts are driven out the chisel-pointed spiles, 3 inches by 6 inches., 7 feet long, as far as they will there go. Next begin at the face by working around the top breast-board until it can be pushed ahead 6 to 12 inches, and held there by props against the sett, and then the other planks down to the bottom. As soon as possible the "false sett" is put in place to prevent the spiling from closing in too soon, and I believe the best, handiest and cheapest form of false sett is that used by Mr. D. W. Brunton in this tunnel. When in the wash very difficult ground had been traversed by spiling, but the old method of keeping the heading open until a new sett could be put in, by holding the spiling out by any possible prop or scheme, used a great amount of timber and allowed an immense deal of sand and mud to enter the tunnel. With this new device the work was wonderfully simplified and much better controlled. Two strong posts notched at the foot to crow-foot into the corners of the windsill and posts, supporting on their top rods a length of 5 inch gas-pipe, bent to a shape to correspond with the timbering used, were fastened to the cap of the last sett by turn buckles and rods passing through near their heads This last sett was tied back to the next sett with turn-buckles and rods passing through holes near the four collar-braces. Now, when the breast boards have been gradually and laboriously worked forward far enough, and held by stays that could not obstruct the new sett, this was now set up, the bridging put on to keep the spiling from pressing down directly on the timbers, and reserve a space through which the new spiles should pass, and then by loosening the turn-buckles the false sett was lowered until the enclosing shield of spiles rested on this new timber and four more feet were won. If a great flow of water and sand under great pressure is experienced, about all one can do is to let it drain until it lessens or stops, as will be nearly always the probable result. One detail in this kind of work must never be forgotten—100 feet or so back from the face, and perhaps again at 200 feet, is kept a supply of planks of proper length so that should the breast suddenly give way, the miners running back can at once build up a dam or bulkhead by laying these planks across the tunnel against the timbers. This is generally done in the dark, the sudden in-burst extinguishing the lights, and the treacherous sands may pour in as fast as the men can run. In a larger tunnel in the same place through neglect of this precaution, 600 feet of the tunnel was thus filled up and temporarily lost, necessitating a heavy additional expense for the recovery, most of which would have been avoided had some such precautions been observed.

NOTES ON THE (WHITE) MICA DEPOSITS AND MINES OF THE SAGUENAY REGION QUEBEC.

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By J. Obalski, M.E., Inspector of Mines, Quebec.

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This district, from a mining point of view, is an entirely new one, the first working having been commenced in the fall of 1892.

Some time prior to this date, it was known that mica existed at certain places, but no attempt was made to work it. Recently, however, the increased demand for mica, by reason of its extensive use in the generation of electricity and its accompanying requirements, caused prospectors to take the field, and certainly the results have proved satisfactory and gratifying.

The locality most prominent in this district at present is in the township of Bergeronnes, Saguenay county, and situated about twenty to thirty miles below the village of Tadousac, and at a distance of about ten miles from the shores of the St. Lawrence.

In addition to the discoveries made in above mentioned locality, indications have been found in the adjoining townships of Tadousac and Escoumains, also in the valley of the river "Aux Canards," on the other side of the Saguenay river.

The formation belongs to that of the Lower Laurentian, the country rock being mainly feldspathic and dioritic gneiss frequently crossed by trap-dykes, easily discernible on the formation bordering the Saguenay river.

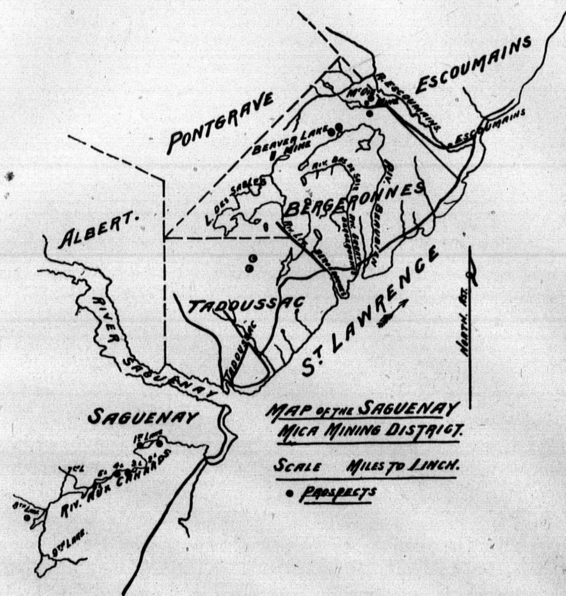
The character of the country is, generally speaking, barren, and is as yet unsurveyed and belongs to the Crown ; the facilities for transportation, although one would think differently at first, are in reality good, by following the valleys of the streams running to the St. Lawrence.

Numerous veins of quartz and coarse granite traverse the country rock, and in some instances are of great magnitude. We will only consider the latter kind. The elements, quartz, feldspar and mica, are well separated and in some places large enough to warrant the name of mica mines being applied to them. The general direction of the veins is N.E., the dipping, as well as the forms of same, being variable.

While prospecting this district I met with several of these veins, not less than fifteen in number, well defined and worthy of consideration, but they do not all merit the title of mica mines ; sometimes the mica being too small, or the veins themselves too narrow to admit of being profitably worked.

I will now give some details concerning the two most important properties and which have been developed with a marked degree of success. The kind of mica found in this district is uniformly of the white (muscovite) variety, and of a brownish color when in thick crystals, whereas the same variety in the Ottawa region is invariably green under the same circumstances. It is remarkably clear, free from spots, is elastic, and the cleavage is excellent. I have not any minute test of this mica, but have seen by the correspondence of the operators that it is highly appreciated and the demand is much in advance of the production, up to the present time. The mica is used for stove and also for electrical purposes.

The McGie Mine.—This mine is the property of Daniel McGie, Esq., and others, of Quebec. It is situated in the township of Bergeronnes, (block G), twelve miles from Escoumains Bay. It comprises an


PONTGRAVE
ESCOUMAINS
R. ESCOUMAINS
ESCOUMAINS
BEAVER LAKE MINE
L. DES SABLES
BERGERONNES
ALBERT.
TADOUSSAC
ST LAWRENCE
NORTH
RIVER SAGUENAY
SAGUENAY
RIV. AUX CANARDS
MAP OF THE SAGUENAY
MICA MINING DISTRICT.
SCALE MILES TO 1 INCH.
PROSPECTS

area of 58 acres. The vein, about a quarter of a mile long, which crosses the property in a N. E. direction, is crooked, and the dip is on an average about 40° N. W., and crosses the stratification of gneiss country rock. This mine, the pioneer property of the district, was opened in October, 1892, and was worked during the summer season with a force not exceeding ten men.

At the southern extremity of the property the vein is 15 feet to 25 feet wide, and was operated on a length of 140 feet by means of an open trench 15 feet deep and a shaft 25 feet deep. About 15 tons of undressed mica have been taken out, from which 15% of dressed or cut mica has been obtained and marketed. The largest pieces produced cut 7 x 10 inches, and the average may be considered as 3 x 4 inches. In addition to the above, I may say that roads have been constructed and the necessary buildings erected. From the south to the other extremity of the mine, the vein gradually widens and expands until a width of 55 feet is reached, showing numerous crystals and as yet untouched.

The feldspar (orthoclase) is found, as usual, in large quantities, and appears to be of an excellent quality. Crystals of black tourmaline, garnet and emerald (beryl) are found, the latter sometimes 3 inches in diameter.

Beaver Lake Mine (Bergeronnes, Block H).—This mine is the property of P. P. Hall, Esq., and others, of Quebec. It is situated at the head of the Little Bergeronnes river, in proximity to Lac-aux-Sables, and about 11 miles from the shipping point on the St. Lawrence, of which distance 6 miles is preferably traversed by water in crossing said lake. The area comprised is 100 acres; the veins run N.E. on a length of one mile, with a vertical dip; about one half the length of the vein has been prospected, showing same to carry a width of from 100 to 300 feet as per the latest reports. While inspecting this property I measured one exposure 140 feet wide and several others of 100 feet in width, with numerous crystals in sight. An exceptionally fine view of the vein is obtainable from the base of a cliff 50 feet high by 142 feet wide, including a strip of barren rock about 20 feet wide. Here and there a large number of crystals of merchantable mica may be observed, disseminated all through the vein, in some instances capable of cutting 4 and 5 x 6 inches. The mine is as yet unworked, prospecting work only having been done so far, but the appearance leaves no doubt as to its value, These two properties are the only ones in a workable condition at present, but numerous other places have been held under prospecting license, and the results, although not so encouraging, have firmly established the fact that several other veins of similar character exist, some of them not workable, but others favorably situated, and which in all probability will be developed next season.

Labor in this district is plentiful at current prices, but the men are not accustomed to mining work, nevertheless, with a practical man as superintendent, they soon become skilled. The original prospectors had no knowledge of mining to speak of, and especially as regards mica. It is necessary to erect buildings at the mines as the hands have to be housed there. Cost of transportation from the two working mines at present would not be more than 15c. per 100 lbs. from the mine to the shipping point on the St. Lawrence, and from there to Quebec by schooner, say 10c. per 100 lbs., or $5.00 per ton to Quebec, including the handling. If the mica were selected and dressed at or near the mines, the above figures as applying to cut mica are very moderate.

I must again repeat that the district is as yet unsurveyed, and the prospecting was done by people very slightly experienced in such work.

I cannot give any better or more illustrative idea of this country than by comparing it with the Ottawa phosphate region, the important mineral here being, of course, white mica, and the principal veins quartz and coarse granite.

In conclusion I would remark that if there is a future in store for the white mica industry, there is here a large field for research and investigation, and which may well repay practical and intelligent prospecting.

In addition to above notes, I would mention that white mica, in workable deposits, has been located at Lake Manowan, near the head of the Peribonca river, 250 miles north of Lake St. John ; at Watsheshos on the Gulf of St. Lawrence, about 400 miles below Tadousac ; and also at Lake Pieds des Monts, 17 miles north of Murray Bay. These properties, I must observe, however, to avoid confusion, are not in the same district, although of the same character and containing the same variety of mica, viz. : muscovite.

DISCUSSION.

CAPT. R. C. ADAMS—I do not know that I can say anything about this interesting paper, but if I am allowed I might say something in regard to the mica industry. It has interested us phosphate miners very much because we have found mica in connection with the phosphate, and until the last two years have been in the habit of cursing it and throwing it away; but now that the product is extensively used in electrical practice we have turned back to the old abandoned pits and have gone to work to extract the mica, and we think now that the case is just reversed—whereas when we were mining phosphate the mica came in, now that we are mining mica the phosphate comes in, and if I go to a pit with a fine vein of mica it often gives place to phosphate which formerly I would rather have seen. We find the occurrence of mica so irregular that it is hardly profitable to mine except when one gets large sizes, and many miners have abandoned its production, but if phosphate prices advance, I think the properties that have phosphate and mica together will be profitably worked. The prices quoted may at first sight seem high, but when you come to have your mica culled over by the purchaser's experts and find that four-fifths goes with the pile valued at $25 per ton, whereas only a small remainder goes into the $100 pile, you will find that your average price is low. The first lot of mica that I sold averaged $80 per ton, and encouraged by that I went on and got out a large quantity, which, after being culled over by the buyer, averaged $35 per ton. I resolved to make one more effort and obtained a large quantity of mica and after two or three months' effort to sell it, finally succeeded in working up the figure to double the former price. I shipped a sample ton lot of this to the States, and to my surprise it was seized on the ground of undervaluation, although it was valued at double the price I had ever sold at before. I went to New York State and found the inspector, who produced the retail price list of the dealers who buy from the miners and he declared that to be the market price at which the goods should be invoiced. Nothing would convince him to the contrary. My mica was seized and the valuation raised and I was told that I had made myself liable to a fine of $250 for not invoicing it at the retail price. From experience I have found it most profitable to sell the product in the rough and let the dealer cut it and retail it to the consumer.

Mr. J. Burley Smith—The merchants in London, England, complain of the want of regularity in prices on this side. It seemed as if nobody knew exactly the value of the article and producers were all trying to get as high a price as possible.

ADDRESS BY THE HON. E. J. FLYNN.

Hon. E. J. Flynn—I must thank you very kindly for the very hearty welcome you were good enough to extend to me on entering the room to-night to witness your good work. I am pleased indeed to have this opportunity and I must congratulate you. I feel that I am in the best of company here, in the company of gentlemen that are imparting practical knowledge, and I put myself in the catagory of those who are acquiring knowledge. Of course I am a public man and I must say I have not got much time to acquire that very useful knowledge, but it is my duty as a member of the administration to encourage as much as possible this good work. It has given me great pleasure to note the progress of the work that is being accomplished by your Association. You have just heard of the mica mines on the lower shore of the St. Lawrence, and I can fully corroborate the statements made by Mr. Obalski, having received from other sources ample confirmation of the extent and value of these mica deposits. I would like to see a greater number invest capital in these mica mines. You will pardon me if I refrain from any further remarks at this time, as I hope to be with you again to-morrow. It has given me great pleasure to have made your acquaintance and I congratulate you with all my heart upon the good work you are doing. Allow me to thank you again. (Loud applause.)

Mr. B. T. A. Bell—I am sure every member of the Association appreciates to the full the trouble the Hon. the Commissioner of Crown Lands has taken to be present at this meeting and the pleasure his company has given us. His presence among us may be taken as a sure indication that the Government is disposed to meet us fairly and to do everything in its power to promote the development of the mining industry of this province. We must not forget also that it is to the Hon. Mr. Flynn we are indebted for the complete repeal of the Mercer Mining Act. (Applause.)

After a vote of thanks to Messrs. Smith, Carlyle and Obalski for their papers, the meeting adjourned until Thursday afternoon.

The members re-assembled in the Club Room on Thursday afternoon, 12th January, at three o'clock. There was again a large attendance. Owing to the absence of the President, who had to leave town, Mr. George E. Drummond, Vice-President, occupied the chair.

PROPOSED VISIT OF BELGIAN AND OTHER EXPERTS.

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MR. B. T. A. BELL—Before proceeding with the business of the meeting, I desire to make a statement respecting a motion that was submitted yesterday by Mr. Leofred. We were told that the Belgian, French and other foreign governments had determined to appoint a commission to enquire into the mineral resources of the Dominion, and we were asked to endorse it. We passed a resolution to that effect. Since then, however, it has transpired that the proposition is simply being promoted by certain individuals to obtain large sums of money from the Dominion and Provincial governments to *invite and defray* the expenses of a commission which is to spend a number of years in this country in the work of acquiring knowledge, and, as it would seem to be largely of the nature of an individual enterprise, I think that as an association we are unanimous in our desire to withdraw any countenance that may have been granted to such a scheme. There could be no objection in asking the government to co-operate with a commission that was being sent here by any country, but as this bears on its face a strong suspicion of a scheme to put money in the pockets of the promoters, I desire to move that we erase from our minutes the resolution adopted entirely under a misapprehension at yesterday's meeting.

MR. T. J. DRUMMOND—I have much pleasure in seconding the motion. From what we have learned the matter is one which this Association cannot countenance. We were certainly misled by Mr. Leofred's statement that these foreign governments were to send such a commission at their own expense.

MR. B. T. A. BELL—I distinctly asked Mr. Leofred the question when he submitted his motion, and I think it was adopted purely on his assurance that the foreign governments were sending the experts at their own expense. Personally, so far as I can gather, the whole affair is a pretty healthy scheme to put money in the pockets of the promoters.

MR. T. J. DRUMMOND—Our government can aid the mining industry much better by advertising the resources of this country in more legitimate ways than this.

Mr. F. Cirkel—I certainly never heard of the German government making any such proposition. If it had I should have heard or read of it in the German papers.

The Chairman—The motion was passed, as Mr. Bell says, entirely under misapprehension. Is it the sense of the meeting that it be rescinded?

The motion was then put and carried unanimously.

ORE SAMPLING.

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

Worcester defines a sample as "that which is taken out of a large quantity as a fair representation of the whole."

Webster says a sample is "a part of anything presented for inspection as evidence of the quality of the whole."

Ore sampling may therefore be defined as any process which will enable us to obtain from a large quantity a fair representation of the whole. To fairly sample a pile of ore is indeed no simple matter, although there are many engaged in mining who think that all that is necessary is to pick up one or more pieces from the pile at random, and call this a sample.

For instance, some time ago a gentleman brought me a lump of phosphate weighing about half a pound as a sample of a pile of about 200 tons. He said he considered it a fair sample, although the pile contained some better and some worse, and requested that it be analyzed. A few months later the ore was sold, and the purchaser had the pile properly sampled; the results of analyses in the two cases, it is needless to say, showed a marked difference.

On another occasion, a company engaged in mining a certain ore determined to send samples to Canadian and English chemists. The party who was detailed to draw the samples went to the pile, selected a few lumps of ore and laid them aside as one sample; he then collected another few lumps of similar size and considered the latter as a duplicate of the first. In due time the certificates of analyses of these samples, by English and Canadian chemists, were laid side by side, and as might be expected were far from agreeing closely. The company who owned the ore blamed the chemists, and the chemists, of course, declared that the fault lay with the samples, and as a chemist I am bound to say I quite agree with the view that the sampler was the party at fault.

As a matter of fact, I may be permitted to say that one of the greatest difficulties with which the analyst has to contend is defective methods of sampling. It is no uncommon thing for a chemist to hear a miner say, "You analyzed for me a sample of phosphate, and when the cargo was sampled and analyzed in Hamburg it went much lower than you made it." It must be borne in mind that it is most unfair to hold an analyst responsible for anything except the accuracy of work on the actual sample on which he has worked. If a miner instructs a chemist to sample and analyze a pile, then it is another matter.

The time was when chemists working on duplicate samples did not always obtain closely concordant results, for the reason that different methods were employed by different chemists. This condition of affairs is a thing of the past, and now throughout Europe and this continent uniform methods of analyses are employed in the valuation of the more important ores of commerce, with the exception of copper, which in America is determined by the electrolytic method, whilst in Britain the old Cornish assay flourishes.

The ideal method of ore sampling is to crush the whole parcel, and then let it fall in a steady stream through a machine which, working automatically, diverts at fixed intervals, and for a fixed length of time, a portion of the stream of falling ore. For instance a stream of ore may be allowed to fall vertically for two minutes, then that which falls during the third minute is thrown automatically away from that which fell during the first two minutes, then for another two minutes the ore falls vertically, then again for one minute the stream is deflected, and so on. In this way the whole parcel of ore is divided into two lots, one containing two-thirds of the original parcel, the other one-third. The latter part is then taken and put through the same machine, exactly as was the original lot, and similarly divided. The lot deflected from the main body in this second process now constitutes one-ninth of the original parcel. It may be put through the process a third time if desired; and in the latter case, the deflected part will represent one twenty-seventh of the original parcel. This portion is next spread out and quartered, and an equal quantity taken from each quarter. This portion is again quartered and a portion taken from each, and so on until a sufficiently small quantity has been obtained, and this last is considered a sample. I think no one will deny that a sample thus obtained will undoubtedly fairly represent the whole.

The method outlined is that which is in use in the large copper ore and matte sampling works in New York; but, of course, it cannot be carried out in the case of quantities of ore which have to be sampled at the mine or any point except the sampling works. Nevertheless, all sampling should aim to approach as closely as circumstances will permit to this ideal method.

To see how closely this method may be approached, let us suppose the case of a quantity of phosphate in bins, and it is required to draw a sample for analysis, the sampler acting for both buyer and seller.

If not fairly level, it is advantageous to first level the pile, and then to place stakes at points, say 10 feet apart. Next, workmen, at these marked points, dig down through the ore until the bottom of the pile is reached, and in digging the contents of say each fifth shovel is thrown into a box and carried off to a level floor. When the bottom of the pile has been reached at every staked point, the portion that has been carried off is broken into fragments not larger than an egg, thoroughly mixed, then spread out and quartered, and the selected portion is again crushed, so that now it will contain no lumps larger than an almond. This portion is then mixed and quartered, and so on until a sufficiently small sample is obtained; this may be a quantity that will fill an ordinary pickle bottle.

If ground ore in bags is to be sampled, it will suffice to take a portion from the middle and bottom of every fifth bag; the whole lot thus drawn should be mixed and quartered as already explained.

Closely related to ore sampling is ore grading, which prevails to a certain extent in all mining regions. There is, however, one distinctively Canadian ore which nominally is graded, but in which the grading is of but little importance, for the reason that there is no uniformity in grading; and since it is an ore whose value cannot be determined by analysis, grading is all the more necessary. I refer to asbestos. It is well known that No. 1 grade of some producers is no better than the No. 2 of others, and a purchaser buying No. 1 ore is by no means certain of the character of the ore he will receive. Such a state of affairs is a blot on the asbestos industry, and should be removed. In the case of wheat and flour, for instance, standards are chosen by parties appointed for the purpose, and these are accepted by the trade as standards. Why cannot the same thing be done for asbestos? It should not be difficult for producers to agree upon standards, and to grade their ore accordingly.

Certainly closer attention to sampling and grading ore on the part of miners would tend to an increase of good-will between buyers and sellers, and would in the end be directly profitable to the miner.

ON THE IGNEOUS ORIGIN OF CERTAIN ORE DEPOSITS.

By FRANK D. ADAMS, McGill University, Montreal.

The numerous and elaborate investigations into the nature and origin of ore deposits which have been carried out in recent years have led to the somewhat startling conclusion that certain of the deposits in question are of igneous origin. In stating that they are of igneous origin it is not meant merely that heat was in some way connected with their genesis, but that using the term as it is employed by geologists, that these deposits have cooled down and solidified from a molten condition like the other igneous rocks with which they are associated. The most important investigations into this class of ore deposits are those of Professor J. H. L. Vogt, of the University of Christiania, the results of these, however, having been published principally in the Swedish language, are not so well known as they deserve to be, and as a valuable resumé of his investigations has just been given by Prof. Vogt in the Zeitschrift für praktische Geologie, (numbers 1, 4 and 7, 1893) it has been thought that a brief presentation of the facts known concerning these deposits might be appropriately brought before the Mining Association at this time, especially in view of the fact that although this is a comparatively small class of ore deposits, it seems to be one especially well represented in Canada.

In order to present this subject in as clear a manner as possible, it will be advisable first to say a few words on some recent investigations into the nature of igneous rocks in general, and the processes which are at work during the cooling of molten magmas, by the solidification of which igneous rocks are produced.

Recent researches have shown more and more clearly that a fused mass of rock is very similar to any ordinary solution of salt or sugar in water or any other solvent. As the fused mass slowly cools one mineral after another crystallizes out, a definite order being always observed. The mineral containing the largest amount of base, such as iron, lime or magnesia, first separates out, then a series of other minerals containing less base, until finally there remains only a comparatively acid portion of the magma which may be considered as the solvent of the others, corresponding to the water of the saline solution above mentioned, which solvent may eventually crystallize itself. Thus, for example, in the case of a granite, we find that the various ores, magnetite, titanic iron ore, pyrites, etc., first separate out, then the mica or hornblende, then the feldspars, and finally the quartz. The ores, together with the mica and hornblende, may thus be considered as having been originally held in solution in the molten feldspars and quartz. Now it is known as the result of elaborate experiments on various saline solutions, that if a solution of any salt be heated and allowed to cool gradually the salt tends to concentrate in the cooler portions of the solution. It is also found that in concentrated saline solutions there is a certain tendency for the lower part of the fluid to become richer in salt than the upper portion, that is for the salt to settle toward the bottom. In the case of certain alloys also, as is well known, it is often impossible to obtain a homogeneous mass on casting, owing to the persistent way in which certain constituents of the alloy will concentrate toward the top or bottom of the bar or casting during cooling. Even in pig iron it is found that the amount of sulphur and phosphorous will vary considerably in the different portions of the same pig for similar reasons. This phenomenon in the case of alloys has long been known as liquidation.

In molten rock also a similar tendency to separate into portions differing in composition is clearly shown to exist by our geological studies of eruptive magmas, this tendency resulting in the separation of certain more basic parts of the magma from others which are less basic—that is to say, the dissolved or basic material concentrates in certain places and this gives rise to a lack of uniformity in the mass—part of it being richer in certain minerals than other parts. In all probability differential cooling and the action of gravity are not the only factors which tend to bring about these remarkable phenomena in rocks, many other factors, some of which we do not even suspect as yet, probably also working in the same direction. But whatever the causes may eventually prove to be which are most potent in bringing about these remarkable irregularities in molten rock masses, the fact remains that in cooling such masses do fall apart into portions differing in composition.

Now it stands to reason that since these changes are brought about by movements in the molten mass, the more fluid the mass is, the more favorable will be the conditions for such irregularities to develop themselves, and hence as basic magmas, both natural and artificial, are more fluid than acid magmas, it is in basic magmas that such irregularities will be most strikingly seen. As actual examples of this process we may take, for instance, the basic borders which we find in connection with so many granite masses, where during cooling the more basic part of the magma has concentrated itself toward the sides of the mass. The dark spots and patches which disfigure so many granites are, in many cases at least, portions of such basic parts which have been separated by subsequent movements in the magma. As a granite, where this is excellently seen, the Garabal Hill granite of Scotch Highlands may be cited, or the celebrated Brocken massif of the Harz Mountains, in which a gradual passage from granite to gabbro can be clearly traced. Many similar examples nearer home may be cited, as for instance the igneous core of Mount Royal and many of its associated dykes in which remarkable variations of composition may be observed.

It is a universally recognized fact that ore deposits usually have some connection with igneous rocks, that is, with rocks which have solidified from a molten condition. Of these ore deposits, however, two classes have, as Prof. Vogt points out, a peculiarly intimate relation to such rocks, namely:

1st. Titanic iron ores.

2nd. Sulphide ores containing nickel.

These deposits not only occur in connection with the igneous rock but actually appear to form part of it, the ore occurring distributed through the rock and the heavy bodies of ore merging gradually into it in many places, so that it is impossible to tell where the rock begins and the ore body ends. The ore body in fact seems to be merely a portion of the igneous mass in which the ore, which is one constituent of the normal rock, is concentrated sufficiently to form workable deposits.

TITANIC IRON ORES.

One of the most celebrated deposits of this class is that occurring at Taberg in Smaland, in Sweden, and which has long been recognized as merely a local variety of a great intrusive mass of rock belonging to the gabbro family, and known in Sweden as Olivine Hyperite. This rock, which is poor in iron ore, can be observed step by step to pass over into the ore body, which has been extensively worked, and consists of a mixture of titaniferous iron ore and olivine, the ore forming about 50 per cent. of the rock.

A sketch of this occurrence taken from Prof. Vogt's paper and showing the concentration of the iron ore in the central portion of the mass is given in Figure 1.

Another large deposit of iron ore at Cumberland, Rhode Island, occurs in a precisely similar manner as part of a gabbro mass and was for years extensively worked, but had to be finally abandoned on account of the large amount of titanic acid which it contained. In Brazil, Derby has also described the occurrence of large bodies of iron ore which gradually pass over into a mass of pyroxenite, of which they form part. Similar deposits of titaniferous iron ore of large extent have recently been recognized by Winchel in Minnesota, and by Kemp in the Adirondacks. In the latter case, where the body of iron ore is about 20 feet in thickness, the great mass of gabbro of which it forms a part is closely related in petrographical character, and probably in age, to the great areas of gabbro or anorthosite which in Canada occur in a number of places in our Laurentian country, occupying in some places hundreds, and in other places thousands of square miles.

These Canadian rocks also contain in many places large deposits of iron ore which are invariably rich in titanic acid, a fact which has made itself very patent in the failure which has followed all attempts to work them. Of these one of the best known is the great body of titanic iron ore near Baie St. Paul on the Lower St. Lawrence, where, in a great mass of gabbro or anorthosite, solid bodies of the iron ore 90 feet in thickness occur, which have been traced for a mile or more. An attempt to work these, made years ago, resulted in the loss of about

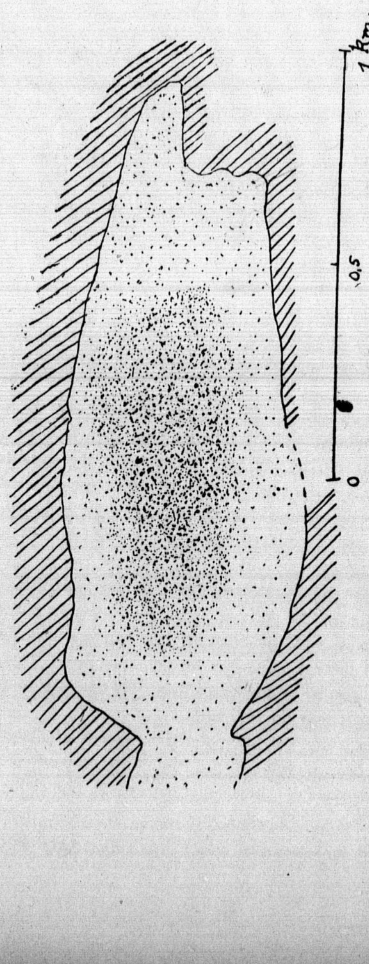

FIG. 1.

Sketch showing the mode of occurrence of the Iron Ore at Taberg in Sweden. The lighter portion is the gabbro mass with the iron ore concentrated toward the centre. (After Vogt.)

£80,000 sterling. Other deposits of considerable size are known in the district north of Montreal, near St Hypolite and St. Julienne, as well as at several other points in the so-called Morin gabbro area. In these as before, the iron ore occurs as a constituent of the gabbro, but is locally concentrated so as to be very abundant at these points. Another extensive deposit, although less widely known, occurs on the River Saguenay, between Chicoutimi and Lake St. John. Here on the north shore of the river there is a group of hills composed of the titanic iron ore which occurs in another great gabbro mass having an area of not less than 5,800 square miles. This iron ore occurs principally in three bands, the most easterly of which is about 75 yards wide.

It is thus evident that we have in these great deposits of titaniferous iron ore, true eruptive or igneous masses which are merely local and extremely basic varieties of the gabbro in which they occur, due to the concentration in certain parts of the mass, from some of the cases before mentioned, of the most basic constituents of the rock. It will also be seen that these peculiar deposits are not confined to one locality, but are found under similar conditions in widely separated parts of the world.

When it is once recognized that these deposits have the origin here described, a solution is afforded to what has hitherto been a puzzling fact, namely, that all the iron ores occurring in the so-called Norian series in the Laurentian, which series is composed exclusively of eruptive anorthosite or gabbro, are rich in titanic acid, while in the same district deposits of magnetite free from titanic acid will be found in the associated gneisses.

Vogt notices that in the cases which he mentions, these iron ores occur toward the central portions of the igneous masses rather than toward their margins, while in the case of the sulphide ores forming the other class of these deposits the reverse is the case. This does not, however, appear to be by any means invariably the case in the similar deposits of titanic iron ore in Canada.

The igneous origin of many of these deposits of titaniferous iron ore has long been recognized, but Prof. Vogt proceeds to show that certain great deposits of sulphide ores have in all probability a similar origin.

SULPHIDE ORES CONTAINING NICKEL.

He first shows that the nickel ores of the world fall into three principal classes.

1. Ores containing arsenic and antimony, with or without bismuth.

2. Sulphuretted ores without arsenic, that is to say, nickeliferous pyrrhotite or pyrite, millerite, polydymite, etc.

3. Silicated nickel ores.

Of these, No. 1 occurs principally in veins, as for instance in various places in Saxony also, at Mine la Motte and Bonne Terre in Missouri.

No. 2, which is the class of which this paper treats, occur in basic intrusive rocks being apparently formed by a differentiation of the magmas and local concentration of the ore. Of these, the celebrated Norwegian deposits as well as those of Varallo in Italy, and of Sudbury in Canada are examples.

No. 3, occur as veins in serpentine, which results from the alteration of basic eruptive rocks, the ore being leached out during the process of decomposition and accumulated in the veins by lateral secretion as in the case of the great nickel deposits of New Caledonia, which are now the principal competitors of our Canadian nickel deposits.

Dismissing the first and third classes of deposits as having quite a different origin and confining our attention to the second class, the first striking fact to be noticed concerning them is, that they are so simple and uniform in character in all parts of the world, that a mineralogical description of one set of deposits would serve for all. The principal minerals which they contain are pyrrhotite or magnetic iron pyrites, a sulphide of iron which almost invariably holds a little nickel and cobalt, but which in these deposits usually contains 2 to 5 per cent. of these metals. Pyrite containing nickel and cobalt is also present, usually in smaller amount than the pyrrhotite, and having a better crystalline form owing to the fact that it is crystallized sooner. This mineral usually contains proportionately more cobalt and less nickel than the pyrrhotite. With these in a few deposits, minerals richer in nickel have been observed, three of these have been certainly recognized and possibly others may yet be discovered. Of these pentlandite (Fe, Ni) S has been recognized at two Norwegian localities, and in considerable quantities by Mr. D. H. Brown at the Copper Cliff and Evans mines and at the Worthington mine in the Sudbury district. (*Eng. and Min. Jour.*, Dec. 2nd, 1893). Polydymite (Ni_3 Fe S_5) occurs at the Vermillion mine in the Sudbury district, while Millerite also occurs in certain of the Sudbury deposits, as well as at the Lancaster Gap mine in Pennsylvania. Copper pyrite, usually present in considerable amount, and titanic iron ore, complete the short list of minerals found in these deposits. Other metallic minerals are present only as the rarest exceptions and in very small amount, among these the most noteworthy being sperrylite, an arsenide of platinum (Pt As_2), discovered in the ore of the Vermillion mine above mentioned, and not known to occur anywhere else in the world.

This remarkable group of ores therefore contain nickel, cobalt, copper and iron, united with sulphur and some titanic acid, while lead, zinc, silver, arsenic, antimony, bismuth and tin are absent, or occur only in traces. Moreover, a remarkable fact in connection with this class of deposits is that—as Prof. Vogt shows—if the average of large quantities of ore such as the output of a mine be taken, there is a certain ratio between the richness of the pyrrhotite in nickel, and the percentage of copper contained in the deposit. Thus in the Norwegian deposits he states that in those workings which produce an ore containing from 75 to 80 parts of copper to 100 parts of nickel and cobalt, the pure pyrrhotite holds about 2.5 per cent. of nickel and cobalt, while as the copper sinks the per cent. of nickel and cobalt in the pyrrhotite rises until when but 20 to 25 parts of copper to 100 parts of nickel and cobalt are present in the ore, the pyrrhotites holds over 7 per cent. of the latter metals.

In this connection a recent statement by Mr. D. H. Brown (*loc. cit.*) is of interest, namely that in the case of the Copper Cliff Mine, which, as the name indicates, was opened up and worked for copper before the ore was known to contain any nickel. On sinking, a decrease in the amount of copper has been followed by an increase in the richness of the pyrrhotite in nickel, the very large body of ore struck on the 7th level and which is almost entirely free from copper pyrites, consisting of a pyrrhotite averaging about 10 per cent. of nickel.

The following table will show this relation in the case of a number of the Scandinavian deposits and it would be a matter of great interest if it could be ascertained that a similar relation exists in the case of our Canadian deposits. As Prof. Vogt points out, in order to obtain averages for large deposits, it is best to draw the results from the analysis of the mattes obtained by smelting the ores of the several deposits, copper and nickel being concentrated in almost exactly the same proportion. It has been found in the case of the Scandinavian deposits that although the proportion between pyrrhotite and copper pyrite may vary considerably from day to day, the average for a considerable run is pretty constant.

RATIO OF NICKEL TO COPPER IN SOME OF THE MOST IMPORTANT NORWEGIAN AND SWEDISH MINES.

Name of Mine.	Content of Copper corresponding to 100 parts of Nickel.	Percentage of Nickel and Cobalt in the pure Pyrrhotite.
Graagalten mine.......	75–80	About 2·5
Klefra mine..........	55	" 2·75–3·0
Erteli mine...........	45–50	" 3·0
Bamle district........	35–40	" 3·5 –4·0
Flaad mine	37	" 4·5
Senjen mine..........	35–40 (about)	" 3·5 –4·0
Dyrhaug mine........	30–35	" 3·8 –4·2
Beiern mine..........	20–25 (about)	" 7·0

Prof. Vogt also draws attention to the fact that the average proportion of nickel to copper in the Norwegian ores is about 100 to 40 or 50, and that in the Piedmontese occurrences about the same proportion holds good, while in Canada where the associated igneous rocks are of a somewhat different character, there is often relatively more copper, 100 parts nickel to 100 or even 150 of copper being found in some deposits, while in others the ordinary Norwegian proportion still holds good.

In Norway there are some 40 gabbro masses with which deposits of nickeliferous pyrrhotite are associated, these being the largest nickel deposits in Europe. The gabbro, which is undoubtedly an igneous rock, is composed of plagioclase feldspar and a rhombic pyroxene, thus belonging to the variety of gabbro known as Norite. These masses of gabbro occur in the Archean schists, generally intruded between the layers or beds but often cutting across them. The Norite of all the masses shows a remarkable tendency to differentiation, so that one and the same mass, in different parts of its extent, will vary greatly in relative proportion of the constituent minerals.

The pyrrhotite, pyrite and copper pyrite are regular constituents of the norite occurring in small quantities all through the various masses, but like the other constituents being found more abundantly in certain places, so that a gradual passage can often be observed from the normal norite through a pyrrhotite norite to masses of pure ore. (Fig. 2.) Sometimes on the other hand the ore occurs in masses sharply separated from the Norite. (Fig. 3.) These segregations of ore are in the great majority of cases situated at or near the edge of the norite masses, and Vogt regards them as strictly comparable to the basic borders or edges so often observed about granites and other igneous rocks as before mentioned, in which the basic portions are sometimes marked by similar gradual passages and in some cases by sharp transitions. These sharp transitions are easily explicable when one considers that any part of the magma having once separated itself from the rest, being possessed of a decidedly different specific gravity, and perhaps of a different degree of fluidity, would, if the whole mass were caused to move, keep itself separated by a comparatively sharp line from the rest of the molten mass. Figs. 2, 3, 4, 5 and 6, taken from Prof. Vogt's paper, will serve to illustrate the mode of occurrence of these ores. The scale is given in each case in meters.

Furthermore Vogt states—and this is a point which has a very practical bearing with those who are interested in our deposits—that in Norway, although it is of course impossible to establish a mathematical ratio between the area of the gabbro mass and the quantity of ore in the associated ore deposits, nevertheless experience has shown that the deposits associated with the small gabbro masses are always unimportant and that all the larger ore bodies are found in connection with the larger gabbro areas, as might be expected if his explanation of the origin of the ore is a correct one.

The nickel deposits of Varallo in Piedmont, Italy, which were worked from 1860 to 1870, are very similar in almost every respect to those just described from Norway, occurring like them in Norite near the contact with the country rocks. A similar association of nickeliferous pyrrhotite with a rock of the gabbro family also occurs at the Lancashire Gap mine in Pennsylvania and at Schweiderich in Bohemia.

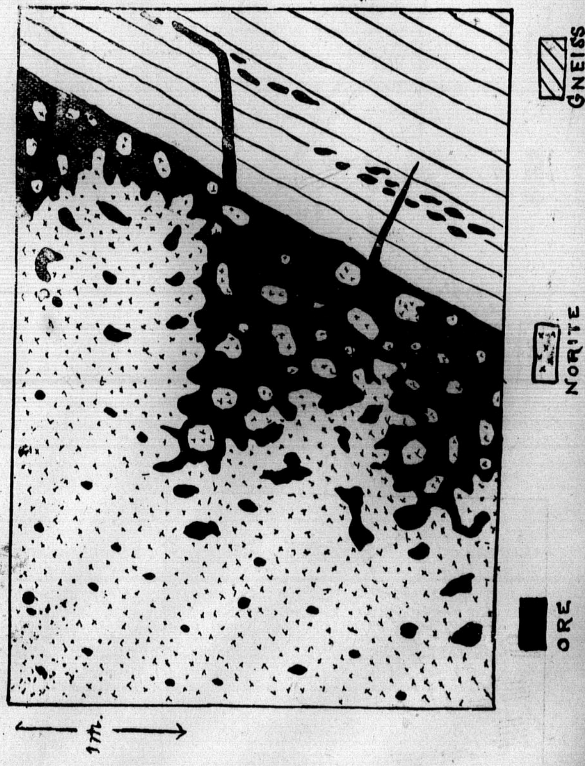

FIG. 2.

SECTION—MEINKJAR DEPOSIT, NORWAY. (After Vogt.)

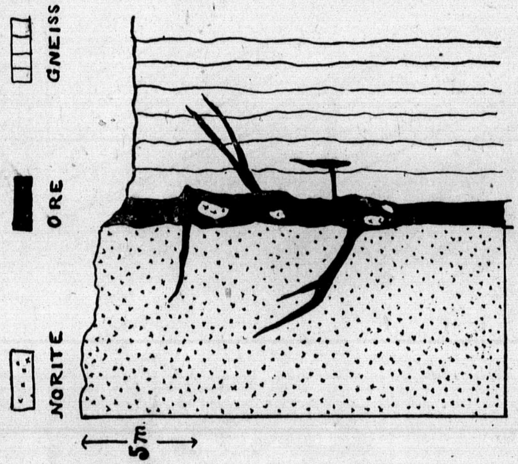

FIG. 3. SECTION—ERTELI MINES, NORWAY. (After Vogt.)

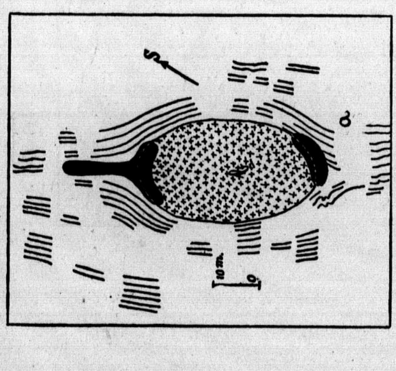

FIG. 4. THE SKAUG MINE. (After Vogt.)

a. Gneiss, etc.

b. Gabbro.

The black portion shows portion of the nickel deposits.

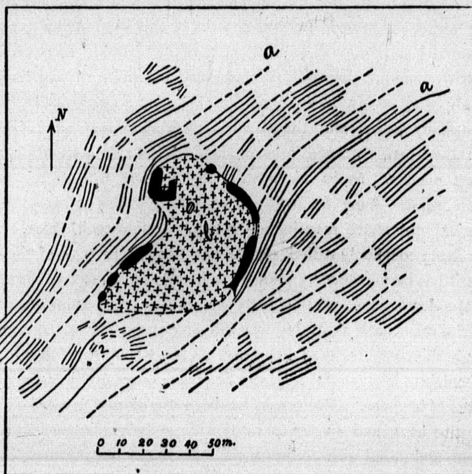

FIG. 5. PLAN OF MEINKJAR MINES, NORWAY. (After Vogt.)

a. Gneiss and Hornblende Schist. *b.* Norite.

The black portions are openings in pyrrhotite with 4 p. c. of nickel.

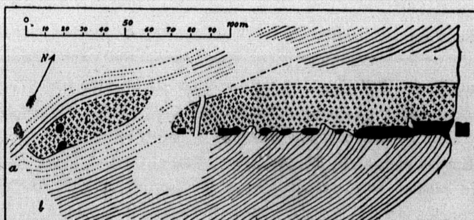

FIG. 6. PLAN OF THE NYSTEN AND BAMLE MINES. (After Vogt.)

a. Red Gneiss. *b.* Black Gneiss and Mica Schist. *c.* Gabbro.

The black portions are openings in pyrrhotite holding 4 p. c. of nickel.

The great nickel bearing sulphide deposits of the Sudbury district —the largest and most important deposits of this kind known to exist—in mineralogical composition and mode of occurrences are remarkably similar to those just described in the several localities above mentioned.

The work of Mr. Barlow and Dr. Bell of the Geological Survey in the Sudbury district and the excellent geological map of the district which they have prepared present these remarkable resemblances in a striking manner. As in Norway, there are here a large number of igneous masses—some 60 in the 3,500 square miles embraced by the geological map above mentioned—composed of a rock, which, though it has been commonly called diorite, has proved in most of the cases where it has been carefully examined to be a gabbro more or less altered with the development of secondary hornblende, that is to say substantially the same rock as in Norway and elsewhere. These diorites cut through the clastic rocks of Huronian age, to whose strike they in most cases conform in a general way, but like these latter are in places cut by granites of later age. The ore, as has been mentioned, is a nickeliferous pyrrhotite associated in some cases with polydymite, pentlandite or millerite and mixed with copper pyrite. It occurs disseminated through this gabbro or diorite, sometimes in sufficient abundance to form deposits which can be worked, the large workable deposits usually being formed by a concentration of these ores near the edges of the gabbro masses or at the contact of these with the Huronian rocks or with the granites, but never extending into these to any considerable distance from the gabbro.

Such deposits have no well defined wall but merge into the gabbro, the wall so far as the miner is concerned being the limit of profitable working due to the fading away of the ore body into the gabbro, so that in underground work an abundant sprinkling of ore through the gabbro serves as an indication of the proximity of heavy ore bodies.

Furthermore, as in Norway, there seems to be in these deposits a certain relation between the size of the deposit and the area of the gabbro mass in which it occurs, since all the extensive mining operations are carried on in deposits associated with large gabbro masses, while in connection with many of the smaller masses, smaller deposits as yet unworked and in many cases unworkable are known to exist. It is also as has been mentioned, not unlikely that a relation between the percentage of nickel in the pyrrhotite and the amount of copper present in the several deposits similar to that which has been noted in the Norwegian deposits may exist in these Canadian deposits as well. In fact these Canadian deposits resemble those of Norway, and all others of the class having similar geological relations wherever they occur throughout the world, in a most remarkable manner, the points of resemblance being so numerous and so striking as to preclude mere chance coincidence.

The facts in the case of these Sudbury deposits point to these also having originated in the elements of the pyrrhotite and copper pyrite, originally disseminated through the molten rocks, having during the process of cooling seggregated themselves together in certain parts of the magma, especially toward the sides, just as certain other constituents have a tendency to do in igneous rocks of various kinds, especially in basic rocks such as these gabbros, and even in these very gabbro masses themselves.

This presented itself to Mr. Barlow, who has made the most careful study of these deposits, as the only tenable view concerning their origin, even before Prof. Vogt published the results of his elaborate studies in Norway. "The ores and associated rock," Mr. Barlow writes, "were in all probability simultaneously introduced in a molten condition, the patches of pyritous matter aggregating themselves together in obedience to the laws of mutual attraction." (Ann. Rep. Div. of Mineral Statistics, Geological Survey of Canada, 1889-90, p. 128). One fact in the case of the Canadian deposits which might at first sight seem to oppose this view of their origin, is the frequent occurrence of the ore along or near the contact of the diorite with granite, which judging from contact phenomena, is more recent than the diorite and consequently would have been intruded after the ore deposits were formed and consequently cannot be considered as the wall rock of the molten diorite toward which the segregation would take place. But it must be remembered that in such a district of hard and massive diorites and soft stratified rocks, any shattering which would precede the intrusion of the granite would probably tend to develope lines of fracture along the contact of these two rocks and thus afford a ready passage for the granite magma in these directions. The contact of the diorite and the granite would thus mark approximately, in many cases at least, the contact of the diorite with the Huronian rocks through which it was intruded.

4

Concerning these sulphide ores containing nickel therefore, Prof. Vogt sums up as follows:—

1. These deposits, which are numerous and occur in widely separated countries, are always found in connection with some basic igneous rock allied to gabbro, and since this is invariably the case we must conclude that the deposits stand in some genetic relation to this igneous rock.

2. Since we can frequently trace a gradual passage from the workable deposits into the igneous rock by a progressive increase in the amount of ore in the rock, we must conclude that the ore masses were not in any way introduced into the rock subsequent to cooling, but were separated out of the molten magma during the solidification of the rock. This conclusion is also borne out by the remarkable simplicity and uniformity of chemical and mineralogical composition of these deposits throughout the world, by the relation between the size of the ore deposit and the area of the gabbro mass in which it occurs, as well as by the absence in these deposits of lead, zinc, arsenic, antimony, bismuth, etc., and of those minerals which are especially characteristic of the so-called pneumatolitic action.

3. Owing to the fact that, as Fournet has shown, the metals copper, nickel, cobalt, iron, tin, zinc, lead, silver, antimony and arsenic have in general a decreasing affinity for sulphur in the order named, the small percentage of copper, nickel and cobalt present in the original magma unites with sulphur and thus becomes concentrated in any sulphide of iron which separates, while any tin, zinc, lead, silver, antimony or arsenic present in the magma is not so concentrated.

4 From what we know of the amount of copper, nickel and cobalt contained in these rocks themselves we are justified in concluding that these metals are always present in the original magma in amount quite sufficient to supply material for all the deposits in question, if only the concentration can be effected, and in this connection it would also follow that there must be a certain ratio between the size of the eruptive mass and the extent of the ore deposit.

5. The copper of the deposit always appears as copper pyrite. The nickel becomes concentrated in pyrrhotite or appears in the form of millerite, pentlandite, or polydymite, all minerals comparatively poor in sulphur, while the cobalt on the other hand is concentrated in the pyrite which is much richer in sulphur.

6. In the Canadian nickel-bearing sulphide deposits, platinum in the form of sperrylite is sometimes found, which would seem to be analogous to the occurrence of native platinum and osmiridium metals in the more or less serpentized basic olivine-bearing rocks in the Urals and elsewhere to be mentioned further on

7. Titaniferous magnetite or ilmenite almost always occurs in small amount in the nickel bearing sulphide deposits, indicating a genetic relation and to a certain extent a transition between these sulphide secretions and the deposits of titaniferous iron ore mentioned in the beginning of this paper as having a similar origin.

8. The nickel-bearing sulphide deposits occur in almost all cases about the edges of their several igneous masses, a fact which, as has been mentioned, is susceptible of explanation in that the sulphides, following Soret's principle, become concentrated toward the cooling surfaces of the mass.

Another remarkable fact tending to the same conclusion and showing the importance of geological studies in connection with ore deposits is that although in the several widely separated countries the pyrrhotite deposits associated in the manner above described with the gabbros are so rich in nickel, the celebrated Fahlbands of Norway which are bedded or apparently bedded deposits consisting of heavy impregnations of pyrrhotite, pyrite, copper pyrites, etc., but occurring in gneisses or schists of various kinds contain hardly any nickel, hundreds of analyses showing the nickel and cobalt contents to range from ·25 to ·50 of one per cent., and what is still more remarkable the same is true of the similar Fahlbands so often associated with our Laurentian limestones in Canada, so far as these have been examined. In these the pyrrhotite and pyrite is present in large amount and is often associated with copper pyrite but only a very small quantity of nickel and cobalt, usually not amounting to more than a trace, is present. (Adams, Frank D., Preliminary Report on the Geology of a portion of Central Ontario, Geological Survey of Canada, 1894, Vol. VI., Part J, 1891-92-93).

METALLIC SEGREGATIONS FROM IGNEOUS ROCKS.

Some few cases of the segregation of metals in a free state are known to occur in igneous rocks. These deserve much more careful and extensive study than has yet been bestowed on them in view of the light which they promise to throw on the origin of ore deposits such as these which have just been considered.

These are of two classes:

1st. Iron-nickel alloys.

2nd. Platinum and osmiridium metals.

The celebrated occurrences of native iron holding about 2 per cent. of nickel, discovered by Nordenskjold in basalt at Uifak and Assuk in Greenland, are now believed to have resulted in the reducing action of the carbonaceous material in the rock through which the basalt was erupted, but these occurrences nevertheless afford an example of the concentration of nickel, which must originally have been disseminated in small amount throughout the molten basalt, in the iron which has been reduced in the way above described.

A more recently noted and even more remarkable occurrence is the awaruite of New Zealand which is composed of 67·93 per cent. of nickel, ·70 per cent. of cobalt and 31·02 per cent. of iron and is found in a very basic igneous rock belonging to the peridotites. (G. H. F. Ulrich, Quart. Jour. Geol. Soc., Nov., 1890).

In the various parts of the world where platinum occurs in alluvial sands it has been found from time to time intimately associated with serpentine and chromic iron ore, thus indicating as its probable source some peridotite or olivine rock, and Murchison long ago mentioned its occurrence in the serpentine rocks of the Urals. ("Russia in Europe," p 484.) Some ten years ago, however, this probability became a certainty, for on the western slope of the Ural mountains platinum was found in grains disseminated through an olivine gabbro, which there forms the bed rock on which the platinum-bearing gravels rest. Recently, at a locality on the eastern slope of the same mountain chain platinum associated with chromic iron ore has been found so abundantly disseminated through an olivine rock that this latter can be actually worked with profit, as much as 93 to 110 grains of platinum to the ton of rock being found. (R. Helmhacker, Zeit. für prak. Geol. Feb. 1893, and Can. Record of Science, April, 1893. *See also* Eng. and Mining Journal, Dec. 22, 1893).

It is thus evident that the platinum of commerce also occurs originally as a segregation from basic igneous rocks.

The uniform character and constant association of chromic iron ore, wherever deposits of this mineral are found, with serpentine, which rock is a decomposition product of basic eruptive rocks rich in olivine, points very strongly to the probability of this mineral also being a product of the differentiation of basic igneous magmas during cooling, and before their solidification and alteration to serpentine Our knowledge of these deposits, however, is not as yet sufficiently extensive, nor sufficiently exact to enable any definite conclusions to be reached on this most interesting question.

Although therefore these mineral deposits which present evidence of having originated in the differentiation of igneous masses during cooling, form a comparatively small class, they are full of interest especially for us in Canada where so many of these deposits occur, and this brief presentation of some of the principal facts concerning them has been given in the hope that the Mining Engineers of our Dominion, many of whom are engaged in working deposits of this class, having these facts in view may be induced to make a careful study of these deposits with a view of extending or perhaps correcting our knowledge concerning them.

THE CANADIAN IRON INDUSTRY.

By Mr. George E. Drummond, Montreal.

"There is a tide in the affairs of men,
Which, taken at the flood, leads on to fortune:
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat,
And we must take the current when it serves,
Or lose our ventures."

These lines apply with peculiar force to Canada, in the present stage of her iron industry.

Events are transpiring from day to day in the neighboring Republic which demonstrate that the iron industry of that great country has now reached such magnificent proportions, under the wise protective policy, so well maintained for the past forty years, that American iron masters are able to compete on equal terms with the world.

History repeats itself. As with England at the middle of this century, so now with the United States. Her iron industry has reached that stage when the government of the country can consider the question of a reduction in its protective tariff, with comparative safety to the industry itself.

Here in Canada, the iron industry, still in the pioneer stage, although under Government encouragement, showing an increase in actual output of over 100% in the past two years, broadening out day by day, making a place for itself in the home market, and in the face of many difficulties displacing gradually the products of American and British furnaces, finds itself, at the most critical stage of its existence, threatened by a premature demand for a reduction in the current protective duties, which, if acceded to by the Government, will surely prevent further progress, if indeed it does not altogether annihilate the industry, by exposing it before it is yet established to the hostile competition of foreign producers, particularly to the competition of American furnacemen, who have of late been the chief, if not the only competitors for our most important territory, viz., the markets of Western Canada.

To produce pig iron, the basis of all subsequent stages of the iron industry, a very heavy initial expenditure has to be made in the prospecting, securing, and developing of mines, woodlands, limestone quarries, railways, shipping docks, etc., necessary to ensure a constant supply of raw material.

The establishment of the plant itself demands a heavier outlay, in proportion to the value of the product, than is required for the production of any other staple. It is the experience of almost every iron master, that in the early period of iron making in all countries, the work is more or less of an experimental nature, and as it must be carried on upon a large scale, and if unsuccessful the investment becomes worthless, the risk of ruin to the first adventurers is great.

It has necessarily resulted from these causes, that to start an iron industry on an important scale, in any country, however favorable its apparent natural conditions, State aid, either by a direct bounty, by a heavy protective duty, or by both combined, has been found necessary, and it is those countries where this has been *effectually done*, which are to-day the large producers of iron, not only supplying their own wants, but also those of other countries.

To deal with this question intelligently, it is well for Canadians to review, as briefly as the importance of the issues will permit, the history of the establishment and successful development of the iron industry in other countries, and particularly note the broad liberal policy of protection under which Great Britain and the United States alike built up the greatest and most successful iron industries of modern times.

The national importance of the question will perhaps in some measure excuse a lengthy reference to the splendid equipment in furnace plant, shipping docks, and other accessories necessary to economical working, now possessed by our powerful competitors in the neighboring Republic.

John Stuart Mill says: "To draw inferences is the great business of life." In the light of what has been accomplished by wise administration in other countries, particularly in Great Britain and the United States. Canada may be guided as to the best and surest course for the early development of the great mineral wealth with which God has blessed her.

Iron is perhaps the Almighty's greatest metallurgical gift to man. Its use can be traced to the very earliest ages. Biblical and secular history abound with mention of the use of iron by the forerunners of our race. Tubal-Cain, born in the seventh generation from Adam, is described in the 4th chapter of Genesis as "an instructor of every artificer in brass and iron."

In the time of Moses, the Egyptians seem to have been engaged in the manufacture of iron, as referred to in the 4th chapter of Deuteronomy, 20th verse: "But the Lord hath taken you and brought you forth out of the iron furnace, even out of Egypt." This expression again occurs in I. Kings, viii. and 51.

Swank, in his admirable "Iron in All Ages," says: "The Egyptians, whose existence as a nation probably dates from the second generation after Noah, and whose civilization is the most ancient of which we have any knowledge, were at an early period familiar with the use and manufacture of iron. Iron tools are mentioned by Herodotus as having been used in the construction of the pyramids. In the sepulchres of Thebes and Memphis, cities of such great antiquity that their origin is lost, butchers are represented as using tools which antiquarians decided have been made of iron and steel. Iron sickles are also pictured in the tombs of Memphis and Thebes, and various articles of iron have been found, which are preserved by the New York Historical Society, and are probably three thousand years old."

Herodotus in the 5th century before Christ speaks of the Chalybians as "a people of iron workers."

The Persians and their northern neighbors, the Medes, made iron and steel long before the Christian era, and so did the Parthians and other Scythian tribes.

Ages ago Damascus, the capital of Syria, manufactured its famous swords from Indian and Persian steel.

It may be assumed as susceptible of abundant proof that the knowledge of iron, if not of its manufatcure, was common to the people of Africa long previous to the Christian era. The decay of the iron industry of these ancient countries probably contributed towards the ruin of the empires of the east, and as Swank says: "With the fading away of Asiatic and African civilization and magnificence the manufacture and use of iron in Asia and Africa ceased to advance."

Following the march of civilization the iron industry took root in the west, and has contributed in a very great measure to the wealth of the two most powerful industrial nations of modern times, Great Britain and the United States.

Great Britain.

The history of the British iron industry dates back to the days of the Roman occupation, as evidenced by the fact that in Kent, Sussex, Gloucester, Yorkshire and many other parts of England large quantities of iron cinder, as old as the Roman era, have been discovered. This has been further proved by the finding of Roman coins, pottery and altars in connection with the cinder.

From the days of the Romans down to the middle of the 17th century, the furnaces and forges of England were operated altogether with charcoal as a fuel. Aided by the protection to native iron inaugurated by Edward III., during his reign from 1327 to 1377, the iron industry made very good progress. In the 14th century the ironsmiths of England had brought the trade to a fine art, aiding thereby to establish the present industrial pre-eminence of England; locks, keys, hinges, and bolts produced during that period having never since been equalled in beauty of design.

In 1615 it is said that there were 800 furnaces, forges, or other mills making iron with charcoal, of which Dudley a few years later estimated that about 300 were furnaces, the weekly product of which was about 15 tons each.

The charcoal iron industry seems to have reached its height towards the close of the reign of Elizabeth, when the trade became so prosperous that instead of importing iron as she had hitherto done, England began to export it in considerable quantities, in the shape of iron ordnance. The extent of the operations, however, began to exhaust the forests of England about the beginning of the 17th century, and the British parliament had to give its serious attention to the question.

In 1740, the production of pig iron in Great Britain was only 17,350 tons, her iron industry at this time having been almost destroyed by the decreasing supply of charcoal.

About 1750 mineral coal, in its natural state or in the form of coke, came into notice as a substitute for charcoal. The iron trade of England and Wales at once revived, while that of Scotland may be said to have been actually created by this new fuel.

Great improvements were introduced in the furnace plants of Great Britain, and the industry from that date forward advanced steadily.

In 1787 the British government adopted a strong protective tariff for their iron industries, the duty on pig iron being placed in that year at 67/2 per ton, with higher rates for manufactured iron. This duty on pig iron was later on increased in 1819, and again in 1825, and the protective tariff in this department was maintained down to the year 1845.

The effect of the introduction of mineral coal, and of the protective duties levied on foreign iron was most beneficial. The industry at once showed strength, and from that date continued to grow rapidly, until in 1796 there were 104 furnaces in England and Wales producing 108,793 tons of iron, and in Scotland 17 furnaces producing 16,086 tons.

In 1820, the total production had reached 400,000 tons; in 1825, 581,367 tons; in 1840, 1,396,400 tons; and in 1854, 3,069,838 tons, this quantity being then estimated as fully one-half of the world's production of pig iron.

In 1889, Great Britain's production of pig iron had reached 9,321,563 tons of 2,000 lbs. This, with a population estimated at 38,000,000, giving the enormous production of 495 lbs. per head. Of this output Great Britain herself consumes 250 lbs. per capita.

In considering the progress made it is well to remember the various Acts of Parliament enforced from time to time by England to protect her national iron industry, by preventing the emigration of her skilled artisans to other countries, by guarding against the sale of her inventions to competitors, and by the imposition of customs duties upon foreign products.

For instance, while the growing scarcity of wood for the supply of charcoal convinced the government and people of England, as early as 1750, (before mineral fuel had come into use,) that it would be to their advantage to allow the free admission of iron in its rudest form from the American colonies, and that as a matter of fact they passed an Act, in that year, setting forth that it would be of great advantage not only to the colonies, but also to the kingdom, that the manufacturers of England should be supplied with pig and bar iron from the colonies free of duty, yet they so fully believed in protecting their own home industries, that the same Act that made the rudest forms of iron free of duty (because England was unable to produce the material herself), contained the following clause :

"That pig and bar iron made in His Majesty's colonies in America *may be further manufactured in this kingdom*, be it further enacted . . . . that from and after the twenty-fourth day of June, one thousand seven hundred and fifty, no mill or other engine for slitting or rolling of iron, or any plating forge to work with a tilt-hammer, or any furnace for making steel, shall be erected, or after such erection continued in any of His Majesty's colonies in America, and if any person or persons shall erect, or cause to be erected, or after such erection continue, or cause to be continued, in any of the said colonies, any such mill, engine, forge or furnace, every person or persons so offending shall for every such mill, engine, forge, or furnace, forfeit the sum of two hundred pounds of lawful money of Great Britain, and it is hereby further enacted . . . that every such mill, engine, forge, or furnace, so erected, or continued contrary to the directions of this Act *shall be deemed a common nuisance, etc., etc.*"

By the Act in question Great Britain undoubtedly encouraged the production of pig and bar iron in America, by exempting them from duties to which like commodities were subject when imported from any other country, but she did this simply because she had not until that date found a fuel substitute for charcoal. A glance at the Act will moreover show that she imposed an absolute prohibition upon the erection of steel furnaces and slit mills in any of her American colonies, Various other restrictive Acts of Parliament were passed in 1781, 1782, 1785 and 1795 to prevent the exportation to foreign countries of machinery and tools used in the manufacture of iron and steel, and to prevent skilled mechanics from leaving England.

For example, an Act in 1785, 25 Geo III., c. 67: "To prevent, under severe penalties, the enticing of artificers or workmen in the iron and steel manufactures out of the kingdom, and the exportation of any tools used in these branches to any place beyond the seas."

The penalty provided in this Act read:

"If any person or persons shall contract with, entice, persuade, or endeavor to seduce, or encourage, any artificer or workman concerned or employed, or who shall have worked at, or been employed in the iron or steel manufactures in this kingdom, or in making or preparing any tools or utensils for such manufactory, to go out of Great Britain to any parts beyond the seas (except to Ireland), and shall be convicted thereof . . . . shall for every artificer so contracted with, enticed, persuaded, encouraged or seduced, or attempted so to be, forfeit and pay the sum of five hundred pounds of lawful money of Great Britain, and shall be committed to the common gaol . . . . there to remain without bail or mainprize for the space of twelve calendar months, and until such forfeiture shall be paid, and in case of a subsequent offence of the same kind, the person or persons so again offending shall, upon a like conviction, forfeit and pay for every person so contracted with, enticed, persuaded, encouraged or seduced, or attempted so to be, the sum of one thousand pounds . . and shall be committed to the common gaol, as aforesaid, there to remain without bail or mainprize for and during the term of two years, and until such forfeiture shall be paid."

In addition to these restrictive measures, a glance at the protection afforded to the British manufacturers of iron from 1782 to the close of 1825, will demonstrate to Canadians the fact that England owes her greatness in the iron industry very largely indeed to the protection granted to her native industries in the early years of the trade.

Quoting from Scrivenor's History of the Iron Trade:

"From 1782 to 1795 the duty on foreign bars was £2 16 2 per ton. It rose to £3 4 7 in 1797. From 1798 to 1802 it was £3 15 5. In two years it had got to £4 17 1, and from 1806 to 1808 it stood at £5 7 5¾. In the three years between 1809 and 1812 it was £5 9 10, and in the five years ending with 1818 it had been £6 9 10.

"At this date a distinction was made in the interests of British shipping, for whilst thenceforward till the close of 1825, the duty on foreign bars was £6 10 if imported in British ships, it was £7 18 6 if imported in foreign. Nor was this all: iron slit, or hammered into rods, or iron drawn down, or hammered, less than three-quarters of an inch square, was made to pay a duty at the rate of £20 per ton; wrought iron, not otherwise enumerated, was taxed with a payment of £50 for every £100 worth imported; and steel, or manufactures of steel, were similarly loaded with a fifty per cent. duty."

Mr. James Mavor, the present Professor of Political Science in the University of Toronto, quoting from Conrad's Handworterbuch der Staats Wissenchafter, Vol. III., page 45, and also from various other authorities, gives the following data in regard to the duties imposed at various times by Great Britain, in the interest of her iron industry.

"The duty imposed on pig iron in 1787 was 67/2 per ton. Duty increased 1819 to 130/- per ton on pig iron. Duty raised 1825 by 10/- per ton. Duty altered 1842, 25% ad valorem on pig iron. Duty abolished 1845.

"Duty on manufactured iron altered 1845, 15% on manufactured iron and steel, this subsequently reduced to 10%. Duty on iron wholly abolished 1860."

Among other measures quoted by this authority are special rates for carrying coals to iron works, embodied in the earlier railway acts.

The period of protection by high customs duties extended from 1787 until 1860, giving to the iron industry protection of a permanent character for upwards of 73 years.

The restrictive measures cited, although they were in many cases harsh, undoubtedly resulted in building up an industry of great value not only to Great Britain, but to the world at large.

United States.

Great as has been the progress made in the iron industries of Great Britain, still more marvellous has been that of the United States, especially when we consider that the development of the American iron industry has been made very largely within the past thirty years, and a full consideration of the facts will show that this rapid growth has been due almost altogether to the fact that during that thirty years the Government of the United States has stood firmly by the policy of protection to the native industry, and that the greatest progress was undoubtedly made when the protection was at its highest point.

The first attempt to establish iron works in the United States was made in 1619, the works being located at Falling Creek, a tributary from the James River, in Virginia. This was unsuccessful, but during the 18th century Virginia became quite prominent in the manufacture of iron.

In 1643 an iron works was started in the Province of Massachusetts Bay, which claims to be the first successful iron works established in America Several other forges were erected at various points throughout New England, in all cases the fuel used being charcoal.

In the State of New York the first iron works would seem to have been erected in 1740 on Ancrum Creek, Columbia County, close to the Hudson River. This furnace was contemporary with our own St. Maurice forge erected A.D. 1752.

In 1800 the celebrated Champlain iron district was developed, and in 1801 the first iron works in the district were built. As in New England, so in New York and throughout the United States, charcoal was the only fuel used at this period.

New Jersey saw her first iron furnace in 1676, and Pennsylvania, the greatest producer of all the States, saw the inauguration of the industry under the able administration of Wm. Penn in 1716, the iron produced by one Thomas Rutter Smith, who lived not far from German Town, being said to have proved equal to the best Swedes iron.

In 1728 there were four furnaces in blast in Pennsylvania, and from that date forward the iron industry of the State was assured.

Space prevents a more minute description of the difficulties experienced and overcome by the pioneer furnacemen of the United States.

Coming down to more modern days, the following statistics, dating from 1854 to 1890, will serve to show the magnificent development of the American iron industry, under the protective tariff shown in the list.

PRODUCTION OF PIG IRON IN THE UNITED STATES FROM 1854 TO 1890.

Net tons of 2,000 pounds.

Calendar Years.	Anthracite and mixed Anthracite and Coke.	Charcoal.	Coke and Raw Bituminous.	Total.	Duty on Pig Iron of all Kinds.
1854.	339,435	342,298	54,485	736,218	30 per cent.
1855.	381,866	339,922	62,390	784,178	30 "
1856.	443,113	370,470	69,554	883,137	30 "
1857.	390,385	330,321	77,451	798,157	30 "
1858.	361,430	285,313	58,531	705,094	24 "
1859.	471,745	284,041	84,841	840,627	24 "

PRODUCTION OF PIG IRON—(*Coutinued.*)

CALENDAR YEARS.	Anthracite and mixed Anthracite and Coke.	CHARCOAL.	Coke and Raw Bituminous.	TOTAL.	Duty on Pig Iron of all Kinds.
1860.	519,211	278,331	122,228	919,770	24 per cent
1861.	409,229	195,278	127,037	731,544	24 "
1862.	470,315	186,660	130,687	787,662	$6.00 per ton.
1863.	577,638	212,005	157,961	947,604	6.00 "
1864.	684,018	241,853	210,125	1,135,996	6.00 "
1865.	479,558	262,342	189,682	931,582	9.00 "
1866.	749,367	332,580	268,396	1,350,343	9.00 "
1867.	798,638	344,341	318,647	1,461,626	9.00 "
1868.	893,000	370,000	340,000	1,603,000	9.00 "
1869.	971,150	392,150	553,341	1,916,641	9.00 "
1870.	930,000	365,000	570,000	1,865,000	9.00 "
1871.	956,608	385,000	570,000	1,911,608	7.00 "
1872.	1,369,812	500,587	984,159	2,854,558	7.00 "
1873.	1,312,754	577,620	977,904	2,868,278	6.30 "
1874.	1,202,144	576,557	910,712	2,689,413	6.30 "
1875.	908,046	410,990	947,545	2,266,581	7.00 "
1876.	794,578	308,649	990,009	2,093,236	7.00 "
1877.	934,797	317,843	1,061,945	2,314,585	7.00 "
1878.	1,092,870	293,399	1,191,092	2,577,361	7.00 "
1879.	1,273,024	358,873	1,438,978	3,070,875	7.00 "
1880.	1,807,651	537,558	1,950,205	4,295,414	7.00 "
1881.	1,734,462	638,838	2,268,264	4,641,564	7.00 "
1882.	2,042,138	697,906	2,438,078	5,178,122	7.00 "
1883.	1,885,596	571,726	2,689,650	5,146,972	7.00 "
1884.	1,586,453	458,418	2,544,742	4,589,613	6.27 "
1885.	1,454,390	399,844	2,675,635	4,529,869	6.72 "
1886.	2,099,597	459,557	3,806,174	6,365,328	6.72 "
1887.	2,338,389	578,183	4,270,635	7,187,206	6.72 "
1888.	1,925,729	598,789	4,743,989	7,268,507	6.72 "
1889.	1,920,354	644,300	5,951,425	8,516,079	6.72 "
1890.	2,448,781	703,522	7,154,725	10,307,028	6.72 "

In an able article, "From Mine to Furnace," Mr. John Birkinbine, Past President, Am. Inst. M. E., recently said: "The following remarks concerning the progress of the pig iron industry, and a prophecy as to its future, appeared in Vol. XV. of the tenth census, that of 1880, which is presented here to show how much more rapidly the industry has developed than was then anticipated would be the case eight years ago, when it was written.

"'In 1866 the United States had reached the production of Great Britain in 1835, that is to say, she was then 31 years behind the latter country. In 1884 she was about 21 years behind England, and at the same rate of increase for both countries the United States will be about 15 years behind England in the year 1900, and will reach and pass her in 1950. The production of pig-iron of each country for that year, as determined from the equation of their respective curves, being a little over thirty million tons.'

"The facts are that in 1890 the United States passed, and has since that time led Great Britain as a producer of pig iron."

In a paper read at a meeting of the American Institute of Mining Engineers, in October, 1890, by its then President, Hon. Abram S. Hewitt, he showed a comparative rate of increase in population and pig-iron production in the United States for six decades, and brought out the striking conclusion that the production of pig-iron has always increased more rapidly than the population, and that the ratio is an increasing one.

Between 1830 and 1860 the production of iron increased twice as fast as the population. Between 1860 and 1890 it increased four times as rapidly, in reality over four times, thus proving that the national wealth continues to grow from decade to decade, at a rate of acceleration of which the world affords no previous example.

Inasmuch as during all this time the United States have imported iron in addition to their native production, it follows that the consumption per capita has also increased more rapidly than the population.

In 1855, according to careful calculations made by Mr. Birkinbine, the United States was consuming iron at the rate of 117 lbs. per head, whereas in 1890 the consumption had increased to rather more than 300 lbs. per head, the whole of which, for the first time in the history of the country, was being produced within American borders.

Mr. Birkinbine, in speaking of the present and future of the iron industry, deplores the fact that part of the development has been brought about by real estate speculations, which he rightly conjectures will exert a restricting influence in the near future. He is however of the opinion that:

"If political action does not disturb the industry, or if labor troubles do not seriously interfere with the development, there seems to be no reason for expecting that the pig-iron industry will remain dormant, but we may rather look for a nearly steady growth, which at the expiration of 25 years will probably make the annual requirements of the United States in pig iron, or its equivalent, amount to between twenty and twenty-five million gross tons."

These figures Mr. Birkinbine states are the result of a careful study of statistics, taken in connection with an intimate knowledge of the present state of development, and a personal acquaintance with the possibilities of various portions of the country. He says:

"There will be times of depression like the present, preceded and followed by others of unusual activity, but we may confidently look forward to a material advance, perhaps greater than estimated, but certainly much more pronounced than was believed possible ten years ago."

IRON ORE.

The following figures taken from the "Report of Mineral Industries in the United States," at the 11th census, 1890, will give some idea of the magnitude of the iron industry of the United States.

In 1889 the production of iron ore in the United States, including red hematite, magnetite, brown hematite and carbonate, amounted to 14,518,041 gross tons, of a total value of $33,351,978.

The total capital invested in the ore mines in the same year is given as $109,766,199. This is all expended within the country on the native ores.

In addition to this, iron ore was imported in the same year from foreign countries to the extent of 853,573 tons, valued at $1,852,392.

With reference to foreign ore imported into the United States, Mr. Birkinbine in his "Production of Iron Ore," 1892, says:

"While the United States has large deposits of iron ore of all kinds, widely distributed throughout the various States and Territories, still the low rates of wages in foreign countries, and cheap water transportation rates, have admitted considerable quantities of iron ore into this country, in spite of a specific duty of 75 cts. per ton, which is collected on all iron ore imported. In the year ending December 31st, 1892, iron ore to the amount of 806,585 long tons, valued at $1,795,644, or $2.23 per ton, was thus imported. All of this iron, however, is consumed near the ports of entry, and much of the ore entering the port of Baltimore is unloaded direct from the vessels to the stock piles. This is also the case with one Pennsylvania furnace."

All the iron ore imported from Cuba is taken from the mines operated by American companies. Until 1892, but one company was mining and shipping ore from Cuba, but last year a second enterprise was represented by actual shipments, and 1893 is expected to add at least one more active corporation to the list of Cuban mines.

It is significant, in looking over the list of imports for 1889, to find that whereas Cuba supplied 243,255 tons, of a value of $535,524, the Provinces of Quebec, Ontario, Manitoba and the North-West Territories combined, supplied (be it remembered under equal conditions as to the tariff), only 4,091 tons, of a total value of $10,697.

Again in 1892, statistics show that whereas Cuba supplied 307,115 tons, valued at $618,222, Quebec, Ontario, Manitoba and the North-West Territories supplied only 8,606 tons, British Columbia 2,749, a total export for all Canada of 11,355 tons, valued at $27,340.

Spain was the largest supplier of ore in 1889, sending 298,568 tons, of a value of $621,481.

These statistics prove that up to the present time Canadians have found it impossible to compete successfully against the negro labor of Cuba, and the cheap labor of Spain in supplying iron ore to the American market. The question Canadians have to ask is whether under uniform free trade Canada can hope to improve her position as against her Cuban and Spanish competitors. This seems highly improbable. All the facts point to one conclusion, viz., that Canadians must turn their attention to smelting their own ore for the home market.

EQUIPMENT AND SHIPPING FACILITIES.

The equipment of the American mines and furnaces surpasses in excellence that of any of the European nations, and the facilities they possess for cheap transportation of ore from mine to furnace is unrivalled. The shipping docks at Marquette, L'Anse, and St. Ignace, Mich., are worthy of special notice.

These docks have been constructed at a heavy cost by the railways which penetrate the interior, for the special purpose of facilitating the handling of Lake Superior ores at the minimum of cost, and they furnish a very striking example of the foresight and enterprise of American railroad men, who perhaps more than any other class, realize the national importance of the iron industry.

These terminal facilities consist of shipping docks, with elevated railroad tracks from 35 to 47.5 feet above water level. By means of drop bottoms the ore is dumped from the cars into pockets, thence to be discharged at will by means of iron chutes let down into the vessel's hold. By this system the ore is rarely, if ever, handled, from the time it leaves the mine until it reaches lower lake ports.

The total investment for docks, specially equipped for handling and shipping iron ore is placed, by so good an authority as Mr. Birkinbine, at approximately $4,000,000 in the year 1889.

RECEIVING DOCKS.

Of equal importance is the system of receiving docks, specially erected for the purpose of handling ore to blast furnaces, or at points from which railroads radiate to blast furnaces.

These docks are of various types, generally furnished with swing boom derricks operated by steam power. By means of these derricks iron buckets are lowered into the holds of the vessels. After being filled with ore by the navvies the buckets are raised again, and swung to the point where the ore is to be deposited, or if for distant points, into hoppers, thence to be discharged into cars. The buckets dump automatically at the point desired, and return to the hold without detaching from the machinery.

It is estimated that the capital invested for receiving docks fully equals that mentioned for shipping docks, and that one such receiving dock alone costs, equipped, fully $800,000.

The investment, although large, is well spent, for by means of these facilities it has been found possible to handle quantities of ore, which could not have been moved in any other way, while the cost of handling has been reduced to a minimum.

Mr. Birkinbine gives the following data as to the cost of handling ore by the new system of receiving docks.

"The expense of shovelling ore into buckets in the holds of vessels varies from 10 to 15 cts. per long ton, the rate being controlled by stevedores, while with the improved apparatus at some of the docks, this ore in buckets is lifted from the vessel, carried back 350 feet, and dumped, at a total cost, including labor, wear and tear, interest, fuel accounts reported, of from 1 to 1.5 cts. per ton.

"With 21 men in the hold of a vessel carrying 2,000 long tons of iron ore, the entire cargo has been stocked in 17 hours. Other instances are mentioned where with 28 men 2,200 long tons were similarly handled in 15 hours, and 2,100 long tons were handled by 18 men in 17 hours.

"In using these improved apparatuses in loading from stock piles to railroad cars, it is not uncommon to have a gang of men shovelling into buckets, and loading the ore on cars at the rate of 8 or 9 tons per man per hour."

In addition to these unrivalled facilities for economical handling of raw material, the American furnaceman works under most advantageous circumstances with regard to the large output of his furnace.

As an example, one of the furnaces in connection with the Edgar Thompson Steel Works, of Pennsylvania, recently produced the remarkable output for a single day of 623 tons of iron. In a week one furnace stack in connection with this company produced 3,203 gross tons, and in a month one stack produced 12,800 gross tons. That is, in one month, one of these furnaces produced fully as much as twenty-five years ago would have been turned out in a year, from the best and largest of the American blast furnaces.

With such splendid facilities for economical working, with ample capital, and many other benefits accruing from a long continued policy of protection; the American iron industry stands to-day in a perfectly safe position, the trade (aside from the ordinary periods of depression common to all industries) bound to increase in volume, the whole future of the industry linked with the life of the nation.

CONTINENTAL STATES.

Following the example of Great Britain and the United States, France, Belgium, Germany, and other continental States established, and still maintain, high protective duties with most beneficial results in many branches of the iron industry.

Germany's case is especially worthy of mention.

On the 11th May, 1882, Bismarck, in a speech before the German Reichstag, said:

"The success of the United States in material development is the most illustrious of modern time. The American nation has not only successfully borne and suppressed the most gigantic and expensive war in all history, but immediately afterwards disbanded its army, found employment for all its soldiers and marines, paid off most of its debt, gave labor to all the unemployed of Europe, as fast as they could arrive within its territories, and still by a system of taxation so indirect as not to be perceived, much less felt. *Because it is my deliberate judgment that the prosperity of America is mostly due to its system of protective laws, I urge that Germany has now reached that point where it is necessary to imitate the tariff system of the United States."*

Bismarck gave to Germany a protective policy with something of a permanent character, and the result has been the building up of a great national industry in that country.

In 1834 Germany and Luxemburg, included in the Zollverein, produced only 116,000 metric tons (2,204 lbs.) of pig-iron. In 1881 Germany and the Grand Duchy of Luxemburg produced 2,914,009 metric tons (2,204 lbs.) In 1890 the production had increased to 4,637,239 metric tons. This increase in pig-iron has been accompanied by an enormous increase in the output of coal and lignite.

As an illustration showing Germany's progress in the manufacture of basic steel, in 1890 England produced 503,400 tons of basic steel, Germany, Luxemburg and Austria produced 1,695,472 tons.

CANADA.

Canada's "natural fitness" for the successful establishment of the iron industry is beyond question.

The earnest work performed by the Geological Survey of Canada, and by private prospectors, has well established the fact that throughout a very large part of her vast territory (three and a half millions of square miles in extent) she is rich in iron ores of almost every variety known to metallurgy.

Commencing at the Atlantic seaboard, Canada can claim in

CAPE BRETON

Extensive deposits of brown hematite, magnetite and spathic ores, lying side by side with coal fields of great magnitude.

NOVA SCOTIA.

The limonite, specular and spathic clay iron-stone and hematite of Pictou County, specular ore in Guysboro County. At Londonderry an immense vein of anchorite holding brown hematite.

Between Truro and Windsor numerous deposits of brown hematite often highly manganiferous.

A range of ferro-ferous strata extending from Digby to Windsor, embracing red hematite and magnetite of Nictaux and Clementsport.

Throughout the whole of this district mineral fuel and fluxes occur in close proximity to the iron mines, affording exceptional facilities for economic furnace practice.

NEW BRUNSWICK.

Magnetic and bog ores, with coal fields at Grand Lake and elsewhere, and a plentiful supply of hard wood for charcoal purposes.

QUEBEC.

The bog and lake ores of this province are probably the most extensive deposits of a like nature in the world. The ore-bearing area extends from the borders of Ontario in the west, to Gaspé in the east, and on the other hand from the Eastern Townships to the Laurentian range of mountains, embracing the historical Three Rivers ore district.

Good deposits of magnetic ores are found throughout the province, especially in the vicinity of Sherbrooke, Leeds, Sutton, St. Jerome, and in Pontiac County.

An inexhaustible growth of hard wood, suitable for the manufacture of charcoal is everywhere found in close proximity to the iron deposits. Limestone for flux is most abundant throughout the province.

ONTARIO.

Vast deposits of ore exist throughout Ontario, from the Ottawa Valley to the head of Lake Superior.

The ore is of many varieties, magnetic, red hematite, limonite, specular, and occasionally bog ores, all more or less rich in metallic iron.

At the recent World's Fair in Chicago, Ontario exhibited no less than 120 samples of iron ore taken from her various mines, all these samples averaging 60% and over in metallic iron, and many of them exceptionally free from impurities. Most notable among the localities sending exhibits were the Ottawa Valley, including Lanark, and the Kingston and Pembroke districts, Madoc and other points in the County of Hastings, Haliburton, Coehill, and other locations in the County of Peterboro', East Algoma, Thunder Bay District, including Atak-Okan range.

In the matter of fuel, Ontario, like her sister province, Quebec, possesses most extensive forests of hard wood, admirably suited for the production of charcoal.

She is also rich in fluxes.

MANITOBA.

Deposits of magnetic and bog ores on Lake Winnipeg, with an abundant growth of hard wood suitable for charcoal in the vicinity of the mines.

BRITISH COLUMBIA.

While the work of exploration has necessarily been limited, yet the magnetic ore deposits at Texada Island and Cherry Creek Bluff are already fairly well proved by actual work. The ore from these mines has found a market at Tacoma, Wash, U.S.

British Columbia is very rich in both coal and wood, the output of her collieries at Nanaimo, Wellington and Comox showing a steady increase in tonnage.

Raw Material.

While in the actual work of proving and developing her mines Canada has up to the present accomplished comparatively little; yet the careful preliminary explorations already referred to make it most evident that in raw materials Nature has unquestionably endowed Canada with everything necessary to success.

Market.

Satisfied as to the possession of raw materials, the next most important question for Canadians is a market for the finished product. All facts and figures go to prove that for many years to come Canada's natural market for iron products lies within her own borders, side by side with her mines and forests.

According to the best authorities, Canada uses to-day upwards of 250 lbs. of the products of iron per capita. This on a population of say five millions means, roughly speaking, an annual consumption of 600,000 net tons. In his report of the Bureau of Mines of Ontario for 1892, Mr. Arch. Blue estimates the consumption to equal (after making all due allowance for waste in converting pig iron into finished iron and steel) say, 604,252 tons for 1891-92. To better realize the accuracy of these figures, it must be remembered, for instance, that Canada possesses to-day not less than 15,000 miles of railway, standing high among the nations in this particular regard. When her 15,000 miles of railway line is laid with standard 72 lbs. rails (the rail of the future) she will have, at 113 tons per mile, in round figures, 1,500,000 tons of steel rails, The average life of a rail is 15 years, therefore renewals are being made continually, and as a matter of fact the Dominion is using in this department alone, 100,000 tons of the product of iron annually.

During the past year one of our great trans-continental lines alone imported 36,000 tons of steel rails.

The Canadian railway companies, if they follow the example of their American rivals, will heartily support the production of steel rails from Canadian ore by Canadian labor. The revenue to be obtained from the carriage of raw materials to the furnace, and of the finished product to the market, as well as through an increased passenger traffic, will more than compensate for the extra price they will be called upon to pay for rail equipment during the first few years of the industry.

All the rails used in Canada to-day are of foreign make.

As a further illustration, the Rolling Mills at Montreal, Hamilton, Swansea, New Glasgow, N.S., and elsewhere, are producing annually, at a fair estimate, 80,000 tons of the products of iron. Unfortunately, the raw material for this great output is very largely foreign, although there is no good reason why within the next few years every ton of this should not be supplied by Canadian labor from Canadian ore.

Our iron-founders use annually about 80,000 tons of pig-iron in castings such as stoves, agricultural implements and machinery of all classes, one half only of the material used in this class of work being the production of Canadian furnaces.

Aside from these leading lines the country consumes each year a large quantity of such products of iron as band and hoop-iron, special quality bar-iron, steel boiler plates, steel sheets, sheet-iron, chain cables, slabs, blooms, bridge and structural iron, railway fish-plates, rolled beams, nail and spike rods, wire, locomotive tires, iron and steel for ships, steel ingots, bars, and other forms of iron too numerous to mention, but almost wholly the product of foreign labor.

In railways and shipping, Canada pretty well holds her own, proportionately to population, with either Great Britain or the United States.

Possessed of the necessary raw materials, and reasonably protecting her own home market, there is no reason why she should not, in proportion to her population, hold an equally prominent position in her iron industries.

The history of the Canadian iron industry dates back to the establishment of the St. Maurice forges by the French government about the year 1737. This was followed at various periods by the erection of iron works at Batiscan, L'Islet, Hull, Baie St. Paul and Mosaic, in the Province of Quebec.

Furnace Falls, Normondale, Marmora, Madoc and Houghton, in the Province of Ontario.

Woodstock, in New Brunswick.

Moose River, Nictaux and Bloomfield, in Nova Scotia.

In course of time each and every one of these enterprises had to succumb to the competition of foreign iron, then admitted free of duty into Canada.

In addition to the difficulty of competing with the more advanced industries of other countries, Canadian pioneer furnacemen labored under many grave disadvantages. The records in every instance speak of small outputs, lack of capital, lack of shipping facilities, mismanagement—good and sufficient reasons in any country, or in any branch of industry, for ultimate failure.

In not a single case has it been shown that lack of raw material necessitated the closing down of a Canadian furnace. It is true that an almost absolute want of proper shipping facilities in these earlier days made it troublesome and costly to procure raw materials and deliver them at the furnace, but this difficulty has long since been removed by the easy shipping facilities afforded through the net-work of railways now in operation all over the country, not to speak of the perfect waterways and splendid system of canals now possessed by the Dominion.

Passing over the pioneer stage, we come to perhaps the most important epoch in the history of the iron industry in Canada, viz., the introduction of the protective tariff on iron, which came into force in 1887. The tariff as then framed and still in force, was based upon the American tariff of import duties on iron and steel and their products, in the proportion of about two-thirds of the said American tariff, and unquestionably the Dominion government designed the tariff with a view to protecting *native Canadian labor* against the cheaper labor of Europe, and the better equipment of the United States. It was evidently the intention of the Government in doing this to afford at least approximately an equal ratio of protection to labor in whatever branch of the industry it was employed, as this is the system upon which the American tariff is undoubtedly based, and the only system possible of complete success.

Unfortunately the Dominion Government made one mistake, viz., the admission of wrought scrap iron, as the raw material for the manufacture of bar-iron, at a less rate of duty than puddled bars, blooms, and billets, with which it came into competition. This exception is, as Sir Charles Tupper once said, "the one blot" on the tariff, for it has ever since deprived Canadian furnacemen of a home market for their forge iron, a class of iron which in the order of things they must necessarily produce from time to time, and which should be used by the Canadian rolling-mill men as their raw material for bar-iron, either in the shape of puddled bars, or soft steel billets as the trade may demand.

The admission of scrap iron at a low rate of duty has resulted in two evils. First, it has retarded the progress of the manufacture of pig iron from Canadian ores, inasmuch as the iron masters cannot afford to produce puddled bars or steel billets at competitive prices with cheap wrought scrap. Secondly, it has caused the Canadian rolling-mill proprietors to make investments in special plant for the manipulation of scrap, and brought about a condition of affairs in the rolling-mill business that will be greatly disturbed by any sudden change in the tariff with regard to the admission of wrought scrap.

It is the plain duty of the Government to rectify the mistake it has made, but to do so with due regard to the vested interests of all sections of the industry.

This may be done in several ways, for instance, by naming a definite date, say within from three to five years, when wrought scrap, the present raw material for Canadian bar-iron, shall be placed at the same rate of duty as puddled bars or steel billets with which it comes into competition, and that in the meantime a sufficient bounty be granted, either to the rolling-mill companies on such iron and steel as they may produce from the products of Canadian blast furnaces, or to the blast furnace companies direct, as an inducement to them to produce steel billets and puddled bars, so that they may shortly be in a position to supply the mills (at a reasonable living profit to themselves) with all the raw material necessary for the manufacture of bars and other finished iron.

It is not improbable but that a comprehensive arrangement on some such lines would result in the rolling-mill companies considering the question of going into blast furnace work on their own account, with most beneficial results to the whole Dominion, or they may adopt the course of erecting plant for the manufacture of steel billets and puddled bars from Canadian pig-iron.

In the face of many difficulties the pig-iron industry has continued to make creditable progress since 1887, and especially has this been the case within the past two years.

At the close of the calendar year 1891, the total production of pig-iron in Canada was only 23,891 tons. Within 18 months, that is to say, at the close of the fiscal year 1892, the output had increased to about 51,000 tons for twelve months, a gain of upwards of 110%. Sixty thousand tons will be a fair estimate of the output to the close of the present fiscal year.

The following will show the furnaces now in blast, with capacity and output :—

LONDONDERRY IRON CO., LONDONDERRY, N.S.

Description of Plant, with Capacity.

Thirty-six thousand acres free-hold land.

Ore mines, yield from 50,000 to 70,000 gross tons.

Limestone mines, yield from 12,000 to 15,000 gross tons.

Railways—about 12 miles, company's own property.

Two Blast Furnaces—Capacity about 40,000 gross tons.

One Rolling Mill—Silent, capacity about 8,000 gross tons.

One pipe foundry—Silent, capacity about 5,000 gross tons.

Number of men employed—about 350.

Maximum number which has been employed when running all departments full, 807.

Make of pig iron—1892—28,052 net tons.

Ore charged (partly bought)—64,430 net tons.

Coke charged—41,006 net tons.

Coal charged (all bought)—1,740 net tons.

Flux—14,907 net tons.

The Londonderry Co. purchase from outside sources a very large proportion of their ore and coke. It is therefore altogether fair to credit them with the hands employed in the production of this material, in all some 450 men. This gives a total at the present time of 800 employees connected directly and indirectly with the operations of the Londonderry Co.

THE NEW GLASGOW IRON, COAL AND RAILWAY CO., FERRONA, PICTOU COUNTY, N. S.

Ore mines—Limonite and Hematite, yielding 60,000 to 75,000 tons per annum.

Coal mines.

Limestone quarries.

Railways—The property of the Company, about 13 miles in length, connecting the furnace with the mines.

One blast furnace—65 ft. high, bosh 25 ft. 6 in., hearth 9 ft. 6 in. Capacity 100 tons per day.

Battery of Coppeé kilns.

Number of men employed—425.

Iron produced in 1893, for nine months campaign—22,500 net tons.

Ore—about 50,000 net tons.

Coke—30,000 net tons.

Flux—13,000 net tons.

The company purchase all the coal required for the operations of the furnace. Last year they bought, washed and consumed 90,000 tons of coal. It is only fair to credit the industry with the men steadily employed in the fuel department, viz., 150 men and 50 boys, giving a total average of 625 employees in connection with the Ferrona works.

Allied with this company, and as an important consumer of its forge iron, is the

NOVA SCOTIA STEEL AND FORGE CO., LTD., OF NEW GLASGOW, N.S.

The following descriptions will show the great importance of this steel industry :—

The plant consists of:

Two Siemens melting furnaces, 20 tons capacity each.

Three gas heating furnaces.

Five reverberatory heating furnaces.

Twenty-six inch reversing cogging mills with train of live rolls.

Heavy vertical hot billet shears with live rolls.

One 20 inch plate mill.

One 16 inch bar mill.

One 12 inch bar mill.

One 9 inch guide mill.

Ten pairs shears, 40 tons and smaller.

One 5 ton steam hammer, with 15 ton hydraulic crane.

Four smaller steam hammers.

Machine shop 175 ft. x 75 ft. with 30 ton travelling crane commanding whole shop, equipped with 24 inch slotter, 6 drills, (one a 9 ft. radial, 5 inch spindle) 9 lathes, one of which will take in 50 inch over carriage, and 8 inch x 10 inch in the gap, will take 37 feet between centres, small shapers, etc. Power is supplied by some 50 steam and 10 hydraulic cylinders. Entire works are lighted by arc and incandescent light plant.

Output 100 tons of steel ingots per day, all of which is worked up into bars, sheets, axles and other forgings.

Over 97,000 axles of this company's make were supplied to Canadian railways.

This company employed in 1893 an average of 425 men at the works, and expended in wages to this staff $185,471. Aside from this they should be credited with the labor necessary to mine and raise the average quantity of coal required per day, in all one hundred men, giving a total of 550 men connected with the Nova Scotia Steel and Forge Co. Ltd.

The company consumed 36,000 tons of coal in 1893.

It may be mentioned also that they paid in 1893 for freights, inwards and outwards, $86,667.61.

THE PICTOU CHARCOAL IRON CO. LTD. BRIDGEVILLE, N.S.

Ore Mines—Brown hematite and limonite in the immediate vicinity of the furnace.

Wood Supply—The company controls 8,500 acres of hard wood lands, yielding principally yellow birch, beech and maple. This land is situated 15 miles from the furnace.

One Blast Furnace—55 feet high, 11 feet bosh, built of red brick. Capacity 5,000 tons charcoal iron per annum

Charcoal Kilns—19 Beehive kilns, capacity 50 cords each.

This company has barely commenced operation. So far only 700 tons of iron have been produced. Working full blast however it will give employment to 300 men in the woods, mines, and at the furnace.

JOHN MCDOUGALL AND CO., DRUMMONDVILLE, QUE.

Ores—Bog ores secured within a radius of 12 miles of Drummondville.

Charcoal Fuel—Soft wood, principally balsam and spruce, secured in practically the same district as the ores.

Two Furnace Stacks—Both built of stone, 35 feet high. Capacity about 6 tons per day each; 200 men employed.

At present the whole of the output is used in the manufacture of car wheels at the company's works in Montreal. The campaign is therefore largely regulated by the requirements of the car wheel department.

THE CANADA IRON FURNACE CO., LTD., RADNOR FORGES, CHAMPLAIN, P.Q.

Ores—Bog and Lake. The company control 100,000 acres of ore bearing lands in the districts of St. Maurice, Three Rivers, Vaudreuil, Joliette, St. Ambrose de Kildare, Point du Lac, Gentilly and Baconcour, including the important deposits of lake ores at Lac-a-la-Tortue and Lac-au-Sable, which the company hold in fee simple. Also magnetic iron mines at Sherbrooke, St. Jerome and other points in the Province of Quebec.

Wood Supply—Free-hold and royalty rights on hard wood lands extending throughout the country north of Radnor Forges.

The supply of wood is practically inexhaustible. The company's location at Grandes Piles securing to them practically the "key" of the St. Maurice River, and the control of most valuable hard wood lands on either bank of the river for seven miles of the navigable waters of the St. Maurice. The wood is principally hard maple, birch and beech.

Charcoal Kilns.—A battery of 11. kilns on the furnace property at Radnor Forges, capacity 55 cords each.

A battery of 14 kilns at Grandes Piles, capacity 55 cords each. Charcoal also made in pits in the Swedish manner.

Limestone Quarry.—The company owns what is perhaps the most important limestone quarry in the Three Rivers district. This lies within 50 yards of the furnace.

Railways—A railway line from Piles Branch, C. P. Ry., to the furnace. This together with switches is three miles in extent, all the property of the company.

Car Wheel Shop—Located at Three Rivers.

Furnace—Iron shell, height 40 ft., bosh 9 ft. diameter. Crucible and bosh from mantle down is encased and protected with a Russel Wheel and Foundry Co. water jacket. The furnace is complete with all modern accessories. Hot blast stove, Drummond pattern. Steam and water power. New Weimer blowing engine, also complete auxiliary plant, blowing engines, steam and force pumps ready for use at any moment should the permanent plant become disabled.

Capacity—40 tons per day of high-class charcoal iron, specially adapted for the manufacture of chilled car wheels.

This iron stands an average breaking strain of 63,000 lbs. per square inch, the test being on standard bars 1 in. x 12 in.

During 1893 the company produced 7,423 net tons of charcoal pig iron. They made all their own raw material, not alone for the production of the quantity of iron named, but also for sufficient stock to provide for a largely increased output during the present year, 1894.

The average number of men employed is 650, with about 400 horses.

During the winter months when the company require to cut all the hard wood necessary for the year's production of charcoal, and when they take delivery of a great deal of the ore made during the summer months, they often find it necessary to employ a staff of upwards of 860 men, with about 550 horses.

Of the large staff of men, at least three-quarters are drawn from the ranks of the farmers and habitants, and the operations are carried on by them over a very large territory.

Politicians will do well to notice that each and every one of the Canadian blast furnaces are located in rural districts, and that in a very peculiar degree the pig iron industry is one closely identified with the interests of the farmers.

The coke furnaces of Nova Scotia draw a large proportion of their employees at mines and furnaces from the farming class. In many instances the farmers take work in the mines, while other members of their families look after their agricultural interests. The charcoal iron furnace especially may well be classed as a farmers' industry. For example, in the case of the Canada Iron Furnace Co. already cited, out of a staff of 850 men employed at the present time, 700 at least of the employees are farmers or habitants, who work for the company during the winter months and in their slack seasons, between seed time and harvest. These men find that the arduous work of clearing their land is no longer unprofitable, as it has been in the past, but that on the contrary they are now able to derive a very good living from the earliest days of settlement by supplying wood to the charcoal kilns.

Another ready source of employment is the raising of ore on portions of their own and neighboring lands, which would otherwise be wholly unproductive.

The successful re-establishment of the charcoal iron industry at Radnor Forges has greatly improved the condition of the farmers of the historical Three Rivers district. They now find steady and profitable employment on their own land at all seasons, a steady market for their farm products, and ample work for their horses.

During the present season the Canada Iron Furnace Co. are using in their camps and ore fields upwards of 500 horses, 80 per cent. of which are the property of the farmers.

This close identity of interest between the farmer and the manufacturer is also characteristic of the work done at Drummondville, in the Province of Quebec, and will no doubt prove equally true with regard to the operations of the Pictou Charcoal Iron Co. at Bridgeville, N. S.

It will be largely in the interest of the farmers of Ontario and Quebec if the charcoal iron industry is allowed to grow and prosper. What has been possible in the case of Sweden is equally possible for the Provinces of Ontario and Quebec, where the raw material and the market lie side by side. In 1890 Sweden had in blast 154 charcoal iron furnaces producing 456,102 metric tons, an industry of which that nation may well be proud. The utilization of the hard and soft woods of our forests, at present waste material, would be of incalculable benefit to the provinces of Ontario and Quebec, and above all to the agriculturalists of these provinces.

Next to the farming class the railways of Canada would perhaps be the greatest gainers by the establishment of an iron industry. In the case of the Government railway, the Intercolonial, it is safe to say that the combined operations of the Londonderry Iron Co., the New Glasgow Iron, Coal and Railway Co., and the Nova Scotia Steel and Forge Co., furnish one-fifth of all the freight business of the railway in question.

The Piles Branch of the Canadian Pacific Ry., on which the works of the Canada Iron Furnace Co are located, is perhaps the best paying piece of line possessed by that great trans-continental road, and this is very largely due to the fact that every pound of raw material inwards to the furnace and finished product outwards to the market contributes to the revenue of the railway company.

It is quite plain that any policy that would serve to cripple these iron industries *will be severely felt* by the railways

Perhaps the greatest difficulty that has stood in the way of the advancement of the Canadian iron industry up to the present time, has been the uncertainty of the tariff, and political cries of "Commercial Union," "Unrestricted Reciprocity," "Free Trade" and "Revenue Tariff" have served to frighten capitalists, so that Canadian iron masters have found it very difficult to obtain investors for the carrying forward of the work on a proper basis. When the difficulties are all considered it is remarkable that the industry has reached even its present stage.

The United States at the present time presents an example of what uncertainty, regarding tariff changes will do. During the past six months business has been completely demoralized in the iron trade of the republic by the fear of a possible change in the duties. This in face of the fact that both parties in Congress are known to be more or less protectionist in theory and practice, the difference being only one of degree, whereas in Canada politicians are most extreme in their views, and the battle against protection to native industries has been waged in and out of Parliament during all the term that the so-called national policy has been in existence.

With such a nucleus as the existing establishments afford, with unlimited supplies of raw material, and possessing the best of all markets —a home market—the Canadian iron industry cannot fail to expand rapidly and safely, probably as in the case of the United States much more rapidly than the population, if only the Government of Canada will establish confidence in the minds of capitalists by, in some manner, giving a degree of permanency to the present protective tariff. Minor details will from time to time require adjustment, but the broad principal of protection to an industry for which nature has so eminently fitted the Dominion, must be endorsed by both Government and Opposition, giving a fair period of time in which to secure a full development of the industry, so that it may meet, on something like equal terms, the opposition of its powerful competitors in the United States and Great Britain. Without this the industry will be restricted, and in time of depression such as at present, the iron masters of the United States will simply unload their bankrupt stocks into Canada, with the end that a healthy Canadian industry will be an utter impossibility.

It is a notable fact that during the past four years the increased outputs of the Canadian furnace has led to a decreased cost of production per ton of iron, and Canadian makers have now forced foreign agents to lower their prices fully $3.00 per ton from prices asked four years ago. A well maintained tariff for some years to come will have exactly the same tendency as it had in the United States, viz, to strengthen and expand the native industry to the point where Canadians can control the entire trade of this country, and yet sell to the consumer at as low a price as any foreign competitor can do in his own country.

LOCATION.

The question of a proper location of coke and charcoal furnaces will be settled by the natural fitness of each province. Nova Scotia, possessing as she does a great wealth of mineral fuel, must continue for some time to come to produce the coke iron required by the country. It may be urged that she is far removed from her best market, viz., Ontario. However, Nova Scotia is in as good a position in this respect, and ought to be in regard to freight rates, as her present greatest competitors, viz., the furnaces of the Southern United States. Within the past two years Nova Scotia has made great progress in the erection of modern plants and improved appliances. She must continue on this course, for the time is past when iron can be successfully produced without improved appliances both in construction and modern methods of operation. The blast furnace must meet the consumer's wants, in quality of iron and technical knowledge, and administrative ability must be joined together in Nova Scotia just as in the United States to secure the increased output, and high quality of iron which the times demand. Quebec and Ontario will afford a splendid field for the development of the charcoal iron industry, and this department will become more and more important as the forests of the neighboring republic and Sweden are depleted.

It is hardly feasible under existing circumstances to successfully establish coke furnaces in either Ontario or Quebec, inasmuch as these Provinces would have to depend upon importing their supply of fuel from the United States. Such an industry would be of little value to the Provinces or the Dominion, inasmuch as by far the largest proportion of labor required in the manufacture of iron is that connected with the mines, both coal and iron. Certainly the Government would not be warranted in granting a bounty for the establishment of an industry contributing as largely as this would to the labor of our most important competitor, the United States.

There is a reasonable hope that in due time Nova Scotia coal will be profitably coked at Montreal, and other centres of population, through the utilization of by-products. When that time comes, Ontario and Quebec will be in a position to operate blast furnaces economically with mineral fuel, the product of Nova Scotian mines, thereby adding another link to strengthen the confederation of the Canadian Provinces.

For the immediate future the charcoal iron industry offers the best and surest field of operation and investment to the Provinces of Ontario and Quebec.

A full and unbiassed investigation into all the facts concerning the successful establishment of the iron industry in other countries, and of the circumstances attending the work already done in Canada, leads to the following conclusions :—

First—That the Canadian iron industry has greater and more just claims to the good-will and support of the Government and people of Canada than perhaps any other of the great industries of the country. In tobacco, sugar, and cotton, splendid progress has been made, yet these industries, whilst of unquestionable benefit to the country, all contribute more or less to the labor of foreign countries, by using raw materials of foreign growth, for which nature has not fitted Canada.

The iron industry is altogether different, being purely Canadian from raw material to finished product. Nature has richly endowed Canada with everything that goes to make success in this special line of enterprise. It rests with the Government and the people of the Dominion to foster the industries to a perfect development.

Second—The Dominion Parliament must immediately adopt a course that will give confidence to investors, by demonstrating that the protective tariff and bounty will be well maintained for some time to come. The Government must rectify judiciously any errors that may have arisen, and must seek at least approximately *to grant a uniform protection to labor, in whatever branch of the industry it may be employed*, be it at the mines, furnace, rolling mills, iron foundry or machine shop.

Third—The Provincial Governments must take steps immediately to encourage by every reasonable concession the development of the iron industries now within their respective borders.

In Quebec and Ontario every facility should be granted by the Provincial Governments in the way of privileges for the clearing of hard and soft woods from Crown lands. This course will not only strengthen and build up the charcoal iron industry, but will bring about a rapid settlement of Government lands.

Hitherto settlers have avoided the forest lands of the east, in favor of the more easily cultivated prairies of the west. Establish the charcoal iron industry in Quebec and Ontario, and the settlers will find a sure and profitable return for labor expended in clearing the wood, an inducement that will make the bushlands of these provinces more attractive than the prairies of the west.

The section of the different provincial mining laws, providing for a proper expenditure in the development of mining locations within a given time, should be strictly enforced, and if possible the obligations made even more stringent than at present, so as to ensure a fair amount of work being done promptly, and prevent as much as possible the "locking up" of valuable mines by speculators.

Where the owners of locations are too poor to carry on the work of development in a proper manner, then the Provincial Government should do so by some equitable arrangement with the owner. For this purpose the Provincial Legislatures should vote in each year's supplies a reasonable sum of money. This would serve to bring about a business like development of some very valuable mines that now lie dormant, and must in time bring a very profitable return to the Government by the settlement of Crown lands.

Further, it would tend to prove to capitalists that the ore supplies are all that they are claimed to be, and ample for all requirements.

The Provincial Governments require to deal with the whole question in a business-like manner, strictly enforcing laws that will tend to an early development, but at the same time they must be heartily in accord with the Dominion Government in granting every legitimate encouragement and facility that will tend to build up so valuable an industry.

Fourth—Canadian bankers, capitalists, and men of affairs generally will do well to give the native industry more attention in the future than they have in the past. An industry that is peculiarly Canadian in every branch, drawing all its wealth from Canadian soil, is surely worthy of their legitimate support. The fact that the earlier iron industries of this country failed to succeed under the most adverse circumstances is no reason why, under existing conditions, undeniably more favorable, the industry cannot be made a thorough success, not alone affording a great field for the safe investment of capital, but indirectly benefitting other existing Canadian industries and interests, aiding toward increased population and national wealth.

Let the Canadian Government and people go steadily onward, and by every energy and sympathy build up great national industries and interests, neither doubting themselves nor their resources, but rather cultivating in every department of trade and commerce, and in the hearts of the people, that national pride in national products so characteristic of Englishmen and Americans. Following such a course Canada must soon develop not only in her iron industry, but in every department of national life.

ANNUAL DINNER.

The fourth annual dinner of the Association was held on Thursday evening in the Windsor Hotel, about forty being present, Mr. George E. Drummond, Vice-President, in the chair. Among the guests present were the Hon. E. J. Flynn, Commissioner of Crown Lands, Quebec; the Hon. A. Desjardins, Mayor of Montreal; Mr. John F. Stairs, M.P., Halifax, and Mr. Graham Fraser, managing director of the New Glasgow Iron, Coal and Railway Co., Ltd., New Glasgow, N.S.

SUMMER MEETING.

ON BOARD S.S. BONAVISTA, EN ROUTE FOR CAPE BRETON.

FRIDAY, 6TH JULY, 1894.

MR. JOHN BLUE, C. & M. E., President, in the chair.

The minutes of previous meetings were read, approved, and signed by the President.

NEW MEMBER.

The election of Mr. Cecil H. Bowen, Sherbrooke, Que., to membership was confirmed.

FEDERATION.

THE SECRETARY reported that, in accordance with the resolution adopted at the last annual meeting, he had submitted to the members of the Mining Society of Nova Scotia at their annual meeting the views of the Association respecting a federation of existing Canadian mining organizations, and that after favorable discussion the matter had been referred to a committee of that Society. He had since received the following as the report of this committee:—

REPORT OF COMMITTEE OF THE MINING SOCIETY.

"In the matter of Federation of existing Mining Societies or Associations, it was agreed:—

"(1) That in so far as subsequent paragraphs are concerned, it is deemed desirable that all existing Mining Associations or Societies in Canada should be invited to join :

"(2) That all members of such organizations should become, *ex officio*, members of the proposed 'Canadian Mining Institute':

"(3) That each organization should pay annually to the funds of the Canadian Mining Institute a sum per head of its membership to be hereafter agreed upon :

"(4) That the first and main *raison d'etre* of the Canadian Mining Institute should be the printing and publishing in one volume, under one editing, of all the transactions of each such organization, thereby relieving the local organizations of this matter and expense entirely ; the expense being met by the per capita contribution to the funds of the Canadian Mining Institute :

"(5) That it is not desirable to have, or attempt to have, any large body of officials for the Canadian Mining Institute, but rather that such business as may arise should be transacted by a small body or committtee to be composed either

(*a*) Of the several secretaries to the local organizations, or

(*b*) Of one specially elected delegate, or

(*c*) Of a specially elected delegation, based on one member per so many members, for each local organization :

"(6) That the committee, or governing body, so constituted, should appoint or elect one individual to act as Secretary-Treasurer, Editor of the Canadian Mining Institute.

"(7) That each local organization preserve, to the utmost extent, its autonomy and individuality."

SUGGESTED AMENDMENTS.

After discussion by the members, it was resolved that the Association recommend the following amendments :—

(1) That the managing board of any Federated Canadian Mining Institute consist of the Presidents of the Associations in the federation, together with one member from each such Association, and that these shall have power to elect a chairman and a secretary-treasurer.

(2) That there be a united meeting of the members of the Federated Association once in each year.

(3) That the cost of the publication of the Transactions of the Federated Institute and the means of defraying the same be left in the hands of the governing board.

TREASURER'S REPORT.

THE TREASURER reported that the note of $600 made in January to defray the cost of the Association's volume of Proceedings for the years 1891-2-3, had been reduced to $100, and that there was sufficient money outstanding and incoming to clear the Association from debt and leave a good balance.

This being all the business, the meeting adjourned.

SPECIAL MEETING.

ON BOARD THE S. S. BONAVISTA.

MONDAY, 9TH JULY, 1894.

The President took the chair at eight o'clock.

THE LATE COLONEL LUCKE.

THE PRESIDENT—Before proceeding with the regular business of the meeting, I will ask your permission to make a few remarks regarding the sad event of which we received intelligence this morning. I refer to the death of our esteemed member and Vice-President, Colonel Lucke, of Sherbrooke, who was known to you all as a most active member, having been one of the first of the Association, and a member also of the Council for two or three years. He took a great and energetic interest in all our proceedings; so much so, that he never allowed himself to be absent from a meeting, this present one being the first unattended by him.

He would have come with us upon this excursion, had it not been that his personal friend and fellow-director in mining enterprises, Mr. Jas. Mitchell, was one of our party; and you understand that both gentlemen could not leave their business at the same time.

We are all well aware of, I am heartily glad to say, the many good qualities and qualifications for which Colonel Lucke was esteemed and honored by everyone. His genial disposition and his heartiness of manner endeared him to all who had the pleasure of coming in contact with him; and these qualities, in addition to his business abilities, make his loss felt keenly in the community in which he lived.

We shall miss him from our meetings more than I can say, and from the position which he filled with such great credit to himself and the Association for so many years. The sad news we have received has dampened the enjoyment of our trip; but we must try and be philosophical and remember that such has to be the end of all. We have to do the best we can to fill the Colonel's place, and that is said in no disparagement of whoever is elected in his stead.

Our Secretary has drawn up a resolution of condolence, which I will ask him to read.

THE SECRETARY then read the following motion, which was unanimously adopted :

"The members of the General Mining Association of the Province of Quebec having learned with profound sorrow of the untimely death of Colonel Lucke, of Sherbrooke, an original member and an esteemed Vice-President of the Association, be it resolved : That a minute be entered in the proceedings of the Cape Breton meeting recording appreciation of the work and services of Colonel Lucke ; and that the Secretary be instructed to convey to Mrs. Lucke an expression of sympathy and condolence in her bereavement."

THE SECRETARY then read the minutes of a meeting of the Association held on board the Steamer Bonavista on the evening of the 7th July, 1894.

ELECTION OF MEMBERS.

The following gentlemen were declared elected as members of the Association :

Mr. A. Sangster, Jr., of Sherbrooke, proposed by Mr. John Blue and seconded by Mr. Jas. Mitchell.

Mr. J. W. Woodside, of Sherbrooke, proposed by Mr. Jas. Mitchell and seconded by Mr. John J. Penhale.

VOTE OF THANKS TO CAPTAIN FRASER.

THE SECRETARY then read the following motion, which was unanimously adopted :

"That the very hearty thanks of the Association be tendered to Captain Fraser, the officers and men of the Steamer *Bonavista*, for the uniform courtesy that has characterized their unremitting endeavors to cater to the comfort and pleasure of members during their excursion to Cape Breton."

THE ILLNESS OF THE PAST PRESIDENT.

MR. JOHN J. PENHALE moved : "That a telegram be sent to the Hon. Geo. Irvine, Q.C., enquiring as to his condition of health, and expressing regret at his inability to accompany the members of the Association upon the present trip." The motion carried.

THE SHERBROOKE MEETING.

It was then unanimously adopted that the next general meeting of the Association be held in Sherbrooke on Thursday and Friday, the 27th and 28th of September, 1894. Also : That a local committee consisting of Messrs. John Blue, John J. Penhale, James Mitchell,

F. A Halsey, F. P. Bucke, and E. B. Haycock be constituted to make arrangements for said September meeting. The motion carried.

INVITATION FROM CARRIÈRE, LAINÉ & CO.

MR. J. T. DWYER said:—I may say that I was requested by Messrs. Carrière, Lainé & Company to convey to the members of the Association upon this excursion, an invitation to visit and lunch with them at their works at Levis, and see there under their guidance the various points of interest.

It was then decided that the Secretary should telegraph or write Messrs. Carrière, Lainé & Company, from Sydney, expressing to them the sincere thanks of the members of the Association, their regret at being unable to accept the invitation upon the present occasion, and their hope that they might be able to avail themselves of the invitation at a future and more convenient date if the invitation of those gentlemen would then be good.

The meeting was then declared adjourned.

CAPE BRETON EXCURSION.

By kind invitation of Mr. David McKeen, M.P., Resident Manager of the Dominion Coal Co., Ltd., Mr. R. H. Brown, Manager of the General Mining Association of London, Ltd., and the officers and members of the Mining Society of Nova Scotia, a delightful and instructive holiday was spent in Cape Breton, visiting the collieries and other important features of that beautiful and historic island. The programme included:

An excursion by water to the various shipping piers on Sydney Harbor of the Dominion Coal Company, Ltd.

An excursion by special train to the Bridgeport, Dominion No. 1, International and Caledonia Mines of the Dominion Coal Company, Ltd.

An excursion by water to the Old Sydney Mines of the General Mining Association, Ltd.

An excursion by water to the historic port of Louisburg.

A drive to the Coxheath Copper mines.

The members were entertained to a public banquet at Sydney by Mr. David McKeen, M.P., and to a luncheon by Mr. R. H. Brown at his residence at Sydney Mines.

The cordiality of the reception accorded to the Association by the officers of the various companies and the local authorities was such as is likely to be long remembered by those members who were present. The local committee, comprising Mr. McKeen, Mr. Brown, Mr Blakemore and Mr. Archibald, made the most thoughtful, complete and satisfactory arrangements for the comfort and entertainment of the members of the Association, and special acknowledgment is due to them and to Messrs. Kingman, Brown & Co., agents of the Black Diamond Line, for special rates and excellent accommodation provided for the round trip on their steamer *Bonavista*.

AUTUMN MEETING.

SHERBROOKE, QUE.

WEDNESDAY AND THURSDAY, 26TH AND 27TH SEPT., 1894.

The opening session was held in the Magog House, Sherbrooke, Que., on Wednesday evening, 26th September. The attendance was large. Mr. John Blue, C. & M. E., President, in the chair.

THE SECRETARY read the minutes of the meetings held on 6th and 9th July, which were confirmed; also a letter from the Treasurer, forwarding financial statement for the three months.

NEW MEMBERS.

The following new members were elected :—

R. H. Martin, New York,
B. Marcusé, Danville,
H. D. Lawrence, Sherbrooke,
T. J. Tuck, Sherbrooke,
Wm. Mitchell, Drummondville.
Col. Chas. King, Sherbrooke,
Dr. James Reed, Reedsdale,
Andrew Sangster, Sr., Sherbrooke,
Feodor Boas, St. Hyacinthe.

ELECTION OF A VICE-PRESIDENT.

The next item was the election of a vice-president in place of the late Colonel Lucke, Sherbrooke. Mr. George R. Smith moved that the nomination of Mr. W. A. Allan, (Little Rapids Mining Co.), Ottawa, made at the last meeting of the Association, be ratified. The motion was carried unanimously.

FEDERATION COMMITTEE APPOINTED.

The subject of a federation of existing Canadian mining organizations was next discussed.

THE SECRETARY read the minutes of the joint meeting with the Mining Society of Nova Scotia, held at Sydney, in July, and presented the report of the committee of the Nova Scotia Society upon a scheme. It had been resolved to appoint a committee of four from each organization to draw up a basis of federation. The Ontario Mining Institute had endorsed the proposition and appointed its committee. After discussion, the report of the Mining Society being taken up clause by clause, the following committee to confer with the other organizations was appointed: Mr. John Blue, President, Mr. F. A. Halsey, Mr. L A. Klein, and Mr. B. T. A. Bell, Secretary.

Election of an Honorary Member.

Mr. James Mitchell, Sherbrooke, seconded by Mr. John J. Penhale, proposed the election of the Hon. W. B. Ives, Q.C., M.P., as an honorary member.

The motion was carried unanimously.

The Cape Breton Meeting.

On motion of the President, the Secretary was instructed to convey a very cordial vote of thanks to Mr. David McKeen, M.P., Mr. W. Blakemore, M.E., Messrs. Kingman, Brown & Co., Mr. R. H. Brown, M.E., the President and members of the Mining Society, Capt. Isaac P. Gragg, Col. Granger and the President and members of the Sydney Club, for courtesies extended during the visit of members to Cape Breton in July.

The President then called for the first paper for consideration.

SLATE: ITS FORMATION, EXTRACTION AND USES.

By H. J. Williams, Danville, Que.

The growing importance of the slate industry in Canada demands a consideration of the utility and value of the mineral, its occurrence and distribution, especially in the Province of Quebec, and the method of extraction and usage.

The subject is so comprehensive that adequate justice cannot be given to it in a short paper of this kind.

I find nothing written upon the subject except the meagre references made in the Geological Reports of Sir William Logan and others. Therefore, as no thorough examination has been made of the slate formations of this province, our knowledge of the same must be limited.

No clay slate of any value is found in the Laurentian range nor anywhere in the Province of Ontario. In coming east through the

Province of Quebec, we find the first slate formation near Stanbridge, and this appears to be a continuation of a similar slate found in an island in Lake Champlain, and also in Hatch Hill, south of Whitehall, in New York State. No work has been done on this vein except on the island above mentioned. Then farther east we strike purple and green slate in Missisquoi County and at Granby, where some small openings have been made. This formation continues to the N. E. to Actonvale, where a quarry was opened and operated by Mr. Rankin, of Montreal. Then we come to the Kingsy formation, which is a very wide purple and green belt. A quarry was opened on this vein at Trenholmville, but the slate that was produced was of poor quality. This formation is different from all the others, it being a laminated formation, the bedding about ¼ inch and more apart, and not capable of being split between the beddings. A slate of similar character and texture is found in Birds-Eye Mountain near Castleton, Vt., which possibly is a continuation of the same formation. East of this are the Melbourne veins upon which several openings have been made, to wit, Melbourne quarry, the New Rockland quarry, which is now being worked, the Steele quarry in Cleveland, and the Danville quarry in Shipton. Slate of excellent quality is being produced from this vein.

The next formation east of this is found near Windsor Mills. It is an extensive deposit, but owing to its ribbony character, the ribbons in it being hard and occurring at intervals of only a few inches, renders it unworkable and of no value.

Next we come to the Brompton formation upon which two openings were made near Key Brook, about 34 or 35 years ago, but this also is full of ribbons, which unfit it for the production of roofing slate. Slabs for sidewalks and cellar bottoms have been taken out of it at several places which at a greater depth would be good for that purpose. This formation is very extensive, being about a mile in width at Brompton. It is identical with the beds at Montpelier, North Johnsbury, and also Guilford, south of Brattleboro, Vt. Quarries have been opened in each of these places and were wrought for many years, the Brattleboro or Guilford quarries being undoubtedly the oldest on this continent. They were worked as far back as 1812. This vein runs south of Guilford for about ten miles when it is pinched out by the granite.

Then we come to the formations at East Angus and Garthby and several veins of different colors in Beauce County.

From the number and variety of the slate deposits of Quebec, it would appear that many remunerative quarries might be opened.

The main ingredients in the composition of slate are silica and alumina, which show it to have been at one time ordinary clay. Blue (of different shades), purple, red and green, are the ordinary colors met with. The blue color is derived from the presence of protoxide of iron, or iron and oxygen mixed in the proportion of one part of the former to two of the latter. The red and purple varieties take their color from iron in the form of peroxide, two parts of iron combined with two of oxygen. Into slate of a green color, which is the best common variety, iron less largely enters, and in combination with magnesia, gives them a greenish hue.

The clay beds were deposited in ages long past, in the bottom of the sea, and in process of time they have been hardened into stone, and lifted up so as to form dry land. That these beds were originally deposited in the sea, geological authorities mention among other reasons the fact that they contain abundantly the remains of former sea life, which lie along the planes of the bedding, such as zoophytes, mallusca and crustacea. The fossils of these strata may be studied from Sedgwick and McCoy's "Palaeozoic Rock and Fossils," and other works. The presence of soda and potash in the slate deposits, being the record of the saltness of those ancient seas, is an additional proof of the beds of clay in the sea. It can be well imagined how, when this deposition was made that it went through a process of sorting. The heavy, coarser material would be deposited first near to the shore; the finer matter would be carried farther to the sea, and the lightest portions of all would be held longest in solution and would reach the farthest from the shore line. We can well understand then that the variations we find in the quality, color, consistency and thickness of the strata, etc., are all due to the disturbance of the water, caused by oceanic and tidal currents, as well as by storms, which then as now occurred periodically. As a result of these storms we might naturally expect to find, even in the finest deposits, layers of coarser material.

From these simple statements relative to its formation it will readily be seen that in a slate-bed which extends over miles of country, a great variation in consistency and color will be found. The deposition of the coarser or finer portions will determine the former, while the latter is dependent on the presence in the water of the different oxides of iron in combination with carbon, when vegetable growth has occurred, magnesia and other elements. It will be seen also that it is fallacious to suppose, that because a vein has been proved good or bad in a certain portion, that it must necessarily continue the same throughout its entire course. Each particular portion must speak for itself only.

In all slate veins, lines or bands, sometimes wavy, but oftener straight, will be seen crossing it. These are the lines of bedding and it does not follow that the lines of cleavage will coincide with them, as it can only be supposed that the phenomenon of cleavage resulted from an action which occurred long subsequent to the deposition of the muddy layers in beds. There is some difference of opinion among those who have given attention to the subject as to the manner in which this slaty cleavage was produced. It is explained by some to be the result of a crystallizing action; by others to be due to magnetic currents, while others, again, claim it to be the effect of mechanical forces that compressed the sediment at right angles to the direction of cleavage. Be it one or the other or a combination of forces, we find the line of cleavage always at right angles to the dip of the vein.

The occurrence of joints such as floor or foot joints, face or side joints, is accounted for by the mass slowly hardening and consolidating by pressure as well as heat. Lifted out of the water it cracked and split in various directions in drying, and, influenced by the laws of crystallization, it assumed definite shapes, being split into rough and homboidal masses. Had our original deposition been homogeneous and subsequent action constant and uniform our present slate veins would all have been practically perfect. As such, however, was not the case we find we have to contend against many conditions which determine its possibility of being worked to advantage. The presence of dykes, posts, wavy cleavage, impure beds, etc., we find in all slate formations, and it is only after a careful and intelligent study of the conditions that we are enabled to know of its value.

We will now proceed to the methods of working a slate quarry, which are the same the world over, differing only in the manner of laying them out, which is dependent entirely on the locality of the opening, the condition of the formation, and its position relative to the surrounding rocks It may be: 1st. An open quarry. 2nd. A chambered quarry worked underground by means of levels or adits. 3rd. An underground quarry worked by shafts. I will confine myself to a brief description of the first only, as with one exception all the quarries on this continent are open quarries.

Slate rock being of a soft clayey nature is affected by the elements more, perhaps, than any other rock. In the slate quarries now opened in Canada, the top or rock thus affected is from 30 to 40 feet in depth, all of which has to be removed before sound slate can be made. An opening is made along the face and another across the vein. This portion is quarried back, another bench or gallery started in the same way, and so on until the opening is laid out in a succession of galleries. The first operation is the quarrying of blocks, and it is here that the most intelligence is necessary. It is imperative that the block shall be quarried without shattering, and the skill of the quarryman is attested by his ability to take advantage of the slips, joints, floors, to make each hole do the work properly In some cases wedges are used, splitting and slowly forcing a certain portion from its position, but it is usually done by means of blasting. A hole is put into the face and at right angles to it until a split or bed plane is notched. The hole properly charged is filled with powder to the mouth and as little tamping as will hold the powder in is used. In this way the pressure caused by the explosive being uniformly distributed along the entire width of the portion to be moved, the block is cut its entire length between floor joints and is thus moved without shattering. Had our hole been filled only half full and the balance tamped, all that portion of the block from the powder to the mouth of the hole would be shattered and rendered useless for slate. Ordinary blasting powder is used exclusively in this work as the force wanted is a dull heaving one, which will heave and displace the rock without breaking it. The sudden force of explosion in the higher explosives, such as dualin or nitroglycerine, acts too quickly, and before our rock has time to be cut it is entirely shattered and destroyed by the rapid action.

Our large block has now to be cut up, and here, again, much skill and judgment is requisite. And I might say here, that there is no mining in which such intelligence, skill and judgment are required on the part of the labor employed as in the quarrying and working of slate. With a small steel gauge and light single-hand hammer, a small ditch or trench is cut across the end of our block. Then with a steel chisel, whose point is from 1 1/2 to 2 in. long, the workman follows along this ditch, making its bottom even and straight; a similar chisel, though a dull one is then used, and by heavy blows on this chisel following along the ditch, the fine grains of slate are driven into the end of our blocks, and a cut is started along the grain which if nursed properly will continue straight throughout its entire length. These separate portions are then split into convenient sizes for hoisting and tramming, and are laid down along the sides of the shanties to be further worked into slate. Here, again, skilled labor is required and our "slatemakers," so-called, who usually work in pairs, study their block that they may make the most slate therefrom. As most blocks will contain impurities and disfigurement, he must consider how in cutting it up he can bring these to the end of his slate that they may be cut off in dressing with as little waste as possible. His block is cut lengthwise into two or more widths in the same manner as that employed by the quarryman described before. He then splits them into blocks or slabs of about 2 in. thickness and breaks them cross-wise by striking on the edge with a large heavy wooden buth, having previously weakened the opposite edge by making a gap or cut into it. The small blocks are then carried into shanties to be split and trimmed or dressed into the different sizes of slate used in roofing. The splitting is done by means of a flat, broad, thin-edged chisel and a wooden mallet, for the blows of wood are better adapted for the splitting of slate than those from steel. Splitting is one of the most skilful and particular processes of slate making. A fresh end or side to split from is necessary and the splitter carefully guards this end or side from bruises, and keeps them damp in dry weather, as the split easily runs out the side when the blocks get dry. Again, a block being in a frozen condition will work up readily while frozen, but it is almost impossible to split them when they are thawed out, in which case they are usually left until frozen again. The dresser takes the pieces from the splitter and after trimming as little as possible from one end and one side at right angles to each other, the remaining end and side are trimmed to make the largest size possible from the piece. There are usually about 18 sizes varying from 12 x 6 in. to 24 x 14 in., the sizes being regulated by means of a gauge attached to side of machine, thus ensuring a uniform length and width to all sizes. The slates are carried to the stock piles, inspected by a competent man, and counted into 100 piece lots, allowing from 2 to 5 per cent. breakage. From here they are shipped without further treatment, except in case of transhipment from rail to water, when they are usually boxed.

In the process of school slate manufacturing, the method is entirely similar to that described for roofing slate up to the dressing or trimming stage. In this case the slates are trimmed to size by means of a small saw with few teeth revolving very rapidly In this way a very little splintering on the under side results. The surfacing is done principally by means of emery wheels or rollers revolving in water and the slate forced under the wheels or through the rollers. The hand process of surfacing, however, is much used, and consists of drawing an ordinary drawshave across the surface exactly as one would shave a piece of board. The edges are bevelled to admit of entering tightly in the grooves of the frame. The latter are made entirely by machinery. Boys insert the slate, close and glue the frame, which is then planed and finished by means of machinery. They are packed and shipped in boxes and are sold to the market by the dozen or gross.

Another very large and growing branch of the industry is the milling of slate. There is no rock which so much resembles wood in its method of being worked as does slate. Blocks being brought from the quarry to the mill are sawed by circular saws, and planed by passing under a planer knife, a chisel some 6 or 8 inches long. From the planer the slabs go to the rubbing bed, which is a large, heavy, revolving cast-iron plate, where by means of sand and water the surface is ground down smooth and even, to any required thickness. From here it will go to the jig or band-saw, the boring machine or the groove as the case may require. From here it may go through the marbleizing process, by which it is made to resemble any kind of stone or wood and thus used for ornamental purposes. It may be used for tanks or wash-tubs, or other vessels for holding liquids, in which case it is taken from the machines, put together by means of grooved joints with cement, and bolted or screwed.

The most general use for slate is for roofing. For this purpose it is unexcelled, except, perhaps, by copper, but the relative expense, taking into consideration the utility of the two, is entirely in favor of slate. We have records of roofs laid in Wales in the time of King Henry VIII., which are in a good state of preservation today. The average cost per square, which means enough slate to cover 100 square feet of roofing and which corresponds to 1,000 feet of shingles, is about $4, F.O B. cars at shipping point of quarry. The laying, including nails, etc., will cost from $2 to $2.50 per square.

We have already mentioned its use as manufactured into school slate, which branch of the industry has been checked somewhat by the introduction of cheap paper tablets.

The uses to which milled slate is put are very numerous and varied. Among others the following are the most important: Billiard beds, blackboards, mantles for fireplaces, beautifully polished, marbleized and richly ornamented by hand painting, monuments, washtubs, tanks for water, oils or acids, urinals, closets and all sanitary purposes generally in public institutions and buildings, tiles, steps and all kinds of flooring. It is also becoming more and more extensively used for electrical purposes, such as switchboards, instrument stands, etc.

I will mention one other use, which promises to become a very important branch of the industry. I refer to the grinding of the slate rock into dust from which is made a brick whose compactness and strength and wearing qualities are not excelled by any other brick made. Tiles of any color, both plain and glazed, are another product of this dust.

The industry in the Province of Quebec is at present confined to the workings of but two quarries. One, operated by the New Rockland Slate Co., at New Rockland, and the other by the Danville Slate Co., near Danville. Both these quarries are located on what is known as the Melbourne vein previously mentioned. The former is the most extensively worked of any that has been opened in Canada. Here the rock stands nearly straight, having a dip of 80° to the south-east. The slate is of excellent quality, being hard, tough and strong, and blue-black in color, which is unfading. It is of compact and close grain, admitting of no soakage of water, making it very durable.

The first workings were opened about 1865, on what is known as the west bed, lying in the serpentine rock. Operations were entirely confined to this bed until the year 1881, when a cutting was made through a hard bed, and a body of slate found which was equal in quality to that of the other vein. Operations have continued in this new vein up to the present time. This vein is very regular in formation, not being intersected by any foreign rocks, but parts of it are very subject to chicks, or an unsoundness, known as slants by quarrymen, which chicks, running at an angle with the cleavage, renders it unworkable for roofing slate or slab work.

A very extensive quarrying and milling plant is in use. The Salmon river here affords a very excellent water power, which is conveyed to the hoisting engines and mills by means of wire-rope transmission. Cable derricks of the Blondin system are extensively used. A large mill 100 x 60 feet, thoroughly equipped with all modern milling machinery, produces slab work of all descriptions. A narrow gauge railroad, about five miles in length, connects this quarry with the Grand Trunk Railway, at a point about five miles east of Richmond.

At the Danville quarry the vein is intersected by a series of hard ribbons, which, however, are at a sufficient distance apart to enable slate to be made from between them. The equipment here, though on a much smaller scale, is similar to that at New Rockland, except that the power used is steam. In addition to their roofing slate and slab work, school slates are manufactured.

Owing to the private character of the companies operating, I am not able to give satisfactory statistics of the industry. The trade, however, has grown to be a very important one. This has been due principally to the efforts made by these companies to introduce slate, by the opening up of the country with railroads, and by the protection which the Government has seen fit to bestow upon it. So rapidly has the trade grown of late that the demand is far in excess of the production, and with the extensive deposits of slate that we have in this country, there is every inducement for a thorough examination of the various veins, which I do not doubt would lead to the opening up and working of several remunerative quarries. And I look forward to the time, in the near future, when slate quarrying shall have become one of the principal industries of the province.

VOTE OF THANKS TO MR. GRUNDY.

MR. F. P. BUCK—Mr. Grundy, the General Manager of the Quebec Central Railway, has very kindly placed a special train at the disposal of the Association for the excursion on Monday (applause), and I would move that we tender him a hearty vote of thanks for his kindness. The motion carried unanimously.

INVITATION FROM THE HON. W. B. IVES, Q.C., M.P.

THE CHAIRMAN announced that the Hon. W. B. Ives, Q.C., M.P., had invited the members to dine at his house on Friday evening, the 28th. (Applause.)

The meeting adjourned at 11 p.m.

The members re-assembled on Thursday evening, at eight o'clock, the President in the chair.

THE MAGNETIC NEEDLE.

By MR. A. W. ELKINS, Lennoxville, Que.

A slender bar of steel, charged with some of that mysterious, imponderable fluid or influence, called magnetism, generally about five inches long and about one-sixteenth of an inch thick, pointed or wedge-shaped at the ends, and provided at its centre with a cup-shaped piece of very hard metal, or precious stone, so arranged that the bar may freely turn upon a pivot, is essentially the simple little instrument known to-day the world over as the Magnetic Needle, which possesses the wonderful property of remaining in a direction, (or of turning upon its centre until it assumes a direction), nearly north and south, and this provides data from which the direction of the geographic poles of the earth can be inferred with a fair degree of accuracy

Such is the essential part of the instrument, which, for at least seven centuries, has been the greatest boon to navigators, and of inestimable service to explorers of unknown territory.

The early history of this simple but invaluable contrivance is lost in antiquity. It is thought that the Chinese were its inventors; and one authority states that the Emperor, Ho-Ang-Ti, marching with his army against the enemy, finding himself embarrassed by fog, constructed a chariot which indicated the south. This was in the year 2634 B.C., and it is supposed that the magnetic needle was referred to; but the first time that it was explicitly mentioned was in a Chinese dictionary, finished A. D. 121. However, its use to navigators was probably not generally known till the middle of the twelfth century.

In order to bring forcibly before you some of the wonderful properties of the instrument, I will arrange a needle so that its extremities will turn towards the poles.

I have here a common knitting needle about seven inches long, to which I have imparted some of that subtile, imponderable fluid or influence, generally described as magnetism. Attached to the centre of this bar of steel is a fine silk thread by which I suspend the bar. It will be noted that one end immediately turns towards the north and the other towards the south. That end towards the north is called the north pole of the needle, or more properly speaking, the north-seeking pole, for I will show you that the kind of magnetism that is at the north-seeking end of the needle, is different from the magnetism which attracts it towards the magnetic north pole of the earth.

I have here another needle, similar to the one suspended before you; this one has also the properties exhibited by the suspended one, that is, it is magnetized.

Now, upon bringing the north-seeking pole of this needle towards the north-seeking pole of that one which can turn freely, it is seen that the one I hold in my hand *repels* the other, and the south end of one also repels the south end of the other; but the north end of *either* attracts the south end of the other. Therefore, the magnetism of the so-called north end of the needle is not the same as the magnetism of the north pole of the earth.

An ordinary magnetic needle costs about two dollars, but there are circumstances under which it may, and often has suddenly risen from this trifling value, to the enormous sum of three or four millions of dollars. For instance, in the case of one of our costly modern ships of war. Imagine one of these giants of the ocean cruising in a storm on a dangerous coast, the sun, moon and stars obscured by clouds and rain; her commander unable to find anchorage, must depend entirely upon that tiny bar of steel for guidance, to save his ship and the lives of all on board.

Insignificant though the needle seems to be, there is no known substitute for it, under conditions such as I have named.

Though the value of the magnetic needle cannot be over-estimated, it is subject to changes or influences which are not perfectly understood, and which, at times, cannot be successfully guarded against. It is, therefore, necessary to use it, or to follow it, very cautiously, otherwise serious consequences might result.

The magnetic poles of the earth are not identical with its geographic poles, and this difference, which is indicated by the angle, contained by the astronomic and magnetic meridians, is called the declination of the needle; which difference is not everywhere the same.

In this eastern part of America the direction of magnetic north is about sixteen degrees *west* of true north, whereas in British Columbia, it is about twenty degrees *east* of north; and this declination is continually changing, to the extent of about five minutes in a year, the north end of the needle now gradually moving towards the west in this eastern part of America. It is, therefore, of primary importance that, before using it in any section of the country, its direction be ascertained by astronomic observation.

It is likewise subject to another change, known as the diurnal variation, which deflects it from its usual course about twelve minutes in twenty-four hours, and must be taken into consideration in using it, the maximum variation occurring about 2 p.m., after which it slowly returns to its former position.

In these northern latitudes the north end of the needle is drawn downwards, the extent of the inclination varying in different locations even in the same latitude.

It has been ascertained that the north magnetic pole is situated in about latitude seventy degrees north and longitude ninety-six degrees forty-six minutes west, which is a little north-west of Hudson's Bay, and not far from Chesterfield Inlet.

The magnetic equator does not correspond at all points with the earth's equator, but it is a curved line, in places a number of degrees from the equator proper. On the magnetic equator the needle remains in a horizontal position; but in southern magnetic latitudes the south end is drawn downwards in the same way that the north end inclines in northern magnetic latitude. In order to counteract this dipping, and to keep the needle in a horizontal position, a sliding counterpoise is placed upon most needles. Sliding, because, as the instrument, from long use or any other circumstance, loses its magnetism, the north end dips less.

I have spoken of the changes that take place with a greater or lesser degree of regularity; there are others, sometimes very material, that cannot be accounted for and which require the constant watchfulness of the observer to detect. The greatest change of this unaccountable character that has come under my personal observation, was a deflection of about forty-four minutes in eight or ten minutes of time. This was probably due to an electrical storm, which could not otherwise have been noticed.

The glass cover of the compass sometimes becomes charged with electricity, which causes the needle to apparently stick to the glass. This is of rather frequent occurrence. Wetting the glass immediately dispels the electricity.

Any state of the atmosphere in which electricity is an element, greatly affects the needle, electricity and magnetism being, it would seem, almost the same; the power of an electrical motor, for mechanical purposes, being dependent on the magnetic force induced in iron by an electric coil surrounding it.

In many places a purely local attraction causes the needle to swerve from its general course from five minutes to fourteen degrees, as noticed by myself during the twelve years I was actively engaged in surveying, and instances have been recorded where this local swerving exceeded twenty-five degrees.

These considerable deflections of the magnetic needle in certain localities are doubtless due to large deposits of magnetic substances. In the vicinity of Thetford and Coleraine the iron ore, that is disseminated through the serpentine and so-called asbestos, attracts the needle very sensibly.

Navigators have to contend with another perplexing source of error in compass reading, which is not easily overcome, particularly in these days when iron enters so largely into the construction of ships, and that iron so used sometimes affects the needle to a serious extent, and from causes that are not always apparent.

It is a well known fact that iron, remaining long in one position, sometimes becomes magnetic, and it has been found that portions of iron ships become magnetic. Now, the action of unmagnetized iron upon the needle is inversely as the square of the distance between the iron and the needle; but if a piece of unmagnetized iron, which at the beginning of a voyage would attract the north end of the needle, should become magnetic, it would repel the north end under certain obvious conditions.

I believe it was recently discovered that the needle was influenced to a dangerous extent on a man-of-war by the side-arms of a sentry who passed near the compass and whose bayonet had become magnetized by having been stored near the ship's dynamo.

All of these irregularities of the needle may be successfully guarded against in fair weather, by frequent astronomic observation, but such observations require special instruments, which are not always obtainable.

In the absence of astronomic observations, the correctness of the work in hand depends upon the skill of the observer and his knowledge of the capricious pranks, so to speak, of this little instrument, which, with all its faults, is so marvellously useful.

With a view to increase the accuracy of compass surveys, I, several years ago, invented and obtained a patent in the United States upon a little instrument which I called "An Improvement on Transit Compasses," and it obtained considerable favor among surveyors; in fact, some of my confreres were kind enough to say that they thought that my instrument would supersede the plain-sight compass.

The instrument consists mainly of a compass, rigidly attached to the upper side of a telescope turning upon trunions in a bifurcated holder. It possesses many of the advantages of the heavy and expensive transit instrument, with the lightness and inexpensiveness of the compass, and it is therefore particularly desirable for surveys in places not easily accessible.

In ordinary so-called "line-running" the surveyor would only use the needle at starting, after which required points in the great circle would be accurately determined by the use of the telescope, indicated in the cut of the instrument.

DISCUSSION.

Mr. Geo. R. Smith—Is the compass of any value in underground workings, such as Mr. Blue's, to determine the true north—in long drifts, for instance?

MR. ELKINS—You could not depend upon it Its principal use in underground surveying is checking deflection angles. Sometimes in deflecting from a line a mistake might be made. By reading the magnetic bearings of the lines and deducing the deflection angle therefrom, the needle would act as a check upon the work of the surveyor.

MR. BLUE—I beg to differ with Mr. Elkins. I was engaged in mine-surveying some years, and we used the compass altogether for all our mine surveys. This was in coal and iron workings in Scotland. There the mine owners are compelled by law to have accurate surveys of all their main workings taken every six months and accurate plans kept To take a survey with a transit in one of those large mines would require a week. I have kept plans of very many collieries in the Old Country, had charge of work where we were approaching boundaries, and have done work with the compass that was perfectly correct, and proved to be so by subsequent workings from the other side of the boundaries. I ran a line by compass from the bottom of two shafts about a mile and a half apart, and brought them close together in coal workings.

MR. ELKINS—Was that work that you did with the compass checked by Rittenhouse's, or any trigonometrical method? By this method latitudes and departures are calculated, and the accuracy of the work can be proved. That is the only way of determining exactitude.

MR. BLUE—No. Each bearing and measurement was plotted separately.

CAPT. BENNETS—I have done correct work with a compass for several years.

MR. ELKINS—For short distance surveys, and for rapid work, there is no instrument to excel the compass or take its place; but for accurate work, you should never depend on it in any extended survey; for reasons that I have mentioned, and which I believe are well known to every careful observer of this valuable instrument. I speak from twelve years experience as a Provincial Land Surveyor, during which time I made numerous underground surveys of metal mines.

MR. LAWRENCE—It seems to me, as one without experience, after hearing what has been said, that both gentlemen might be entirely correct. In the workings Mr. Blue spoke of, in coal-bearing strata, there might not be any local cases of variation to interfere with the compass;

but in many localities it is utterly impossible to make any correct survey without the transit instrument. I do not see why, in many cases, the rapid work of the compass should not be as correct, and would be cheaper; but it must be a fact that in many localities the compass would be entirely valueless.

Mr. Blue—I agree that in some cases where there is local attraction, such as iron or steel rails, &c., the compass is of no value whatever. But I must say that in a great many places the compass is of more value than the transit.

Mr. E. B. Haycock—I think that if I had to do work and was allowed to use the instrument I considered would do the best work, I should take the transit. Some years ago I made a survey on Lake Erie, and my chief instructed me to take the compass and make the survey, as being quicker and cheaper. I had a run of fourteen miles and ran it with the compass, and I can assure you that that compass line was as crooked as a lame dog could have made it. I then took the transit and ran the same trip, and came within an inch and a half of a perfectly straight line. I also that summer did some short line work with the compass, and found that the best way I could use that compass was to start the line and use the pickets

Mr. Blue—To run a fourteen-mile line by compass is asking too much from it; but in surveying a coal mine where the method of working was stoop and room it would entail as many as five hundred bearings in some cases, and you could only get the bearings of the length of your rooms, twenty to forty feet. Anyone who has used both the compass or transit can just imagine the difference of time in taking those five hundred measurements. Can you see any reason why one should be more accurate than the other? You are plotting little bits of short distances to a small scale. The width of your pencil line in plotting would amount to several degrees.

Mr. Elkins—I would compute the total latitudes and total departotal departures by Rittenhouse's method and lay off these total latitudes and departures, which would ensure practically absolute accuracy in plotting.

Mr. Klein—I had a little experience with compass surveying, and the question was settled only lately in court, and our company was about one hundred acres out—against the compass. I may say that lately a survey was made of a town line and through the compass quite a deposit of chromic iron was discovered. This line had been previously run by compass, and on the three different occasions produced three different lines, which varied about half a mile. If I had a survey to make I would in every case use the transit for the first time.

MR. ELKINS—Does chromic iron attract the needle?

MR. OBALSKI—I do not think so. I have never found magnetic chromic iron in this country.

CHROMIC IRON: ITS PROPERTIES, MODE OF OCCURRENCE AND USES.

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

It has long been known that chromic iron occurs in this province in the Cambrian serpentines that stretch from the Vermont boundary to Gaspé, and in the past, at various times, small quantities of the ore have been mined and shipped, but the total output from the time of the discovery of these deposits to the present year is perfectly insignificant.

There are at present, however, indications that the raising of chromic iron may become an important industry in this district. The writer has examined the deposits that are now being worked at Black Lake, and has studied the occurrence of this ore in California during a professional visit to that State in June and July of the present year. The object of this paper is to clearly set forth the character of the ore, its mode of occurrence and uses, with a view to enabling the prospector and the miner to avoid those snares that have befallen other Canadian mining industries in their infancy. Take our phosphate for example. It is well known that in one or more cases tons of pyroxene were, by mistake, mined for phosphate. And again shipments of valuable mineral were sold at a loss simply because they did not come up to the required grade, and this simply because of a lack of care in dressing or in sampling the lot. It is to be feared that unless care is exercised similar costly mistakes will be made in connection with chromic iron. I repeat that the object of this paper is to furnish information that will enable those interested in this mineral to avoid such costly mistakes.

Chromic iron, or chromite, is a compound of chromic oxide and ferrous oxide together with variable proportions of magnesia, alumina and silica. It is the only important ore of the metal chromium, and its value depends of course upon the quantity of chromic oxide it contains. Chromite as usually found is a massive compact mineral, possessing a granular or sometimes a slatey structure. Its color is iron-black or brown-black, and its streak or powder is decidedly brown. Chromite is sometimes magnetic, but my experience with Canadian ores is that the high grade ores are not magnetic. Chromite has a hardness of 5.5, and a specific gravity of 4 4, that is, it is about twice as heavy as ordinary serpentine.

Our ore may be distinguished from magnetic iron, which is the only common mineral it resembles by the fact that its powder is brown whilst that of magnetite is black, and also by the fact that the chrome ore gives, with borax, a beautiful emerald-green glass before the blow-pipe.

Chromite occurs usually in serpentine, not in beds or veins, but in detached pockets, but sometimes these pockets seem to have been deposited along certain definite lines. This is the case in the Lambly and Robichon properties at Black Lake. The ore pockets vary greatly in size, some being exhausted by a single shot, whilst others yield hundreds of tons. Mr. Lambly has taken nearly 500 tons from one pocket, which is not yet exhausted. As a rule, however, the pockets do not persist to any great depth, and in California it has been found that the ore does not improve with depth, but rather contrariwise.

The principal uses of chromite ore is the manufacture of the chromates and bichromates of potash and soda, and the preparation of chrome steel, an alloy of iron and chromium very valuable for special purposes on account of its great hardness.

But not all chromic iron is acceptable to these users of the ore. Ore containing less than 50 per cent. of chromic oxide is not desired, although, I believe, in certain cases, 48 per cent. is accepted. There are only two important manufacturers of chromates in America, viz: the Tyson Co., in Baltimore, and the Kalion Co., of Philadelphia, and these companies pay at present about $26 per long ton for 50 per cent.

ore delivered at their works, which is equivalent to about $20 per long ton at Black Lake.

Now, whilst deposits of chromite are by no means rare, it happens, unfortunately, that but few—very few—of them are capable of producing ore of 50 per cent. chromic oxide. I have analysed a number of samples from various parts of this province, and only those from the Black Lake district have been up to the mark, the others ranging from 35 per cent. to 46 per cent. Selected specimens from Black Lake have analysed as high as 56 per cent., and Mr. Lambly informs me that the only shipment for which he had received returns averaged 51 per cent.

The question arises: Are chrome ores of less than 50 per cent. valueless? The answer must be, in their natural condition they are practically valueless at present. Recently, in California, attempts have been made to concentrate or work up the low grade ores to the market standard. Certain low grade ores are intimate mixtures of chromite and serpentine, the latter being much lighter than the chromite. It is on this fact that the system of concentration is based. It consists in crushing the ores to a fine powder and passing them over vanners or concentrators. Certain ores lend themselves readily to this system of concentration; for instance, a crude ore of only 24 per cent. has been dressed up to 50 per cent., whilst on the other hand some ore of 40 per cent. could not be dressed to grade over 42 per cent. The success of the operation depends upon the nature of the foreign matter associated with the chromite.

In conclusion, permit me to note two points on which special emphasis should be laid by those who are interested in this mineral, or may contemplate engaging in mining it: First make sure that your ore is up to the standard, that is, that it contains 50 per cent. chromic oxide. Secondly, remember that although a hand specimen may test over 50 per cent., it does not follow that the ore in shipping quantity will test as high. It is almost certain to test notably lower; indeed, it will be found that very careful dressing or cobbing is necessary in order that large quantities, say car loads of the ore, do not test lower than 50 per cent. If selected hand specimens test not over 51 per cent. any miner knows that his ore as a whole will test considerably lower. And finally, if I may venture on a third point, permit me to say that no single fragment can possibly represent a pile of ore, and in taking a sample take a large number of small pieces chipped from all parts of the pile, from rich and poor masses alike, indeed, I would say, let your sample whether it be sent for analysis or to a buyer, be rather under than over the average of the pile. In the end the results will be none the less satisfactory.

CHROMIC IRON IN QUEBEC.

By J. OBALSKI, M.E., Inspector of Mines.

The occurrence of chromic iron, or chromite in the serpentine rocks of the Eastern Townships, has been known for many years, and it is mentioned by the late Sir William Logan, in the Geology of Canada, for 1863. eleven tons of over 50 per cent. having been then shipped to Glasgow at a price of $52 per ton. Ten years ago a few tons were extracted from Lot II. Range 24, of Wolfestown, and, in 1887, Dr. James Reed made a shipment of from 4 to 5 tons, low grade ore, from Lot IV. in the 16th Range of Thetford, and 40 tons of 52 per cent. from Lot X. in the 1st Range of Leeds. At the same time specimens sent to the Antwerp Exhibition attracted much attention and a demand for the mineral was created; but owing to the small size of the deposits then known nothing eventuated. In April last (1894) a good surface show was discovered at Black Lake Station on the Quebec Central Railway, and specimens having been forwarded to Baltimore, it was established that owing to the fair price offered and the facilities for working and shipping it would become a profitable business. With such encouragement prospectors took the field. Other discoveries were made and a little excitement followed.

Chromic ore is found in irregular pockets and only in the serpentine rock. I will recall then that the main belt of serpentine which runs through our province and contains the well known asbestos mines starts from the south of the 5th and 6th Range of Bolton, forms partly the mountains of Orford, passed east of Brompton Lake, and in the Ranges 5 and 6 of Melbourne, 14 and 15 of Cleveland, appears in Shipton (Jeffrey's Mine), Tingwick, Lot XI., 21, Ham, north and south, near the

Nicolet Lake, Garthby, and takes a large development in the south-east part of Wolfestown, forms the mountains of Ireland and Coleraine by Black Lake and Caribou Lake with a branch to the little lake St. Francis and Adstock mountains. It comprises the important asbestos mines of Black Lake and Thetford, passes in Thetford and Brompton and is met on the rivers des Plantes and Echemin. No more serpentine is then noticed except in Gaspesia, forming a large mass at the head of St. Anne River and at least on the Darmouth River. On the course of that formation chromic ore has been noticed, especially near the lake Memphremagog, in Bolton VI. 27, VII. 13, 23½ W.; Melbourne, VI. 22½ N.E.; South Ham, I. 27, II. 4, 20; Garthby, I. A. B. I.; Island of Breeches Lake, V. 35, 36; Wolfestown, II. 24½ N.W., VII. 23, 24, 25; Coleraine, Block A., near Black Lake Station, X. 19, XII. 8, XIII. S. 7, 8, IV. 25, III. 25, II. 26, B. 3, 6, and on the Mount Albert in Gaspesia. All those deposits are of variable importance, and in some places like Memphremagog Lake and Mount Albert, only loose rocks detect them. As a rule the chromic ore appears at the surface of the serpentine as a form of black sponge, which sometimes is only superficial or penetrates in on a width of few inches which can increase as far as several feet. Sometimes, too, the ore appears at the surface in its largest dimensions. Loose rocks in the earth are also considered as an indication of a deposit in the vicinity. This ore is in pockets of variable sizes and forms very irregular and disappears suddenly without any trace for further investigation. I have not remarked any kind of walls except the ordinary slides in the serpentine rock.

I will give some details on a few of those deposits. 1st. Several shows exist in the part of Block A. of Coleraine, situated between the Q. C. R. and Lot X. 19, and near this one. The most noticeable and first discovered has been developed by M. Nadeau & Co., and latter by M. Lambly & Co. The ore appears there but little mixed with serpentine on an area 10 x 30 feet, with same indication at a distance of 200 feet N.E. At a depth of a few feet the pocket was exhausted, having produced about 500 tons, of which a shipment of 250 tons sent to Baltimore yielded 50.3 of sesquioxide of chrome.

Another pocket on an adjoining property at about 400 feet N.E. shows also some good indications, but has been but very little worked. On the same block near the Black Lake some valuable deposits have also been found.

Lot 19½ N.W., in the 10th range, belongs to Dr. J. Reed, and at a little distance from the above deposits several shows are opened by small parties of miners, the most important being the one of Mr. J. Lemelin & Co., who works in from different places, one of them showing a width of 4 feet. 150 tons have been taken out, of which one car (18 tons) has been shipped to Philadelphia and four to Pittsburg. At some distance N.E. another good show is developed by M Frechette & Co. from which 30 tons have been extracted.

Lot II. 26 has been bought recently from the Government by M. M. Leonard, Morin and Labreque, who will develop it on a large scale. This deposit is very remarkable, showing solid chromic ore 60 by 150 feet, with important indications connected with the main body at 50′ N.E. and 100′ S.W. From a small opening 5 feet deep, more than 100 tons of good ore have been extracted by only a few shots. So far it is impossible to appreciate its depth, but the ore has been found at a difference of level of 20 feet In admitting the depth corresponding to the other dimensions we find that we have there a considerable quantity of ore, which will be of great value if it only reaches the standard. This mine is six miles distant from the Q. C. R. between the stations of Black Lake and Coleraine, and the company is just building a road for getting it. The above described deposits are all in the Township of Coleraine. The quantity of ore extracted represents about 850 tons, of which 270 have already been shipped to Baltimore, 55 to Philadelphia, and 70 to Pittsburgh.

Distinctive Characters.—The chromite has a specific gravity of 4.5 representing about 7 cubic feet per ton in situ. Its hardness is 5.5. It gives a brown strike and dust of the same color. Some mineralogists pretend that it is magnetic, but I have not remarked this fact in our province, although I have found specimens of magnetite yielding some chrome.

Its composition is of sesquioxide of chrome and protoxide of iron; nevertheless, the elements chrome and iron are often partly replaced by alumina and magnesia, which lessen the percentage, beside the mixed serpentine easily discerned. Theoretically it would contain 68 per cent. of sesquioxide, but it scarcely yields over 56 or 57 in picked specimens and 53 to 54 in cargoes. The commercial grade is 50 per cent., but 49 and sometimes 48 is accepted. Below this it is considered as low grade

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ore and not used for chemical purposes. The Black Lake ore gives 49.8 and 50.3 on cargoes (analysis of Baltimore chrome works), and 54 and 56.02 on picked specimens (analysis of Donald).

Uses.—Chromite is mainly used for manufacturing bi-chromate of potash which is employed for calico printing, for making pigments called chrome yellow, orange and green, in the construction of electric batteries and in chemistry. Chrome in alloy with other metals communicates to them its hardness, elasticity and unalterability, and now it is quite extensively used as ferro-chrome for manufacturing steel armor plates, special hard tools, stamp shoes and dies, safes, etc. It is proposed too for hardening alumina.

Sources.—Chromite is always found in connection with serpentine, and the main producing countries are, or have been, Syria (Asia Minor), New Zealand, New Caledonia, which produced high grade ore. Some Some chromite is also obtained from Austria, Greece, Norway, Russia, and Australia is reported as containing important deposits, but difficult of access. There is some, too, in Newfoundland. In the United States, Pennsylvania and Maryland, have been as far as 1880 and for many years, large producers of this ore, while California contains important deposits, but of low grade ore (38 to 47%), and of difficult access. Nevertheless, they can be concentrated there and sent after in a granulated form with a percentage of 50 per cent and over.

Market.—In the United States there are two companies manufacturing bi-chromate: the Baltimore Chrome Works (Jesse Tyson & Son), Baltimore; the Kalion Chemical Co. (Harrison Bros.), Philadelphia. The following companies are using chrome for metallurgical purposes: Brooklyn Steel Chrome Company, Brooklyn; Bethlehem Steel Company, Bethlehem; Carnegie Steel Works, Pittsburg.

In Europe there are several manufacturers in England, France, Norway, Russia, but we have no information regarding them. Glasgow (Scotland) seems to be the most important place for chrome manufacturing, and I will mention as purchasers: John Nelson Cuthbertson, Stevenson and Carlyle, J. & L. White. It is worthy of mention that for metallurgical purposes the low grade ore can be used, it is said as low as 40 per cent.

For the United States, the manufacturers of Baltimore and Philadelphia give $26 per gross ton (2,240 lbs.), delivered, for 50 per cent.

and over. For a few years there was a duty of 15 per cent. *ad valorem*, representing $2.90 per ton, but with the Wilson bill this duty has been removed and chrome ore is now on the free list. The freight is $5.50 from Black Lake to Baltimore, and $5 to Philadelphia. The cost of carting from the mine to the railroad ranges from 25 cents to $2 per ton, and mining and hoisting vary from $1 to $8, leaving then a good margin for profit.

I am not well informed about the European market, but I understand that in Glasgow they pay $22.50 per ton delivered, the freight amounting to $4.50.

According to the "Mineral Industry" the price in Europe would be £5.10 per ton of 50 per cent. with a rise of 5s. per unit. In the United States the price paid for Turkish ore would be: for 48 per cent. $26, 50 per cent. $27.50, 52 per cent. $31.80, 54 per cent. $34.50. The production of the United States in 1893 would have been 1,620 tons, and the importation 6,354 tons, total 7,974 tons. The manufactures of bi-chromite require from 5,000 to 6,000 tons.

I don't know what the consumption in Europe is, but from what is said above, the market and the demand for chrome ore appear to be favorable, our deposits being in the best condition for working and shipping. At date, the annual consumption of chrome ore for commercial purposes is from 10,000 to 12,000 tons.

The present paper has been prepared at the request of the President of the Association, after only a few days of notice, which explains and may excuse its elementary form. For better information on the subject, I refer to a very good article of the "Mineral Industry for 1893," in which I have found a good deal of facts. I must mention, too, the information I have obtained from Dr. J. Reed, one of the first exporters of Canadian chrome ore, and from Dr. W. Glenn, of the Baltimore Chrome Works.

As a conclusion, I will recall the irregularity of those deposits, which make their exploitation an investment favorable only under certain conditions.

DISCUSSION.

MR. BLUE—What is the difference in the specific gravity between chromic iron and gangue?

MR. OBALSKI—Between 3.20 and 4.50.

Dr. Reed—The papers just read are very exhaustive and cover the whole ground. People have an idea that chromic iron is generally found in small pockets. I believe that to be a fallacy. I have been told by parties who have mined in California and the States that they found very deep pockets, five hundred feet, and chromic iron there. You can find pockets in a certain strike in the rock; you go along a mountain and find five or six pockets all in one stretch. You go off that stretch thirty or forty yards north or south and will not find it. Large portions of this ore will be found in veins. If that can be found correct, we will be able to mine chromic iron as we do other minerals. You will find at Coleraine the pockets nearly touch each other. The most important thing to miners is the acid. We sent to Baltimore a car load of chromic iron. They say: this is forty-eight per cent.—and you must take their word for it. Now, that is a bad position to be in. You notify them to come and examine what you have and say what it is worth. They say: you must send it to us, and take whatever we will give you. See how much better it would be to send it to Glasgow. In Glasgow they have an official analyst who examines not only chrome but other minerals, and his assays are binding on both buyer and seller. Why should not our Government be able to furnish correct assays for our people, so that when we who have a large quantity of ore to send away the certificate of our Government would give the quality of our ore? I would suggest that our Secretary correspond with the Government upon that subject that we may have a proper chemist who will certify as to the quality of our ore, not only chrome, but other ores, so that we will not be at the mercy of the buyers, and that we may be in the same position in regard to ores as in regard to timber. We sent a carload down to Philadelphia. They wrote back that the ore was only forty-eight per cent. We had to take their word and reduce the price so much a ton; and the same thing occurred in regard to our Baltimore shipments. I believe ores as low as forty per cent. can be sold to mix with iron and steel.

Mr. Obalski—I noticed at St. Francis a very large pocket. I do not suppose that chromic iron is found in regular veins. Sometimes some inside pockets can be found, which could be tested by a diamond drill. I agree with Dr. Reed as to having an analyst appointed by the Government, and I think we should have a Bureau for this purpose, and a certificate could be issued by the Government.

MR. B. T. A. BELL—I have argued for a long time that our Mining Bureaus should give more attention to the commercial aspect of our mining industries.

MR. GEORGE DRUMMOND—My friends, Dr. Reed and Mr. Bell, have made a good point with reference to the appointment by the Government of an analyst, but I cannot see how that is going to bind the American buyer. The latter will be bound, not by the Canadian chemist, but by his own chemist. I think it would be well for those gentlemen if each had his own chemist, and then a sample could be sent to some independent or neutral chemist in the United States, as a safeguard against the courts later on, so that his certificate would be just as good as the certificate of the buyer. Buyers in the United States are more competent than gentlemen mining in Canada to tell the correct percentage of ores. We have got to meet our customers and admit that they are honest until we find them otherwise. There are only a few buyers in the United States, and they are not likely to defraud wilfully. I think Mr. Donald and Mr. Obalski have pointed out a few facts we ought to look at squarely. There is a tendency which almost every miner, particularly those who own property which they desire to sell to some unfortunate speculator or financial men—there is a tendency to go down and pick out the best specimen and say: There! that is a fair sample of my mine? With regard to Black Lake, I had a gentleman call on me the other day with a very fine specimen, and he said he had "mountains of it?" Dr. Reed says you have very large pockets, but he has not said as much as the gentleman I have just referred to. I think the concensus of opinion is that in the majority of cases chromic iron occurs in pockets, and although it is a good thing to push our mines to development, I think it would be wisest for those going into these mines to go very cautiously. They should be very careful in the selection of their ores and in the amount of money put into these mines until it is proved that there is a large supply.

MR. JOHN J. PENHALE—Mr. Obalski mentioned the cost of carting chrome as 25 cents to $1 per ton, and the cost of mining from $1 to $8 per ton. I would like to know how that is arrived at.

MR. OBALSKI—I mentioned the case of Lake St. Francis, lot 26. I was there myself and saw the place. After making inquiry, I estimated that it would not cost more than one dollar for carting. Eight dollars would also be the maximum for mining.

MR. JOHN J PENHALE—Would that be a fair statement to put be-before the public? Is it fair to suppose that the miner is mining at as high a cost as he ever will mine it? If he has to pay a royalty, and the cost of mining is eight dollars, and the freight five dollars and fifty cents, and there is a duty of 15 per cent., he would be left a very narrow margin.

MR. BELL—The duty has been taken off.

CAPT. BENNETTS—I went out to examine these chrome mines, and the first question I considered was the geological question. Was it serpentine? And if so, is that serpentine congenial to the deposition of chrome iron? I found it was. These ores are in pockets. The quantity of ore raised has been considerable, considering the amount of work done—between 900 and 1,000 tons—and by the returns of the United States they raise there 1,200, so that gives me the idea that these ores are worth not only recognition, but searching after. So far, they appear to be of great value. The occurrence of the mineral covers a wide area, extending from Black Lake into Coleraine. I should like to ask Mr. Obalski if he noticed any other minerals that might be of value to the prospector in connection with serpentine.

MR. OBALSKI—In Bolton there is a great deal of magnetite.

MR BLUE—I hardly agree with Dr. Reed in his suggestion of a Government analyst for determining the value of chrome iron and other ores. If a man has an article to sell, and another wants to buy it, they ought between themselves to establish a value. As to finding the proportion of valuable metal in ores—say, the amount of iron in these minerals—there is no difficulty whatever in taking a sample and having a public analyst, of whom there are plenty in Canada and the United States, make a complete analysis I do not see what the Government has got to do between the private transactions of two persons. In our copper business we do not have the least bit of trouble, and I do not see any difference between selling copper and chrome iron. We sometimes have a little argument, but no trouble in having it ultimately settled If the assayer of the buyer does not agree with the assayer of the seller, a third party can be called in. In regard to low grade ores, it is claimed that ores under 50% are not of much value, and Mr. Obalski says the specific gravity of the chrome iron is 4.50 and of the rock about 3. This being the case it would not be difficult to establish a system of concentration that would bring up low grade ores to the required standard.

MR. GEO. DRUMMOND—In selling chrome, as a safeguard, why not sell it so much per unit? You will have to determine the unit by having your own chemist and a corresponding chemist in the United States. I ship goods to a man and he says he receives only 990. Who will settle the difference? You must fight that man in the courts. These differences will arise and no government can help you out. A great many young men come out of our colleges every year as trained chemists—some of them members of this Association—are you going to shut them out because you want to appoint a government official? If you find that a man in the United States has been acting badly and been trying to cheat you, why, find another buyer.

DR REED—The laws of England are pretty good laws, and based upon justice, and if it is right and proper for the British Government to appoint Dr. Clark to assay ores and weigh them, why should it not be right for our Government to appoint one here?

MR. DRUMMOND—Dr. Clark will not be bound by any Government chemist appointed here.

DR. REED—I know of a case of an American who took Dr. Clark's decision as final.

The meeting adjourned at 11 o'clock p.m.

REPAIRING ROCK DRILLS.

By A. SANGSTER, JR., Sherbrooke, Que.

It is to the interest of every drill user to keep the repair bill as small as possible. The Canadian Rand Drill Co. believe it to be their interest also to have their drills require few repairs, and in the following suggestions the writer would endeavor to show how a drill can be made to last longer and do more work The repairs will refer more especially to those for which it is necessary to send a machine, or part, to the shop.

In nearly every case of a drill coming in for repairs, we find the cylinder worn in the bore from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch (mostly on the bottom side, from using the drill in a horizontal position), so that it will require to be bored $\frac{1}{8}$ to $\frac{1}{4}$ of an inch larger.

The rings are generally worn out.

The split bushing for the lower head, and the stuffer, are generally worn 1/8 or more, and the piston (barring accidents) usually in good condition; in fact, it is a common occurrence to get a piston that has been in use for years, not worn more than 1/64 inch in diameter, running in a cylinder 1/8 inch larger.

The drill is often accompanied by an order to re-bore cylinder and put in new rings, or larger rings; but the lower head is considered good enough.

As the cylinder is one of the most expensive parts of the drill, we should consider how to prevent this excessive wear. It is the opinion of the writer that it could be prevented by putting in a new split bushing in the lower head when that part wears out. It is very evident that when the bushing is worn so loose it no longer forms a guide for the rod, and all the wear caused by the drill bits being out of truth, or by the drill moving on the mounting, comes on the piston and cylinder, and the cylinder being the softer suffers most.

Some drill repairers recognize and try to prevent this wear, and keep a guide on the rod by putting in a new stuffer, but it is designed only to tighten up the packing, and will not take the place of the bushing, which is a steel casting and has a bearing surface nearly four inches long, while the stuffer is of malleable iron and has a bearing only 2 inches long.

The bushing is held in place as solid as the cylinder itself, by a projection into the cylinder, a large shoulder on the cylinder, and firmly clamped in the lower head, which is pulled up tight with the side rods; while the stuffer is only held in place by being pinched on the threads, a bearing of about one inch. This soon wears itself loose (and the threads in the lower head as well), when this extra duty is imposed upon it.

We supply at least ten stuffers to one lower head bushing, and as many cylinders as bushings, yet if the bushing was renewed in time a new stuffer would be unnecessary, and the cylinder would last much longer; and this bushing might be renewed five times for the price of a cylinder.

We will now consider how to repair a cylinder already worn out as described.

When the piston or cylinder of your pumps, hoists, or compressors is worn too loose, you have the cylinder re-bored and a new piston made to fit, at a comparatively small expense; but in a rock drill, where the piston with the rod and chuck are all one piece and the most expensive part of the drill, the case is quite different.

To re-bore the cylinder 1/8 inch larger requires a collar on the ratchet box and on the lower head bushing, to fit necessarily enlarged counterbores. If this is done and only larger piston rings put in, it is not worth the doing, as we have then only 3/4 in. bearing at each end of piston, that is the width of the rings, which will wear out and be as bad as ever with a few days' use.

If a new piston is made for the re-bored cylinder, it is the most expensive and troublesome way to repair the drill, as the part saved (the cylinder), is the cheaper of the two. This also requires the collars in counterbores. Then, in the Little Giant Drill the piston is too close to the rocker pin hole, by one half the amount bored out. This necessitates reducing the rocker on the face, and as it is tempered it is a difficult job, and could not be done nicely outside of a machine shop without considerable time and trouble. This difficulty is not confined to the Little Giant Drill, but occurs in any drill in which the valve is moved by mechanism in contact with the piston.

It would be better and cheaper to put in a new cylinder. If necessary the piston can be trued up, and the new cylinder made a little smaller to fit.

The only way an old cylinder can be economically repaired, and a way which is made a regular practice in some of the American mines, is to bush the cylinder with a brass tube. These can be obtained drawn the standard size of the cylinder, and if the piston is not worn much, a good fit can be made, with all parts standard size, which is a matter of great convenience at the mines when it is desired to exchange parts from one drill to another.

The cost of boring and lining the cylinder the first time would be less than half that of a new cylinder, while to renew the lining would be less than one third.

Of course it cannot be expected that the brass lining will last as long as a new cylinder, but it can be renewed as often as desired.

A point in the Little Giant drills where much loss of power can be prevented, is in the rocker. With the wear on both points of contact with the piston, the ball of the rocker, the hole in the slide valve, and the dropping away of the piston itself there is sometimes in an old drill, a very small port opening. This can be remedied by swaging out the rocker, as well, and even better, than with a new rocker, as it can be drawn a little more to allow for the wear in the other parts. But it is a fine job, and could not be done by every drill sharpener; but in the hands of a good mechanic it is one of the best ways to liven up an old drill. We usually swage the rocker on every drill that comes in for repairs, and have had old rockers sent in to be swaged.

We use, in repairing an old drill or in setting up a new one, a skeleton valve, which is simply an ordinary slide valve, with the port cut right through so as to show it working on the seat.

By leaving the steam chest off, and moving the piston backward and forward by hand, we can see exactly what port opening the drill has, and in swaging the rocker can see where to draw it so as to give full and equal port opening at both ends of the stroke.

I would recommend that every repairer have a skeleton valve, and examine the drills with it when they come out of the mine, and not wait till the drill gets weakened in its action.

At some mines, after the slide valve and seat have been used as long as they will work, they are thrown aside, and new ones put in.

This is unnecessary, as a valve seat can be planed up as good as new several times. The same with the slide valve; but as it can be dressed as cheaply with a file as on a planer, it can be done at the mines. The recess or steam passage must be looked to and dressed out to its original depth, otherwise the steam or air would be throttled at this point.

A customary way in which the drills are abused is by pounding on the piston rod or chuck with a hammer or bar, when for any reason the drill gets stuck in the hole. With our hexagonal chuck there seems to be no excuse for this undue punishment of the piston. And the fact that some pistons which have been out for years, even without the hexagonal chuck come in with very few marks upon them, plainly shows that it is not necessary.

About a year ago we repaired several chucks which had been pounded out of all shape, some of them right through to the bushing, and all of them allowing the bushing to project from an 1/8 in. to 1/4 in.

These are repaired by turning up the end as large as possible, and shrinking and pinning a steel collar on about 1 in. or 1 1/4 in. wide. The collar was bored to fit the bushing at one end, thus lengthening out the hole of the bushing. They were held in place by two large pins screwed and riveted in parallel with the rod, and several put in diametrically. Upon inquiry last week it was learned that they were giving good satisfaction.

The annoyance of nuts working loose can be prevented by using lock washers which we now put under each nut on all drills. They also make practicable the use of a Pawl stud, which many prefer to the stud we regularly put in. It has a long taper head, fitting in a reamed hole in the ratchet box, and passes right through the cover, and has two nuts with a lock washer between them. The first nut is to make a close joint about the hole; the washer and second nut to keep it from slacking back. These, or the regular studs can be put in any old ratchet box, no matter how large the hole may have become, by plugging it and making a fresh hole for the stud.

In the progress which has been made in the construction of rock drills better material is being used, parts which were once made of cast iron have for several years been made of malleable; amongst them the steam chest and ratchet box, making the breakage of those parts a rarity. In fact the cylinder and valve seat are the only parts of the Little Giant Drill which are made of cast iron.

Great care should be taken to see that the drill is oiled regularly with a good quality of lubricating oil. From the rough nature of the work for which this class of machinery is used, this important point is often overlooked and by using an inferior oil, through misrepresentation or from a sense of economy, a plant which has been laid out with expert engineering advice and the best machinery put in, is often seriously crippled.

DISCUSSION.

MR. GEORGE R. SMITH—In expressing an opinion upon Mr. Sangster's paper I should exercise great care, for it is entirely, I presume, based upon his acquaintance with the Rand machine; and, as you all know, my ideas are founded upon experience with the Ingersoll make. The valve motion of the Rand is entirely different from the Ingersoll, there being no tappet. The bushing of the cylinder is a new idea to me. Is his idea that the company who furnish the drill furnish the bushings?

MR. SANGSTER—Yes.

MR. GEORGE R. SMITH—The trouble is, I think, that the bottom side of the cylinder is usually worn more than the top side. The latter would either have to be bored out a little to take the bushing, or the bushing would have to be tapered to be put in. How can we use this bushing without re-boring the cylinder or getting a taper brass lining? Would not the cylinder have to be re-bored to take the brass lining?

MR. SANGSTER—The cylinder would have to be re-bored the first time. Afterwards the bushings would be renewed without re-boring.

MR. GEORGE R. SMITH—Of course, the only point is that you could use the old cylinder; but I think the idea a new one and a good one.

MR. BLUE—How is the bushing kept in place?

MR. SANGSTER—It has such a long fit in the cylinder that the danger of moving would be very slight. It could not move sideways, as the heads and two pins screwed in and rivetted over would prevent its turning round.

MR. BLUE—Would it not be possible when a cylinder was in the shop to bore it out a certain size and get several bushings, all fitted for that size, and when sending the drill back to the mine owners send several bushings at the same time.

MR. SANGSTER—Yes; the bushings would all be the same size, and a cylinder once re-bored a bushing could be exchanged.

MR. L. A. KLEIN—The economical part of the question has not been referred to. Have you, Mr. Sangster, made any practical test of your theory? How long will such a brass bushing stand?

MR. SANGSTER—A practical test has been made at some of the American mines. I have only had experience in bushing one cylinder. I never heard anything against its use.

MR KLEIN—Would it not pay better to have a new cylinder instead of putting in four or five bushings? How would that compare?

MR. SANGSTER—The cost would be less than one-half to bush it the first time, and less than one-third to renew the bushing. Many mine owners are averse to putting in new cylinders. They wish to use out the old parts.

Mr. Klein—Wrong tactics!

Mr. Sangster—No doubt a new cylinder is the best method. But how many are there who will do that?

Mr. F. P. Buck—We would all do it if we knew it to be cheaper.

Mr. L. A. Klein—Is it not better to have a new cylinder than new bushings, and be obliged to renew these brass bushings so often?

Mr. Sangster—My argument is that the old cylinder can be used economically.

Mr. S. L. Spafford—My experience is that after a drill gets to a certain stage, when the cylinder is worn and the piston is worn, and the general repairs would be heavy, it is better to get a new machine than try and patch the old one up. Such a policy is a saving in your fuel, and I do not believe in bushing old machines. It is possible that bushing a cylinder is a good idea; but I think that if the cost of bushings were taken into consideration, and the time of repairing the machines, it will be found that it did not pay. Brass bushings wear out rapidly.

Mr. Blue—I think if the manufacturers of drills would be content with a moderate profit, on the manufacture of drills, say if they would give us a drill for something like 25 or 50 per cent. on the cost, it would be the wisest plan for all users of steam drills to throw them away after the first six months' work and get new drills. I have always found the first six or eight months' work of drills the best work, and not very satisfactory after that time.

Mr. George R. Smith—We all ought to feel very grateful to Mr. Sangster for having introduced such a subject. If there is a sore point among mining men it is that of repairing drills and drill parts.

Mr. Blue—The use of better oil is a good suggestion by Mr. Sangster. A drill is the worst used piece of machinery on the face of the earth.

Capt. Bennetts—I have been using these drills some two hundred miles from a machine shop; and in such a case as that, many points of Mr. Sangster's paper would come in usefully.

Mr. A. Sangster, Sr.—I think there is not enough care exercised in the choice of oil. Agents will come along sometimes and offer you an oil at a cheap rate, telling you it is of the same grade and quality as the best. But instead of this cheap oil keeping the machinery lubricated, the machinery begins to cut, more especially in the case of cast iron. We always try to get the best oil; and when we once get a good grade of oil, we keep to it, no matter what agent comes along. I think there is a great deal in the oiling of machinery to keep it running longer than it ordinarily does. I am not acquainted with any kind of drills, but simply with the running of machinery so far as oil is concerned. That one point has been very well taken by Mr. Sangster.

MR. SPAFFORD—What do you consider, Mr. Sangster, the usual cost of repairs per month?

MR. SANGSTER, JR.—I refer you to Mr. Jenckes, and to those who use drills, on that question.

MR. L. A. KLEIN—We have had a few American and Canadian machines. Our repairs in the first year, on five machines, did not amount to more than $42, using them all the time, two of them underground and three at open work. But in the interests of drill manufacturers, I do not like to mention what they cost afterwards.

MR. BLUE—That bears me out.

MR. GEORGE R. SMITH—Mr. Spafford's question is a hard one to answer. With us a drill will last longer than in the copper mines. Our rock is solid. A seamy rock seems to break the drills up much quicker than a good straight stratified rock. Another great point is the operator. You can give a new drill each to two men. One man's drill will be in just as good condition at the end of six months as at the beginning; while the other man's drill may have cost in that time six or eight, or sixty or eighty dollars, according to the manner he used it. It depends on the rock and the man who is running the machine.

MR. KLEIN—The difference in cost of repairs between machines run by compressed air and machines run by steam is very considerable. With steam, you break a machine in about half the time that you do one with compressed air. I have been using both on the same ground, with the same men and conditions, and the steam does not stand half the time. There are certain parts which seem to break away, and at certain points.

MR. S. W. JENCKES—I never heard of any difference in working between steam and air, unless there was greater pressure used by steam than air.

MR. KLEIN—We carry eighty and ninety pounds, steam and air.

MR. S. W. JENCKES—Would your pressure be the same?

MR. KLEIN—Not exactly the same, on account of the difference in length of pipe line. 1,800 feet of pipe line, used in the case of air, naturally reduced the pressure ultimately on the machine, while the steam gets nearly the full benefit of the ninety pounds. I know Mr. Halsey fully admitted the repairs to be considerably higher in the use of steam; and his explanation was that it was due to the heating of the drill.

MR. SANGSTER, JR.—Certainly, repairs are greater in the use of steam.

MR. KLEIN—It is not more expensive at the same time to run with steam, though the repairs on a drill are higher. For the ultimate cost of a foot drilling where there is a possibility of running with steam in open works, is considerably lower than using compressed air. We can well afford to repair drills and use steam just the same.

The hour being late, the Secretary moved the adjournment of the discussion, which was carried.

EXCURSION TO THE COPPER, CHROMIC IRON AND ASBESTOS MINES.

Favored with the best of weather, the members drove to Capelton, on Thursday, 27th Sept., and spent a thoroughly enjoyable day as the guests of President and Mrs. Blue. A considerable portion of the time was spent in a profitable inspection of the surface plant of the Eustis mine and in examining the extensive underground works for which it is famous. (For a full description of the operations carried on here, see Vol. I, pp. 387-94.) A *recherche* luncheon, given by Mr. and Mrs. Blue, was served in the Club House. The adjacent pyrites mines of the Nichols Chemical Co., with which are connected extensive works for the manufacture of sulphuric acid, chemicals and super-phosphates were not thrown open to the inspection of the Association, for business reasons, but as the character of the ore and the conditions of its occurrence are the same as at the Eustis mine, both properties being located on what is regarded as the same vein, the real object of the visit was obtained. Too much cannot be said for the geniality of the hosts of the day, who were untiring in their efforts to make everything thoroughly pleasant, and it is needless to say, judging from the delighted remarks of the party, they succeeded admirably. The drive home, over fine roads and through a delightful stretch of picturesque country, was greatly appreciated by all, Sherbrooke being reached in time for supper.

Delightful warmth and glorious sunshine favored the members for their excursion to the mining districts, on the line of the Quebec Central Railway, on Friday. Mr. Frank Grundy, the general manager of the line, courteously placed a special train at the disposal of the members, a token of his good will to the mining fraternity, which was heartily appreciated. A start was made at nine o'clock, the first stop being made to permit an inspection of the important pulp and paper making industries at East Angus. Then a pleasant run through the charming scenery of the St. Francis Valley, brought the members to the quarry and works of the Dominion Lime Co., Ltd., at Dudswell. About 100 persons are employed here. There are ten kilns and the output when running full time is about 150 tons. The face of the quarry is abont 150 feet in height. The lime is celebrated for its great purity, and is surpassed by that of no other lime works in Canada or the adjoining States, the amount of foreign matter being not more than one per cent. The train was soon again in motion for the run to Black Lake, and in order to lose no more time, a lunch, embracing everything that could be desired was served on the way, the fresh air and exercise and the universal feeling of good-fellowship causing everyone to appreciate the good things provided to the fullest extent. Choice bits of scenery abounded, and the run to the chrome workings—they can hardly yet be called mines—which were reached about one o'clock, was enjoyable in the extreme. The members, under the guidance of Dr. Reed, Mr. Lambley and Mr. Robichon, were soon scattered about the various pits and trenches that have been opened recently on the hillside in close proximity to the railway, and from which several hundred tons of chromic iron of excellent quality have been mined. The nature and occurrence of these deposits are fully described in the papers by Mr. Obalski and Mr. Donald, reproduced elsewhere in this volume. A stop was made at Black Lake to visit some of the important asbestos mines, but the main body continued the run to Thetford mines, the headquarters of the industry, where the remainder of the day was spent with profit, examining the important works of the Bell's, Beaver, King Bros., and Johnson mines. The return trip was a fast one, Sherbrooke being reached shortly after six o'clock.

In the evening the members were entertained to dinner by the Hon. W. B. Ives, Q.C., M.P.

FIFTH ANNUAL MEETING.

MONTREAL.

9TH, 10TH AND 11TH JANUARY, 1895.

Session opened in the new Club Room, Windsor Hotel, on Wednesday morning, 9th January, Mr. John Blue, C. & M.E., President, in the chair. There was a large attendance. The meeting was called to order at eleven o'clock, when the minutes of previous meetings were read and confirmed.

THE SECRETARY'S REPORT.

Mr. B. T. A. BELL—Notwithstanding exceptional commercial and industrial depression which, unfortunately, has not been without effect upon the mineral industries of the province, it is gratifying to be able to report that the past year has been in many respects one of the most successful in the history of the Association.

The meetings have been well attended, the excursions full of interest and enjoyable in the extreme, while the numerous papers presented cover a wide field and have been instrumental in increasing knowledge of the art of mining and in spreading valuable information respecting the mining industries and mineral resources of the province and of the country.

By the death of Col. Lucke, we have again to lament the loss of a popular officer, and one who took a deep and energetic interest in all its affairs. The startling intelligence of the sudden and untimely event was received during the excursion to Cape Breton, and was a sad interruption to the enjoyment of the members. A meeting was convened on board the steamer, and a resolution entered in the minutes recording appreciation of his services, and expressing most tender sympathy with his widow in her bereavement.

At the Sherbrooke meeting, Mr. W. A. Allan, Ottawa, was unanimously elected to the vacant vice-presidency.

Meetings were held at Montreal on 11th and 12th January, when four sessions were held; on board the steamer Bonavista, en route to Cape Breton on the evenings of 6th and 9th July; and at Sherbrooke on 26th and 27th September.

During the year twelve papers were considered, as follows:—

1. "The Diamond Prospecting Drill in Mining Canadian Apatite and other Irregular Deposits," by Mr. J. B. Smith, Glen Almond.

2. "Mine Tunnels and Tunnel Timbering," by Mr. W. A. Carlyle, Montreal.

3. "Notes on the White Mica Deposits of the Saguenay District, Que.," by Mr. J. Obalski, Quebec.

4. "On the Igneous Origin of certain Ore Deposits," by Dr. F. D. Adams, Montreal.

5. "The Canadian Iron Industry," by Mr. George E. Drummond, Montreal.

6. "Ore Sampling," by Mr. J. T. Donald, Montreal.

7. "The Silver Mines of West Kootenay, B.C.," by Mr. E. D. Ingall, M.E., Ottawa.

8. "Slate: Its Formation, Extraction and Uses," by Mr. Harry Williams, Thetford mines, Quebec.

9. "The Magnetic Needle," by Mr. A. W. Elkins, Lennoxville, Que.

10. "Repairs to Rock Drills," by Mr. A. Sangster, Jr., Sherbrooke.

11. "Chrome Iron: Its Properties, Mode of Occurrence and Uses," by Mr. J. T. Donald, Montreal.

12. "The Occurrence of Chrome Iron in the Province of Quebec," by Mr. J. Obalski, M.E., Quebec.

As will be seen, these have been presented by three honorary and seven ordinary members, six of whom have contributed before.

A very notable feature of the year has been the interesting character of the excursions held under the auspices of the Association. By kind invitation of Mr. David McKeen, M.P., Resident Manager of the Dominion Coal Co., Ltd., Mr. R. H. Brown, General Manager of the General Mining Association, Ltd., and the officers and members of the Mining Society of Nova Scotia, a delightful and instructive holiday was spent in Cape Breton, visiting the collieries and other important features of that beautiful and historic island.

The programme included:—

An excursion by water to the various shipping piers on Sydney Harbor of the Dominion Coal Co., Ltd.

An excursion by special train to the Bridgeport, Dominion No. 1, International and Caledonia Mines of the Dominion Coal Co., Ltd.

An excursion by water to the Old Sydney Mines of the General Mining Association, Ltd.

An excursion by water to the historic port of Louisburg.

A drive to the Coxheath copper mines.

The members were entertained to a public banquet at Sydney by Mr. David McKeen, M.P., and to a luncheon by Mr. R. H. Brown at his residence at Sydney Mines.

The cordiality of the reception accorded to the Association by the officers of the various companies and the local authorities was such as is likely to be long remembered by those members who were present. The local committee, comprising Mr. McKeen, Mr. Brown, Mr. Blakemore and Mr. Archibald, made the most thoughtful, complete and satisfactory arrangements for the comfort and entertainment of our party, and special acknowledgment is due to them and to Messrs Kingman Brown & Co., agents of the Black Diamond Line, for special rates and excellent accommodation provided for the round trip on their steamer Bonavista.

The Autumn Meeting was held at Sherbrooke in September last, for the second time in the history of the Association, and was one of the most successful, alike as regards attendance, the number and importance of the papers, and the thoroughly enjoyable character of the excursions. At Capelton our members inspected the extensive underground works of the famous Eustis mine, and were entertained with characteristic hospitality by our esteemed President and his good lady, Mrs. Blue.

Our hearty acknowledgement is also due to Mr. Frank Grundy, general manager of the Quebec Central Railway, for his courtesy in placing a special train at the disposal of the members for the excursion on the following day to the Dudswell quarries and the chromic iron and asbestos mines on the line of his railway. A thoroughly enjoyable evening at the hospitable residence of the Hon. W. B. Ives, Q.C., M.P., where the members were entertained to dinner, concluded the proceedings of this meeting.

The question of consolidating the existing Mining Societies into an united organization was discussed at our last annual meeting, but inasmuch as the mineral rights are vested in the local governments and mining is carried on in the Provinces under widely different conditions and laws, it was thought advisable to preserve the autonomy of the societies as they now exist, and a proposition to federate was substituted. The objects in view were three-fold:—

(*a*) Economy in publication.

(*b*) The consideration of such matters affecting or relating to the mining industries of the Dominion as might be within the jurisdiction of such an organization.

(*c*) The holding of a united meeting once a year.

Mr. F. A. Halsey and the Secretary were delegated a committee to bring the matter before the Mining Society of Nova Scotia, and this was done at the annual meeting of that organization in March, when it was referred to a committee to report at a later meeting.

In the following April, the Ontario Mining Institute, a representative organization of the mineral interests of that Province, was formed, and on the question being submitted to it, federation was endorsed and a committee appointed to co-operate with the other societies in drafting a scheme. The desirability of the step was further agreed upon at a united meeting of the members of all three societies held at Sydney, Cape Breton, in July. As the outcome of further discussion at our Sherbrooke meeting, a committee, comprising the President, Messrs. F. A. Halsey, L. A. Klein and the Secretary, drafted a scheme which, with minor changes was approved by the Ontario committee. Both reports were then submitted to the Mining Society of Nova Scotia and considered at a meeting in November, when certain radical amendments were introduced which it will be the duty of this meeting to consider.

Early in the year a complete volume of the transactions for the years 1891-92-93 was issued to members, and the heavy cost of this publication has been a serious drain upon our finances. The Hon. E. J. Flynn, Commissioner of Crown Lands, with commendable enterprise and foresight, purchased fifty copies for distribution among the principal mining institutions and public libraries of Europe and the United States, where it is hoped the information will bear fruit in directing attention to our mineral resources and mining industries. Copies were also purchased by the Hon. W. B. Ives, President of the Privy Council, and the Hon. T. M. Daly, Minister of the Interior. The revenue from these sources was of great assistance.

In view of the importance to the country of a thorough education of Canadian students in mining and metallurgy, the establishment of a course of mining engineering and the magnificent equipment of the Science Departments of McGill College have been a source of gratification to every one interested in Canadian mineral development. With the object of placing such advantages as the Association may offer, within easy reach of the students attending these classes, there has been some correspondence respecting a student membership, or as an alternative, the affiliation of the McGill Mining Society, and a proposition will be submitted for the approval of the members at this session. It has also occurred to me that our appreciation of the good work that is being accomplished might take a still more practical form if we offered a medal or money prize for annual competition among the students for contributions from them to our proceedings.

The Mining Act, the law respecting the storage of powder, and the question of the free importation of mining machinery, subjects that occupied considerable prominence in the operations of the Association in previous years, having all been adjusted more or less to the satisfaction of the Association, there was no action on matters of legislation during the year.

The following comparative statement of the affairs of the Association since its organization to date, is respectfully submitted :—

MEMBERSHIP.

	Active.	Hon.	Total.	New.	Resigned.	Dead.
1891—	52	5	57	—	—	—
1892—	46	5	51	7	12	2
1893—	76	13	89	36	5	1
1894—	78	20	98	18	15	1

	Meetings.	Papers.	Deputations.	Excursions.
1891—	4	7	2	—
1892—	3	8	3	1
1893—	6	22	2	2
1894—	3	12	—	3

	RECEIPTS. Ordinary.	Special.	Total.	DISBURSEMENTS. Ordinary.	Special.	Total.
1891—	$510 00	—	$ 510 00	$ 311 20	—	$ 311 20
1892—	618 80	—	618 80	402 38	—	402 38
1893—	906 42	$1,500	2,406 42	726 19	$1,543 36	2,269 55
1894—	650 00	482	1,268 87	1,291 22	—	1,291 22

	Balance Credit.	Balance Debit.
1891—	$198 80	—
1892—	216 42	—
1893—	136 87	—
1894—	—	$22 35

FINANCIAL STATEMENT.

MR A. W. STEVENSON submitted balance sheet for the year, showing the income received to have been $1,268.87, with a number of members' subscriptions outstanding. The expenditure included:—Printing, $655.88; engraving, $41; Secretary's grant, $150; Secretary's disbursements and expenses, $197.56; Treasurer's disbursements, $58.45; stenographing, $71.90; dinners and luncheons, $106.43; or a total outlay of $1,291.22. The amount charged to engraving was properly chargeable to current year, and when all outstandings were collected there would be a fair balance in favor of the Association.

THE PRESIDENT—Considering that we have had an unusually heavy disbursement on account of printing, the Treasurer's statement is very satisfactory.

Both reports were then adopted.

AMENDMENTS TO CONSTITUTION AND BY-LAWS.

On motion of the Secretary, the following amendments were unanimously adopted to the Constitution and By-Laws:—

Section III.—Membership.

That Par. III. be amended to read:

The Association shall consist of Ordinary Members, Associate Members, Honorary Members and Student Members.

Par. IV.—That the word Ordinary be inserted at the beginning of the paragraph.

That a new clause be inserted to be known as Par. VII.—Student members shall be persons who are qualifying themselves for the profession of mining, metallurgical or mechanical engineering, or other branch of engineering, and such persons may continue student members until they attain the age of twenty-five years. They shall have notice of, and the privilege of attending, all meetings and excursions, and shall have all the privileges of the Association except voting.

Section V.—Fees.

That a new paragraph to this section be added as follows :—Student members shall pay an annual fee of one dollar.

Section VII.—Duties of Officers.

That new paragraphs be inserted as follows :

(a) "The Council may communicate with the Governments, either Provincial or Federal, in cases of contemplated or existing legislation of a character affecting or relating to the interests of mining, metallurgy, engineering or their allied interests."

(b) "The Council may appoint committees, consisting of members of the Association, for the purpose of transacting any particular business, or of investigating any specific subject connected with the objects of the Association."

(c) "A committee shall not have power or control over the funds of the Association, beyond the amount voted for its use by the Council."

(d) "Committees shall report to the Council, who shall act thereon, and may make use thereof as they may direct."

(e) "At meetings of the Council five shall form a quorum."

Section X.—Publications.

That new paragraphs be added as follows :—

The publications of the Association may comprise :

(a) Papers upon the workings of mines, metallurgy, engineering, railways, and the various allied industries.

(b) Papers upon the management of industrial operations.

(c) Notes on questions of law concerning mines.

(d) Such proceedings of the meetings of Council, or of the Association, as they may be determined by the Council.

"The Association as a body is not responsible for the statements and opinions advanced in the papers which may be read, or in the discussions which may take place at any of its meetings, or which may be reproduced in any of its publications."

That a new section be added as follows, to be known as

Section XI.—Medals and other Rewards.

The Association may award annually the sum of fifty dollars, in the form of medals or other rewards, to student members for original papers contributed to the proceedings.

New Members

The following were elected active members :—

Mr. H. A. Budden (Intercolonial Coal Co.), Montreal.

Mr. Huntley Drummond (Cumberland Ry. & Coal Co.), Montreal.

Mr. T. B. Brown (Kingman Brown & Co.), Montreal.

Mr. N. A. Belcourt, Q.C. (Wallingford Mica Co.), Ottawa.
Mr. T. F. Nellis (Vavasour Mining Association), Ottawa.
Mr. G. L. Burritt (Ingersoll Rock Drill Co.), Montreal.
Mr. Walter Fleming (Reddaway & Co.), Montreal.
Mr. Louis Gendreau, Jersey Mills, Que.
Mr. D. D. Mann (Victoria Hydraulic Gold Co.), Montreal.
Mr. J. M. Browning (Horsefly Hydraulic Mining Co.), Montreal.
Mr. C. Berkely Powell, Ottawa.
Mr. C. H. Taylor, M.E., Montreal.
Mr. J. S. Palmer, Sherbrooke.
Mr. F. C. Innes, Vancouver.
Mr. Thos. Drummond, M.E., Montreal.
Mr. G. H. Bradford, Sherbrooke.
Mr. W. F. Dean (Can. General Electric Co.), Montreal.
Mr. J. T. Dwyer (Carrière, Lainé & Co.), Montreal.
Mr. W. H. Nichols, Jr., M.E., New York.
Mr. Moses Parker, Montreal.
Mr. Louis Chouillou, Montreal.
Mr. G. F. Burnett, Montreal.

Student Members.

The following were elected student members:—

Mr. R. A. Gunn, Ba. Sc.,	Montreal.	Mr. E. E. Van Barnweld,	Montreal.
Mr. J. C. Gwilliam,	"	Mr. O. C. Bart,	"
Mr. W. M. Webb,	"	Mr. R. Green,	"
Mr. R. H. Stewart,	"	Mr. J. W. Bell,	"
Mr. W. S. Johnstone,	"	Mr. R. W. Dougall,	"
Mr. W. M. Mussen,	"	Mr. H. N. Thompson,	"
Mr. O. C. Hart,	"	Mr. F. W. Angel,	"
Mr. F. Rutherford,	"	Mr. W. Askwith,	"
Mr. G. Hillary,	"	Mr. F. Wilkin,	"

Mr. W. E. Archibald, Montreal.

Election of Officers and Council, 1895

PRESIDENT:

Mr. John Blue, C. & M. E. (Eustis Mining Co.), Capelton.

VICE-PRESIDENTS:

Capt. Robt. C. Adams (Anglo-Canadian Phosphate Co.), Montreal.
Mr. S. P. Franchot (Emerald Phosphate Co.), Buckingham.
Mr. G. E. Drummond (Canada Iron Furnace Co.), Montreal.
Mr. F. P. Buck (Dominion Lime Co.), Sherbrooke.

TREASURER :

Mr. A. W. Stevenson, C.A., Montreal.

SECRETARY :

Mr. B. T. A. Bell (Editor *Canadian Mining Review*), Ottawa.

COUNCIL :

Mr. Jas. King, M.P.P. (King Bros.), Quebec.
Mr. L. A. Klein (American Asbestos Co.), Black Lake.
Mr. John J. Penhale (United Asbestos Co.), Black Lake.
Mr. George R. Smith (Bell's Asbestos Co.), Thetford Mines.
Mr. H. A. Budden (Intercolonial Coal Co.), Montreal.
Mr. J. S. Mitchell (Beaver Asbestos Co.), Sherbrooke.
Mr. J. Burley Smith (British Phosphate Co.), Glen Almond.
Mr. C. H. Carrière (Carrière, Lainé & Co.), Levis.
Mr. R. T. Hopper (Anglo-Canadian Asbestos Co.), Montreal.

FEDERATION.

The Council having considered the report of the Mining Society of Nova Scotia, on the question of a federation of existing Canadian mining societies, reported the following recommendations :—

Governing Board :

(a) That the clause, "The qualification for full membership shall be an annual fee of ten dollars, etc.," be deleted.

(b) Be changed to read : "The Council shall elect a Chairman and a Secretary-Treasurer each year, the latter to receive such remuneration as may be determined by the Council."

Subscription.

Be amended to read : "The Societies in the Federation shall each pay an annual subscription towards the expenses of the Institute, of such an amount as may be determined upon at each annual meeting; but the contribution from each Society shall at no time exceed in amount the sum of three dollars *per capita.*"

Publications.

Be amended to read : "Publications of the Institute shall be supplied only to members in good standing in their respective Societies, one copy to each member, and the balance shall be sold by the Council at such prices as may be determined.

"Contributors of papers shall be entitled to 20 copies of a reprint of any paper presented by them and published by the Institute.

"Copies of the Proceedings sent for exchange shall be accompanied with a request for such exchange for each society in the Federation."

THE SECRETARY reported that these recommendations would receive the endorsation of the Ontario Mining Institute.

On motion, the suggested amendments were unanimously agreed to, and the Secretary was instructed to forward them to the Mining Society of Nova Scotia for reconsideration.

The meeting adjourned at 1 p.m.

AFTERNOON SESSION.

The members reassembled at two p.m., the President in the chair. The hall, as at the morning session, was crowded. The first item was the consideration of a series of reports on the mineral industries during the year.

NOTES ON THE PIG IRON TRADE OF 1894.

MR. GEORGE E. DRUMMOND, Montreal.

The year 1894 is not likely to go down to history as a year of unparalleled success in the iron trade of the world. In common with nearly all other leading industries, that of iron has been working on "rough ground." In the United States, now the leading iron market of the world, the shadow of the panic year of 1893 seems to have darkened every avenue of trade and commerce, and not least of all the iron industry. The exhaustion following on so severe a shock, of itself prevented any very rapid recuperation at the commencement of the year. At the commencement of 1894 the outlook was gloomy enough, and as the year wore on it brought with it a long series of troubles calculated to prevent reviving confidence and enterprise.

Among the difficulties referred to, the depletion in the Government gold reserve, beginning in January, led to enormous issues of bonds, which, of course, went to prolong the season of depression. Then the coal and railway strikes, and finally the great uncertainty of the tariff question. This combination of adverse circumstances all tended to bring about an unparalled shrinkage in values, affecting everything in the iron line from the raw material to finished product, and, of course, served to restrict the purchasing power of the people.

New and economic methods of production were introduced where-ever capital permitted, but withal the work from the first has been unprofitable to capital and labor. Many works have been kept in operation simply to keep the men employed, even if at what a year or two ago would be called starvation wages.

Despite all this the feeling of hopefulness has never died out, and, at the close of the year the output of pig iron in the several districts reported shows an increase over the production of 1893, with many more furnaces in operation

There is a more hopeful feeling abroad, brought about in a great measure by the result of the recent elections in the United States, and 1895 opens with numerous inquiries from consumers, who are not unlikely to be good buyers in the near future. While the experience of the last two years in the iron trade, and in fact all other trades in the United States, has not been a pleasant one, yet the enforced "breathing spell" is not unlikely to prove a blessing in disguise. Great economy has been practiced in all branches of trade and this must result in good. For instance, the railway companies have been so economical that their rolling stock has run down to a great extent, and they must very soon come into the market as large buyers. When they do the whole tone of the iron trade will be strengthened, and it is hoped that capital and labor will be able to earn at least a fair return.

The course of the British iron market during 1894 was marked by the great strike among the Scotch coal miners, which lasted for several months, beginning in July and not coming to an end before October. It appears to have been altogether uncalled for, and did not awaken the public sympathy as did the English coal strike of the previous year. The result, however, was that the Scotch iron trade was brought almost to a standstill while it lasted, and it will be a long time before the loss of trade can be made up. For over three months hardly a furnace was in blast in Scotland, but owing to the fact that the great proportion of the foundries, rolling mills and other consumers of pig iron were also idle for want of coal, the local demand for iron was light, and prices did not advance to any appreciable extent. Warrants remained stationary about 42s. to 43s. and the closing price on 31st December was close on 42s. The effect, however, on special or shipping brands of iron was to advance the price of these about 5s. to 7s. 6d. per ton, owing to their scarcity. No. 1 "Summerlee" was sold as high as 58s. 6d. in Glasgow, the highest point it has touched for the past two years. Several brands were entirely unobtainable. It shows that the Scotch market no longer controls the iron trade of the world, for such a scarcity happening ten or twenty years ago would have sent prices up to an alarming extent. As it was, however, the production and consumption of iron for 1894 shows a large decrease on the previous year, the figure being as follows:—

	Tons.
Official returns show that the Scotch pig iron production in 1894, was..........	655,614
As against, in 1893....................	783,867
A decrease of	128,253

The consumption also shows a decrease, and whilst taking all British made iron into the calculation the consumption only fell 41,657 tons behind that of 1893, yet the decrease in the consumption of Scotch iron, owing probably to the strikes and consequent high prices of coal, was 125,657 tons.

STOCKS.

	Tons.
At the close of 1894, the stock in Connell's store amounted to..................	287,886
As against, in 1893	320,851
A decrease of	32,965
Stock in makers hands at the close of 1894	70,713
As against, at the close of 1893..........	60,936
An increase of......................	9,777

English irons, that is those made in the Middlesboro' district, remain almost unchanged, and a large quantity finds its way into Scotland.

Bar iron and manufactures of mild steel, such as plates, angles, etc., have remained practically unchanged during the year, but, owing to the quiet state of trade, prices closed a few shillings lower than the opening figures of the year. The change that has come over the trade in these goods is very marked. A few years ago almost the entire requirements of the country in mild steel, and all the bar iron that was not produced in this country, came from Great Britain. During the year just ended the importations of these goods from Great Britain were practically nothing Prices on the American side have been forced down, by keen competition, to such an extent that all the steel plates, and the great proportion of the angles and other shapes now come from Pittsburg, at prices which the English manufacturer cannot touch.

The same general features of restricted production and consumption brought about by the depression in trade, obtains in the iron markets of Germany, Sweden, France and Belgium, with the exception that the returns from Belgium evidence an increase in the output, although the consumption has been unsatisfactory.

In sympathy with the condition of the iron trade elsewhere the Canadian iron industry has felt the depression in some degree. The battle over the tariff question that was fought at Ottawa throughout the winter months, had the effect of retarding the progress of the industry, and it may be safely claimed that the first half of the year was, to a certain extent, lost in uncertainty.

Happily the Dominion Government decided that the industry should be encouraged. This restored confidence, and the iron-masters took up the work promptly. The effects, however, of the depression in the United States had a very marked effect on the trade of the last six months of 1894. The overstocks of the American iron furnaces were thrown into the Canadian market, and American pig iron found its way as far east as Montreal, at prices that, under ordinary circumstances, would be quite impossible, and that certainly did not return any profit to the American manufacturer. In many cases the bankrupt stocks held by American banks were thus unloaded, presenting a formidable competition to Canadian iron-masters. Aside from this, the general depression affected the largest consumers in Canada, such as the railways, and the consumption fell short of the ordinary requirements.

Under the existing circumstances, and compared with the state of the trade in the United States, Great Britain, and elsewhere, the Canadian iron industry made very good progress in 1894, at least demonstrating that those now interested in the manufacture of iron have thrown themselves heartily into the work of development, even under most adverse circumstances.

In Nova Scotia, the New Glasgow Iron, Coal and Railway Co. have kept their furnace in full blast from the beginning of the year, and their record of output for 1894 compares most favorably with that of 1893 The record is as follows :—

	Net Tons.	
Coke used	39,521	
Coal "	2,857	
Ore "	60,817	
Lime "	22,928	
Iron produced	28,142	1,600lbs.

The affiliated company of New Glasgow have gone on steadily extending their operations in the steel department.

The Londonderry Co., who seek their principal market for pig iron in Ontario, have perhaps felt the American competition more keenly than the New Glasgow Co., but they have done comparatively well for the times.

The Pictou Charcoal Iron Co., at Bridgeville, were in operation for several months of the year, and, although closed down at the present moment, will show a fair output.

The same applies to the work at Drummondville in the Province of Quebec

At Radnor Forges, the operations of the Canada Iron Furnace Co. in all branches will surpass the record of 1893. In the charcoal iron department the output is practically the same as last year.

In August last the company, after a continuous campaign of nearly two years, found it necessary to shut down for relining of the furnace, and the campaign for 1894 was, from this, and similar causes, reduced to a period of a little over nine months. In this nine months the company produced of high class:

	Net Tons.	Lbs.
Charcoal iron....................	7,178	660
Ore made.....	15,866	1033
Charcoal.......................	663,269½	bushels.
Cordwood	23,363½	cords.

An average of some 650 men and 300 horses were employed throughout the year, in the field and at the works.

The work of prospecting has been carried on vigorously as in the past, and the ore-fields extended and perfected over a very large territory.

The company have found competition very keen during the year, but the high quality of their iron has commanded a steady market for it. The auxiliary businesses in connection with the company have all shown progress, and the value of the industry to the province, and especially to the farming community, has been more than ever demonstrated.

Aside from the difficulties experienced by Canadian iron-masters in meeting the panic prices of their American rivals, another grave difficulty has recently arisen by the passage at Ottawa of an order-in council, 2nd Nov., 1894, entitled, "*Re* drawbacks on import goods used in Canadian manufactured articles, and exported." This order-in-council was passed with a view of encouraging the exportation of agricultural implements to foreign markets. The principle of encouragement was perfectly correct, but the way in which the enactment is framed, and the manner in which it works, are most detrimental to the development of the Canadian iron industry in its broadest sense.

As it stands to-day, it obliges Canadian consumers to use foreign raw material before they can avail themselves of the encouragement offered by the Government, and it bars out altogether the use of Canadian raw material. A striking illustration of this was given a few weeks ago, when a western plow manufacturer wrote to one of the iron furnace companies, and said that much as he desired to use Canadian material at competitive prices with American, yet, inasmuch as he exported largely to Australia and Great Britain, he was compelled to use American iron and steel, so as to take advantage of rebates from the Dominion Government.

Another Canadian manufacturer, when absent from home recently, received a letter from his house reading somewhat as follows:—

"We beg to advise having just received an order for plows for shipment to Australia. The shipment must be made by outgoing steamer, and we deeply regret that we have been compelled to use Canadian steel, as we have no American steel in stock, hence we must sacrifice the ordinary rebate."

It is quite evident that the manner in which the Dominion order-in-council was drawn up, and is now being acted upon, is merely an error, but it is one that should be rectified immediately, as it simply serves to nullify the protection and encouragement to the Canadian iron industry granted by the Dominion Government itself at the last session of Parliament.

To be entirely consistent with their policy of encouraging the manufacture and use of Canadian iron made from Canadian ores, the Government should so frame the order-in-council in question that manufacturers of agricultural implements be entitled to what the duty would have been had they imported the raw materials used in their machines, but leaving them entirely free to use Canadian raw materials; in other words, the encouragement should rather take the form of a bonus than an actual rebate of duties.

So long as the order-in-council remains as it is to-day, and the present condition of the American iron market exists, Ontario agricultural implement manufacturers will prefer to confine their purchases to American iron and steel, so that they will be relieved from the trouble and annoyance of locating specific importations of iron and steel necessary in making out papers calling for the rebate of duties.

Among other important legislative enactments of the year is one passed by the Liberal Government of Ontario, and which reflects great credit on the wisdom of the legislators of that province. For some time back the Ontario Government have been making a very full investigation as to the importance of the pig iron industry in the proper development of the mineral wealth of the province. Their investigation has finally culminated in the passage of an Act, now in the Statute-books of Ontario, entitled "An Act relating to mines and mining lands," by which Ontario appropriates the sum of $125,000 to aid miners and producers of iron ore in developing the ore deposits of that province.

Clause 12 of the said Act authorizes the treasurer of the province to pay out to miners, or producers of ore, upon all ores which shall be raised or mined, and smelted in that province, for a period of five years from 1st July, 1894, the equivalent of $1.00 per ton on the pig metal products of such ore, this to a maximum amount of $25,000 per annum.

In better times the effect of this Act would likely have been ere this the formation of companies for the erection of several furnaces in Ontario. As it is, a coke furnace of large capacity is now being erected at Hamilton, Ont., and it is expected that it will be in blast during the ensuing summer. Other furnaces are talked about, and there is not the slightest doubt but that Ontario, hitherto so dilatory about developing one of the greatest natural wealths that she possesses, will very shortly, under such wise legislation as the Act referred to, come to the front in the manufacture of iron in Canada.

It will be in the best interests of Quebec if its legislators will meet the action of Ontario promptly, and not only preserve to the province the credit of having been the first iron producer, but to-day the largest producer of high-class charcoal iron within the limits of the Dominion.

Quebec possesses such a great wealth of the very highest class of ores and wood necessary for the manufacture of charcoal, that it only remains for her Government and people to give the industry every sympathy, and at least give the same support as that offered by her sister province, Ontario.

COAL IMPORTS BY RAIL AND WATER.

By Mr. B. T. A. Bell, Ottawa.

The importation of bituminous coal into the Province of Quebec is of so great importance that no mineral statistics would be complete without its figures. The following returns have been compiled with the greatest care, at first hand, and are as authentic as it is possible to make them :—

	Tons.	Tons.
Carried by Water.		
(*a*) *From Canadian Collieries—*		
General Mining Association, Ltd., Cape Breton	109,351	
Dominion Coal Co., Ltd., Cape Breton	544,953	
Intercolonial Coal Co., Ltd., Pictou County	80,587	
Cape Breton Colliery, Cape Breton	900	
Total water imports, 1894	——	735,971

During the season of 1894 this trade employed 363 cargoes, 49 steamers, 18 sailing vessels and two barges, and distributed on account of labor $369,688 ; on wharfage, $55,586 ; pilots, $55,333.

	Tons.	Tons.
Carried by Rail.		
Intercolonial Coal Co., Ltd., Pictou County	100	
Canada Coal & Railway Co., Ltd., Cumberland County	15,800	
Cumberland Ry. & Coal Co., Ltd., Cumberland County	98,913	
Acadia Coal Co., Ltd., Pictou County	5,000	
Total carried by rail	——	119,813
Carried by Water.		
(*b*) *From Foreign Collieries—*		
English, Scotch, Welsh and American (St. Lawrence	73,658	
American bituminous (Canals, &c.) estimated	10,000	
Total foreign by water	——	83,658
Carried by Rail.		
American bituminous, about	1,000	
Total rail bituminous	——	1,000
Or a total import of bituminous coal in 1894 of		940,262

Recapitulation.

Canadian by water	735,791	
" rail	119,813	
		855,604
Foreign by water, about	83,658	
" rail, about	1,000	
		84,658
Total importation of		940,262

ST. LAWRENCE DELIVERIES, 1893-1894.

Port of Montreal.

	1893. Tons.	1894. Tons.	Increase. Tons.
Canadian coal	613,279	655,779	42,500
Foreign coal	36,074	55,849	
Total	649,353	711,628	62,275

Port of Sorel.

			Decrease.
Canadian	16,685	11,636	5,049
Foreign	1,528	1,932	
Total	18,213	13,568	4,645

Port of Three Rivers.

			Increase.
Canadian	9,218	9,481	263
Foreign	nil	nil	
Total	9,218	9,481	263

Port of Quebec.

			Decrease.
Canadian	51,587	46,559	5,028
Foreign	9,520	15,877	
			Increase.
Total	61,107	62,436	1,329

Grand Total.

			Increase.
Canadian	590,769	723,455	132,686
Foreign	47,122	73,658	26,536
Total	637,891	797,113	159,222

THE PRODUCTION OF COPPER PYRITES.

By Mr. John Blue, C. & M. E., Capelton.

The mining of copper pyrites in the Province of Quebec for the year 1894 has been confined to the Township of Ascot, in the County of Sherbrooke. All the pyrites mined was utilized for manufacturing acids in the first place, the copper and silver contents being subsequently extracted.

The quantity mined for the year amounted to...	35,560 tons.
Of this quantity there were exported to different points in the United States	27,960 "
And consumed in Canada....................	7,600 "

The market for the product of these mines has been very depressed during the year, and prices very low in consequence. At the present time, with better demand and increased consumption, better prices are being realized.

THE ASBESTOS INDUSTRY, 1894.

By Mr. John J. Penhale, Black Lake, Que.

The production of asbestos for the year 1894 has been approximately 8,600 tons. These figures indicate a very marked increase over the previous year; and the shipments from the mines show that the demand for crude is vey much better than it has been at any time for the last three years.

During the year just closed the total shipments from the mines on the line of the Quebec Central Railway have run up to 7,318 tons, being only exceeded in the year 1891, when 7,774 tons were sent away.

The figures of shipments sent, do not include the shipments from the Jeffrey mine at Danville, but their output is included in the total given above.

Eight companies have been engaged in the mining of asbestos in 1894—four at Thetford Mines, viz.: King Bros., Bell's Asbestos Co., Johnson's Asbestos Co., and the Beaver Asbestos Co. At Black Lake, the American Asbestos Co., the United Asbestos Co., the Anglo-Canadian Asbestos Co.; and at Danville, P.Q., the Jeffrey Mine. Employing in all about 800 men and boys.

About 1,000 tons have been sent to the United States, and the balance to various European points.

The principal points of shipment in the United States are: New York, Erie, Pa., and Baldwinsville, Mass. In Europe: London, Rotterdam, Genoa, Hamburg, and Glasgow.

Very little has been manufactured in this country, there being only one firm engaged in the business, viz., M. B. Berry, of Quebec; and the record of shipments show only 12 tons sent to that place.

This, however, does not mean that only 12 tons have been used, as I am in a position to know that Mr. Berry had a considerable stock of crude on hand.

The demand for crude asbestos during the year has been fair, but the prices realized have not been up to former years—'90 and '91.

All shipments have gone direct to the manufacturers, and not, as in previous years, to dealers and brokers.

Miners, too, have adopted the plan of mining only the quantity required to fill their contracts, so there is not now the danger of overstocking the market that there was three or four years ago at the time of the "boom."

On the whole, the past year has been a very successful one in this branch of the mining industry of the province.

A rough estimate of the value of the production would be $516,000. This, however, may be too high.

The annual report, "Mineral Statistics and Mines," for 1892, just issued by the Geological Survey, places the production of asbestos from 1882 to 1892, inclusive, at 49,161 tons.

The record of actual shipments, *via* Quebec Central Railway, for that period is 36,630 tons, or a slight difference of 12,531 tons in favor of the Geological Survey. I am aware that these figures are compiled from returns sent in by mine operators; but it shows at once how little reliance can be placed on reports from the Geological Survey Dept., and would give anyone unacquainted with the facts the impression that the asbestos miners were carrying a stock of 12,000 tons of crude asbestos in their sheds at that time, an impression that might do considerable injury to the market, and have a tendency to knock down prices.

GOLD MINING IN QUEBEC.

By Mr. E. B. Haycock, Ottawa.

In the County of Beauce there has been very little mining during the season of 1894.

On the Gilbert river, litigation and the want of a quiet title has much delayed mining. The American Gold Mining Co., under Mr. Fernando Wadsworth's management, ground-sluiced a large piece ready for sluicing. A few men did a little sluicing; the returns gave from $48 to $76 per day. I understand Mr. Wadsworth will push the work next season.

Although the Ditton section has proved rich in gold, little or no mining has been done. This is a section well worth looking into; a good field for prospectors. I have no doubt the veins from which the gold is derived will be found in close proximity to the alluvial.

A little prospecting on the Du Loup and Chaudiere was done during this season, and it is being carried on with more or less success.

MICA, PHOSPHATE, CHROMIC IRON, GRAPHITE, AND PETROLEUM.

By Mr. B. T. A. Bell, Ottawa.

The Mica Industry.—The United States being the principal consumer of Canadian mica, the industrial depression which has existed in that country resulted in an almost complete collapse of our mica trade during the first half of the year, the official returns for the fiscal year ended 30th June, giving only an export value of $26,553, as against $96,900 in 1893. During these periods the distribution of the product was as follows:—

	1893.	1894.
To United States	$86,871	$26,484
" Great Britain	10,024	58
" Germany	5	11
Total	$96,900	$26,553

Towards the end of the season the demand increased very notably and mining was actively carried on at a number of the mines. The companies and operators were as follows:—

Vavassour Mining Association	in the	Township of	Hull.
Lake Girard Mica Mining System	"	"	Templeton.
Wallingford Bros. & Co.	"	"	Templeton.
Cascades Mica Mine	"	"	Hull.
The Blackburn Mine	"	"	Templeton.
Beaver Lake Mines	"	"	Saguenay District.
Hayes Mica Mine	"	"	Murray Bay.
McGie Mine	"	"	Saguenay District.
Goldering Mine	"	"	Templeton.

The total production in the Province of Quebec from returns kindly furnished by the operators being about 400 tons, employment being given to about 150 persons.

The quantity exported for the calendar year from figures kindly furnished by the customs' officials was as follows:—

Port of Ottawa	$22,765
" Montreal	4,347
" Quebec	120
Total exports to 31st December, 1894	$27,232

During the year the Canadian Mica Co., Ltd., was registered in London, Eng., with an authorized capital of £90,000, to engage in mica mining in Canada. The Beaver Lake, Hayes, and Perkins properties were purchased, and work, we are told, is to be conducted on a large scale during the coming season.

The following is a comparative statement compiled from the trade and navigation returns showing the exports and distribution of Canadian mica from 30th June, 1890, to 30th June, 1894:—

Exported to	1890.	1891.	1892.	1893.	1894.
United States	$26,865.00	$21,762.00	$67,238.00	$86,871.00	$26,484.00
Great Britain	42.00	550.00	....	10,024.00	58.00
Newfoundland	25.00	....	25.00	....	....
Germany	....	....	480.00	5.00	11.00
	$26,932.00	$22,312.00	$67,743.00	$96,900.00	$26,553.00

Phosphate Mining in Quebec.—Extreme stagnation in the European fertilizer market, together with competition from other and cheaper sources of supply, have almost obliterated the mining of Canadian phosphates, and the production of this mineral has been reduced from 31,758 tons in 1890 to about 9,000 tons. The exports of the year were to :—

Great Britain.	United States.	Canada.	Total.
3,239 tons.	2,000 tons.	700 tons.	5,993 tons.

Prices have fallen from 16½d. per unit for 80% in 1890 to 7d. in 1894, equal to $8.74 Montreal F.O.B. and $6.88 Buckingham. In 1890 the lower grades brought as follows: 75% 13d.; 70% 12d.; 60% 9d.; while in 1894 70% realized 6d. per unit, equal to $3.70 per ton Buckingham, and 60% $3.00 per ton unground Buckingham. The companies who did any business during the year were the Phosphate of Lime Co., at High Rock; the British Phosphate Co., at Glenalmond; the Lake Girard Mica System, at Templeton; and the Dominion Phosphate Co., at the North Star, the whole of whose shipments were to Capelton, for use in the manufacture of superphosphate

While this industry may be considered in a state of complete collapse, and old time activity may not be resumed in the immediate future, the outlook is not without hope. The expansion of the phosphate business in Europe goes on uninterruptedly, and one would be rash to predict that the end of the century will not find us nearly abreast of supply, if we do not overlap it. Mr. David Boyd, a Glasgow authority, writing in the American *Fertilizer*, says :—

"Besides the gregarious follow-my-leader element in the increase of the use of new fertilizers, it has been wonderfully stimulated by the abnormally low prices of rock which have now ruled for some time. The experience of the past 25 years is likely to hold good again—every cycle of low prices is succeeded by a stronger reflex current, which affects a much larger area, and does its best to make the ends of supply and demand meet but not overlap. Such confidence in the future may appear a little extravagant, in view of the enormous amount of rock now being mined on both sides of the Atlantic, but 'enormous' is really a relative quantity, and the chances are that, while that word may be correct for to-day, it will have a totally different meaning when viewed from the standpoint of 1900. So long as money is abundant and cheap, so long will the enterprise representing lasting industries find favor, even if these for a time tax the patience of investors for adequate returns."

The world must have phosphate; Canada possesses the highest quality known, scattered over a wide area; human ingenuity will surely devise means to make these deposits available for the world's needs. Even though at present there may in some cases be disappointment in the result of phosphate enterpries, as there will be in all mining ventures, we may feel assured that a great and prosperous future awaits the Canadian industry, and that it is destined to fulfil an important part in the economic development of the country.

Canada is an immense wheat growing country, but as yet it uses only a few hundred tons of fertilizers per annum. This cannot continue, and the example of other countries must be imitated. Prof. H. W. Wiley points out that 19 lbs. per acre of phosphoric acid are absorbed by grain and 12½ lbs. per acre are absorbed annually by the grass crop. The cereals and grass crop of Canada extract from the soil (Annual Report, Minister of Agriculture, 1893), 255 million pounds of phosphoric acid, equal to 117,972 tons of 2,000 pounds. Supposing one-half only to be returned to the soil in the stable manure, there is still left a deficit of 59,000 tons of phosphoric acid. The percentage of phosphoric acid in Canadian apatite is stated to be about 33 per cent. Taking this as a fair average the requirement for the production of the needed quantity of phosphoric acid to be restored to the soil would be about 177,000 short tons of apatite. There are extensive mines and workable deposits of pyrites in Quebec and in Ontario containing 40 to 45% of sulphur suitable for the manufacture of sulphuric acid. Indeed at the Nichols Chemical Works at Capelton an important industry in the manufacture of chemicals and superphosphates has already sprung up and is expanding. The older portions of Canada which formerly raised vast quantities of grain have been allowed literally 'to go to grass, but the knowledge of the use of mineral manures rightly applied will redeem the land from barrenness. It is therefore the duty of our Departments of Agriculture, and experimental farms, and those interested in the future of this industry, to spread this information among the farming community, and by the establishment of fertilizing works continue the industry and enrich themselves and the province and the country.

Chromic Iron Production.—The latest addition to the mineral industries of Quebec, and one of some importance in consequence of the comparative scarcity of the mineral and its utility in the arts and industries, has been the development of valuable areas containing chromic iron of excellent quality at Coleraine and other points, on the line of the Quebec Central Railway.

The occurrence, character, uses and methods of working this mineral have been so fully described in the papers by Messrs. Obalski and Donald at the Sherbrooke meeting, that it will be only necessary to supplement their data with such information as has been obtainable respecting the output and shipment of the mineral.

A statement furnished by Dr. Reed, of Reedsdale, an owner of a number of the areas worked, shows the following production :—

Jos. Lamelin, working six months, 20 acres. Lot 10, Coleraine, 350 tons; royalty $5.00 per ton to Dr. Reed.

W. H. Lambley & Co., working six months, 28 acres in Coleraine, on lease from the Coleraine Mining Co., 700 tons.

Frechette & Co., working two months, 28 acres under lease from Coleraine Mining Co., 100 tons.

D. Wilson & Co., working on royalty lands of Dr. Reed, in the Tp. of Coleraine, two months, 25 tons.

Fortier & Co., Tp. of Coleraine: Royalty; Dr. Reed. 1 month, 20 tons.

Lemieux & Co., Tp. of Coleraine: Royalty; Dr. Reed. 1 month, 25 tons.

Leonard & Morris, Little Lake St. Francis. Six months, 500 tons.

The Anglo-Canadian Asbestos Co., Tp., of Coleraine, about 20 tons for two months.

A total production for the year of 1,740 tons, of which 801 tons were shipped, as per return kindly furnished by the Quebec Central Railway.

Dr. Reed again called attention to differences in the buyers and sellers analyses of shipments, and urged the appointment of a government analyst whose certificate would be binding on both.

Mr. G. E. Drummond pointed out that the only remedy lay in careful sampling and the appointment at the mines of an efficient analyst.

After considerable discussion Mr. R. T. Hopper, Dr. Reed and Mr. John J. Penhale, were appointed a committee to enquire into the matter and report to a later meeting of the Association.

Graphite and Petroleum—A large number of men have been employed by the Walker Mining Co. in the Township of Buckingham during the year, and several hundred tons of merchantable graphite is reported ready for the market. A 20 stamp mill equipped with suitable appliances has been erected, having a capacity of 10 tons in the 24 hours. The quality of the graphite mined by the company is excellent. From experiments made in the laboratory of the Geological Survey, Mr. Hoffman, F.C.S., considers that in respect to combustibility it may claim perfect equality with that of Ceylon, and that it is in no wise inferior to the latter as a material for the manufacture of crucibles.

At Gaspé, the Petroleum Oil Trust, Ltd., has had a large force drilling for oil. A heavy expense has been entailed in equipping and putting down numerous wells, some of them at considerable depth, but so far as can be ascertained, only a few barrels of oil have been obtained.

The meeting adjourned at six o'clock.

The following papers were presented at the sessions of the Association on Wednesday evening, Thursday morning and afternoon, and on Friday afternoon:—

ON THE OCCURRENCE OF LIGNITE AND ANTHRACITE AROUND HUDSON BAY.

By Dr. Robert Bell, Assistant Director of the Geological Survey of Canada.

The title of my paper, as announced, is changed to read as above, so that it may give a more definite idea of the region I intend to cover in the following remarks.

The existence of good lignite, anthracite, or coal of any kind, in the northern mainland of Canada, is of so much importance that any information on the subject is eagerly welcomed. I say northern mainland, because it has been pretty well ascertained that workable coal seams do occur on some of the islands of the northern seas, all of which now belong to the Dominion. About all that is known to have been ascertained up to the present time in reference to the lignite around James

Bay, was recorded either in the reports of the Geological Survey, or in those of Mr. E. B. Borron, who has made practical tests of some of the deposits for the Ontario Government; and all the information that could be gathered in reference to the existence of anthracite on the east coast of Hudson Bay is given in my geological reports on that region. The first mention of the occurrence of this mineral on the above named coast is the following, at page 325 of my official report for 1875:

"When at Moose Factory, Captain Taylor, of the Hudson's Bay Company, presented me with several specimens of a mineral having all the ordinary characters of a very fine anthracite, except that it contains, according to Mr. Hoffman's analysis, only a very trifling amount of ash. (*Vide* Mr. Hoffman's report, analysis No. 4.) Two specimens were obtained by an Indian from Long Island, south of Great Whale River. I was told by Mr. James L. Cotter, of the Hudson's Bay Company, to whose intelligent observations I am indebted for much valuable information, that a similar mineral was reported by the Indians as occurring some miles inland from Little Whale River. I could ascertain nothing in regard to its mode of occurrence further than that the Indian who brought the specimens from Long Island stated that there was plenty of it there. It appears to have resulted from the alteration of a mineral like albertite, by losing nearly the whole of its bitumen.

The following is Mr. Hoffman's description and the analysis above referred to.* (Report Geol. Survey of Canada for 1875, page 423.)

ANTHRACITE.

"The specimen examined was very compact homogeneous; color, pitch black; powder, deep black; lustre, bright metallic; fracture, highly conchoidal; it does not soil the fingers. When boiled in a solution of caustic potash, it was apparently unacted on; the solution remained colorless, and the powder black. Gradually heated, or when projected into a bright red-hot crucible, in either case decrepitated but very slightly. The specimen had been kept in the laboratory for months.

"The following is the mean of two very closely concordant analyses:

Fixed carbon	94.91
Volatile combustible matter	1.29
Water	3.45
Ash	0.35
	100.00

"It was scarcely changed in appearance by coking; the ash, which had a reddish iron-black color, was attracted by the magnet; it showed not the slightest disposition to agglutinate, even at a bright red heat."

In 1877 I visited the east coast of Hudson Bay, and in my (Geological Survey) report for that year, page 24 C., is the following statement:

"*Anthracite:* The existence of this valuable mineral on Long Island was referred to in my report for 1875, page 325. It has a conchoidal fracture and bright lustre, and was found by Mr. Hoffman to contain 94.91 per cent. of fixed carbon, and only 0.35 per cent. of ash. It is probable that it does occur as a seam of altered bituminous coal, like ordinary anthracite, but rather as resulting from hardened pitch, or a mineral like albertite by the loss of its bitumen, and it may not exist in large quantities. I was prevented by circumstances from visiting the locality at which it is found, which is said to be on Long Island, at four or five miles from its south-western extremity."

It appears that a trial opening had been made by some prospectors at the above locality many years ago. Two of my men happened upon the spot when out hunting on the island one day, but they did not tell me of it till we had left the neighborhood, and it was impossible for me to return that year, and I have never been near the place since. The island is upwards of 30 miles in length. If an intelligent search for this valuable mineral were made upon Long Island, and some of the islands to the north-westward of it, important results might perhaps follow. It will be observed that the anthracite is of extra good quality. In order that expectations based upon my discovery might not be disappointed, I thought it as well in mentioning it in my report, not to allow it to be inferred that the mineral existed in large quantities until we knew more about it. Still I know of no reason why it may not occur there in some cases in deposits large enough to be valuable. If it exists in workable quantity, it will no doubt be found in the form of vein or veins, analogous to those of albertite in New Brunswick, and not in beds like ordinary anthracite. In my first announcement of anthracite above quoted, I mentioned that the late Mr. Cotter had informed me that a similar mineral was reported by the Indians as occurring inland or eastward from Little Whale River. In confirmation of this report, Mr. A. P. Low, of the Geological Survey, on his late traverse of the Labrador peninsula, found a vein of this mineral about seven inches in thickness. It would be a rare chance if this were identical with the occurrence mentioned by these Indians, and we may presume that these rocks hold many such veins; and this leads us to hope that, sooner or later, one or more of a workable thickness may be discovered.

Lignite.

Indications of a variety of lignite, closely allied to bituminous coal, were observed by me in 1871, when surveying the Albany River, the most southern of the large streams, which flow into the west side of the James Bay. In reporting its occurrence, I said (page 112, Geological Survey Report for 1871):—

"In one place just below the mouth of the Goose River, or three miles below the point where the river turns southeast, bright red marl occurs on the north bank, and on a small island a mile further down some loose fragments of a bright bituminous coal were found. The Hudson Bay Co's officers informed me that coal had never been brought into the country; and considering that the conveyance of even light and valuable goods is so expensive in this region, this is only what might have been expected, so that I cannot suppose this coal to have been brought here by human agency.

The occurrence of lignite on the Kenogami, the great southern branch of the Albany, is mentioned in the same report. On this river, which discharges Long Lake into the Albany, there is an interesting deposit of lignite in the drift filling a preglacial channel of a stream which probably corresponded in its general course with the existing river. It occurs at six miles, by the stream, above the mouth of the large southern branch called the Bagutchewan (or Pa-wetch-a-wan). Here the river makes a sudden bend to the north and about a mile further up another similar bend. These unusually sharp curves, which are unlike any others in the course of the stream, appear to be caused by the river traversing preglacial excavations, in the Silurian strata, which here consist of dull red, coarse, somewhat indurated arenaceous marl with green blotches and layers. These excavations have become filled up with loose material before the formation of the present river channel. At the lower bend gravel fifty feet deep is exposed in the south bank. At the upper bend the excavation of the Silurian marls is plainly seen. Starting from the level of the river, the lower ten feet of the filling of this hollow consists of boulder clay. Upon this rests a bed, six to eight feet thick, of soft lignite, containing many flattened stems of small trees which are partially carbonized, but are somewhat elastic when newly excavated and still wet. The lignite bed is overlain by thirty or forty feet of rudely stratified red and grey drift holding rounded boulders and many pebbles. Marine shells were observed in the drift along the Kenogami, almost up to this point, which, according to my barometric readings would have an elevation of about 500 feet above the sea." (See Annual Report of the Geological Survey for 1886, p. 37-38 G.

With reference to lignite in the basin of Moose River, I will quote the following from my report for 1877, page 4 C :—

"The existence of lignite on the Missinaibi River was referred to in my report in 1875. During the past season I have found it *in situ* in several places on this river between the Long Portage and its junction with the Mattagami. The first or highest of these was in the west bank of Coal Brook, three-quarters of a mile from its mouth. Coal Brook is a small discharge or channel which leaves the main river opposite the head of the fourth or Riverside Portage, and rejoins it at five and a half miles below Round Bay, at the foot of Hell's Gate. This bed of lignite is about three feet thick and is underlaid by soft sticky blue clay, and overlaid by about 70 feet of drift clay or till, full of small pebbles and passing into gravel towards the top. Much of the lignite retains a distinct woody nature. Some of the embedded trunks are two feet in diameter. When dry it makes a good fuel, but contains a little iron pyrites.

"On the south-east side of the river, at nineteen miles below Coal Brook, or two miles above Woodpecker Island, a horizontal seam of lignite was found in the midst of a bank of till 125 feet high. It is from one and a half to two and a half feet thick and is made up principally of sticks and rushes. Below the lignite are 80 feet of yellow weathering grey clay and about 45 feet of blue clay. Both varieties of clay are full of pebbles, and they also hold some striated boulders of Laurentian gneiss, Huronian schists and unaltered Devonian limestone.

"At three miles below Woodpecker Island, or nine miles above the mouth of the Opazatika (Poplar) River, another bed of lignite occurs in the bank on the same side. It is six feet thick, but diminishes to the eastward and is of a shaley character, being made up of laminæ of moss and sticks. Immediately beneath the lignite is a layer, one foot thick, of irregularly mingled clay and spots of impure lignite. Next below this are 40 feet of unstratified drift, full of small pebbles, under which are a few feet of stratified yellowish sand and gravel. Resting upon the lignite are five feet of hard lead-colored clay with seams and spots of a yellow color and layers of red, grey, drab and buff. Above all and forming the top of the bank, 65 feet high, are 10 feet of hard drab clay with striated pebbles and small boulders and holding rather large valves of *Saxicava rugosa*, *Macoma calcarea* (*Tellina proxima*) and *Mya truncata*.

Small seams of lignite were seen in two places in the bank on the same side at, and again half a mile below, the foot of a rapid which occurs about six miles above the Opazatika. In the interval between one and two miles above this stream the whole bed of the river appeared to be underlaid by lignite. When sounded with a heavy pole it has an elastic feel and gives off large volumes of gas which may also be seen at any time bubbling up spontaneously here and there all along this part of the river. This phenomena has been observed by the Indians from time immemorial, and the locality has received the name of the 'Bubbling Water.'"

Since the above was written Mr. E. B. Borron, J.P., stipendiary magistrate for Northern Ontario, was sent by the Provincial Government to test the lignite beds of Coal Brook by boring. I have not seen this report, but I have been told that he found the mineral to be of fairly good quality, I have also been informed on good authority that beds of lignite have been found within the last few years on the lower part of the Abittibi River, where we noticed loose pieces of it in 1877.

Considering the very small amount of exploration which has yet been done in the regions referred to in the above extracts and notes, the discoveries which have been mentioned appear to indicate the existence of a good supply of lignite scattered over a vast area in the level country round the southern and western side of James Bay, where valuable deposits of iron ore are also known to occur.

THE GEOLOGICAL SURVEY OF CANADA AND ITS OPERATIONS.

By R. W. Ells, LL.D., F.R.S.C., Ottawa.

It has been suggested to me that, to those of our members who live in this city where the Geological Survey had its first location, as well as to many throughout the several provinces of our Dominion, some facts relating to the work of such a department, as annually carried out, might be of interest. The question has been often asked, what is the work of the Geological Survey? What does its staff find to do year after year, and what great purpose does it serve in the country's progress and welfare? To discuss this subject fully would require a very long chapter, but I hope to be able to lay before you a few ideas regarding the general character of this work that may, to some extent at least, be an answer to the question propounded.

And first of all, as to its history. The Geological Survey of Canada, whose operations have now extended to every part of the Dominion, has had an existence of fifty-two years, and while it may seem almost superfluous to devote any time to the story of its inception, it is possible there may be some present who are not perfectly familiar with the early struggles and disappointments, which attended the efforts of those who were desirous of seeing such an institution in successful operation, and who firmly believed in its great utility as a factor in the advancement of the interests of the country. As far back then as 1832 a petition, asking for pecuniary assistance in carrying on a geological and statistical survey, was presented by Dr. Rae to the Lieut.-Governor of the Province of Upper Canada; but, though strongly recommended by that gentleman, it was not even entertained by the committee of supply. In December of the same year the York Literary and Philosophical Society also forwarded a petition for the same purpose, which met with a like fate. In 1836 a committee of several gentlemen was appointed by the government to report on a plan for a general survey of the province, which report was presented, but no further action taken in the matter. On motion of the committee of supply it was then resolved that an address be presented to Sir F. B. Head, the Lieut.-Governor for the time, with reference to the practicability of the desired survey. This, however, failed to go any further, and in December of the same year, a Mr. Dunlop gave notice of an address to the King, praying for a grant of wild lands to defray the expenses of a geological survey, which application also met with the same fate as its predecessors, and the matter was thenceforth dropped till the union of the provinces of Quebec and Ontario in 1841.

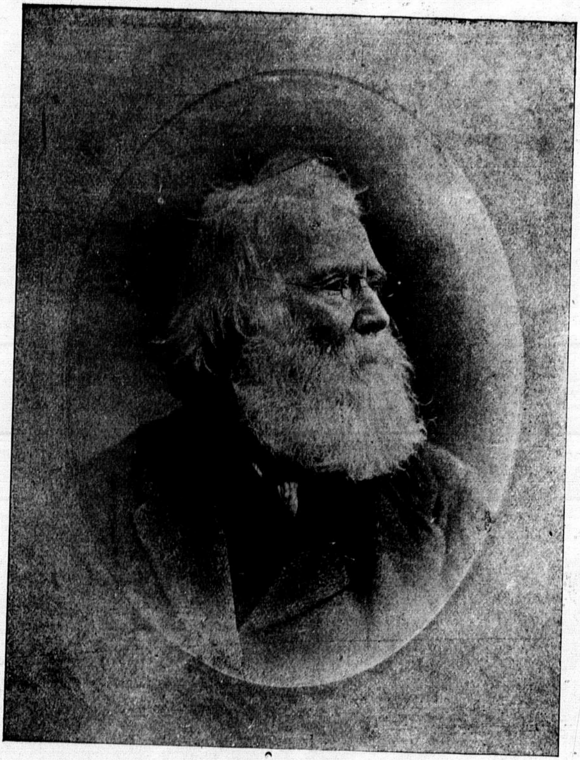
In that year the Natural History Society of Montreal, through Mr. Benjamin Holmes, and the Literary and Historical Society of Quebec, through Mr. Henry Black, again petitioned for aid to carry out a geological survey. The consideration of these petitions was taken up by government, and on the motion of the Hon. S. B. Harrison, the sum of £500 sterling, for the purpose of such a survey, was included in the estimates. As a result of this action, early in 1842, the advisability of appointing a geologist for the work was considered, and the matter was referred by Sir Chas. Bagot, who was then Colonial Governor for the time, to Lord Stanley, then Secretary of State for the Colonies, by whom on the recommendation of Sedgewick, Murchison, DelaBeche and Buckland, the position was offered to Sir Wm. Logan in September of that year.

Logan, who was in England at that time, returned to Canada in the fall and proceeded to Kingston, then the seat of government. Here the question of an assistant was discussed, and, on the recommendation of DelaBeche, the services of Mr. A. Murray, a gentleman who had been educated for the navy, but who had served for some time in the Ordnance Survey of Britain, were secured. Murray was already to some extent acquainted with Canada, having resided here for several years, and served as a volunteer also in the rebellion of 1837. The personal acquaintance of these two men, who have rendered such signal service to this country from a scientific standpoint, began in the winter of 1842-3, and the friendship then established continued unbroken till the death of the former in 1875.

Limited as was the area of Canada fifty years ago as compared with the enormous extent of territory now included under that name—the inception and carrying out of a plan of survey such as Logan contemplated, was not a thing to be lightly entered upon. Great portions of the country were accessible with difficulty, means of communication were slow and expensive, and the amount of money at his disposal, and the staff necessary for the work, were lamentably small. With characteristic energy he addressed himself to the task, and soon formulated a scheme for the carrying on of the explorations required. In the spring of 1843 Logan, who had spent the winter in England, again returned to Canada, reaching Halifax in May, whence he determined to make the journey overland through Nova Scotia, New Brunswick and Quebec, in order to obtain some preliminary ideas as to the structure of that section. It was on this trip that his first work was done in Nova Scotia, and particularly in connection with his famous Joggins section, of which it has been truly said that "it forms a remarkable monument of his industry and power of observation." The remainder of the season was devoted to the study of the carboniferous and underlying rocks of northern New Brunswick and of Gaspé, where a series of elaborate measurements were carried out similar to those of the Joggins sections. The conclusions then arrived at by Logan with regard to the value of these so-called coal fields in New Brunswick and Gaspé were to the effect that no deposits of that mineral could even be found there in workable quantity, and the views then expressed have ever since been accepted as definite, thus preventing the useless expenditure of capital in that direction.

While Logan was thus devoting his energies to the working out of the structure of the eastern provinces, Murray, his assistant, had been equally assiduous in his labors in western Canada, and in the preface of the Geol. Can., 1863, Logan says that "he (Mr. Murray) has worked out nearly all that is known of the distribution of the rocks in that division of the province." In addition to his work in this field, Murray also accompanied Logan in the first great exploration of the Gaspé peninsula in 1845, during which surveys were made of the Shick-Shock range and of most of the larger streams that traverse the section.

The Geological Survey can now be said to have been fairly launched, though under circumstances not the most satisfactory. At the session of the Legislature of 1845-46, the sum of £2,000 was voted for carrying on the work, and in the ensuing year this amount was granted for a period of at least five years. The bill upon which this grant was made was designed by Sir William himself, and was to the effect that a certain number of competent persons should be appointed, "whose duty it shall



THE LATE SIR WM. E. LOGAN.

Director 1843 to 1869.

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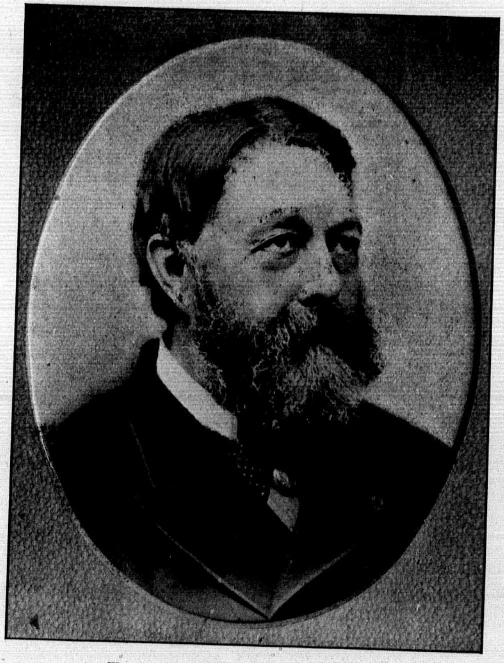
be, under the direction of the Governor-in-Council, to make an accurate and complete geological survey of the province, and to furnish a full and scientific description of the rocks, soil and minerals, which shall be accompanied with maps, diagrams and drawings, together with a collection of specimens to illustrate the same; which maps, etc., shall be deposited in some suitable place, which the Governor-in-Council shall appoint, and shall serve as a provincial collection, and that duplicates of the same after they have served the purposes of the survey, shall be deposited in such literary and educational institutions of the eastern and western divisions of the provinces, as by the same authority shall be deemed most advantageous."

The first chemist appointed by Sir William was the Count de Rottermund, a student of L'Ecole Polytecnique, Paris; whose connection with the official staff was but brief, as he voluntarily resigned the position in 1846. The vacancy thus created was speedily filled by the appointment of Dr. T. Sterry Hunt, who at that date was acting as chemist to the Geological Survey of Vermont. This appointment was a particularly happy one, and for nearly twenty-five years, in his capacity of chemist and mineralogist, Hunt built up, not only for himself, but for the Canadian Survey, a reputation which is world-wide.

With the exception of the department of palæontology, the Survey was now comparatively well equipped and ready to carry on the purpose for which it was established. The staff was small but the material good, and exploration went rapidly forward. In 1847 Mr. Jas. Richardson was added, and in the course of over thirty years work examined many portions of the Dominion from the Straits of Belle Isle to the islands in Queen Charlotte Sound, on the confines of Alaska. Other persons have been added from time to time as the necessities of the Survey demanded or the funds at its disposal permitted. In the branch of palæontology it was, however, found necessary for some years to send abroad for determination, many of the valuable specimens which were rapidly accumulating; and among those who rendered valuable services in this way were Prof. Jas. Hall, of Albany, N.Y., and Messrs. Jones and Salter, of the English Survey. This difficulty was at length overcome by the appointment in 1856 of Mr. E Billings, of Ottawa, whose love of scientific work in this line was such as to lead him to lay aside his chosen profession of the law, and, at the request of Logan, to attach himself to his small but zealous band of workers. Of him also it may be truly said that much of the great reputation the Survey has acquired, both at home and abroad, is due to his indefatigable labors. The appointment of Mr. Robt. Barlow, formerly of the Royal Engineers, as chief draughtsman shortly after completed the official equipment of the staff at that time. The work of exploration was carried on for some years by the employment of specialists, who were selected to undertake the examination of particular mineral locations, and whose reports were of great value; while those who were regarded as permanent employees of the staff carried forward the work along certain regular lines laid down by the Director himself. The particulars and results of these explorations will be found in the preface of that great volume, the Geology of Canada, 1863, in which the leading features of the Survey's operations to that date are admirably presented.

In connection with this volume, and designed to accompany it, the great geological map of Canada, and the adjacent northern States was published in 1866; of which it may be rightly said that no more beautiful work of the kind has ever been presented by this or any other Survey, a work entailing an enormous amount of labor and reflecting the greatest credit upon all engaged in its compilation and in the delineation of the exceedingly complicated geological lines there laid down. This great work will always stand as the map *par excellence*, and will always be pointed to with a feeling of pride, not only by the members of the Survey itself, but by every Canadian who feels an interest in the successful carrying out of the study of geological science in our own country. During all these years of hard work in the field by the officers and staff, other matters involving quite as serious labor, were being presented from time to time. The great exhibitions at London, Paris and Dublin, to which the Survey sent large and characteristic collections, both of rocks and minerals, which set forth in an attractive and forcible manner the great natural wealth of the country, were productive of much good, but involved an immense expenditure of time and energy. The museum and offices were constantly visited by scientific men from all parts of the world who might be passing through the city, as well as others seeking information on various points; and from the old workshop on St. James and St. Gabriel streets, much work of very great importance in connection with the development of Canada's mineral resources was produced.

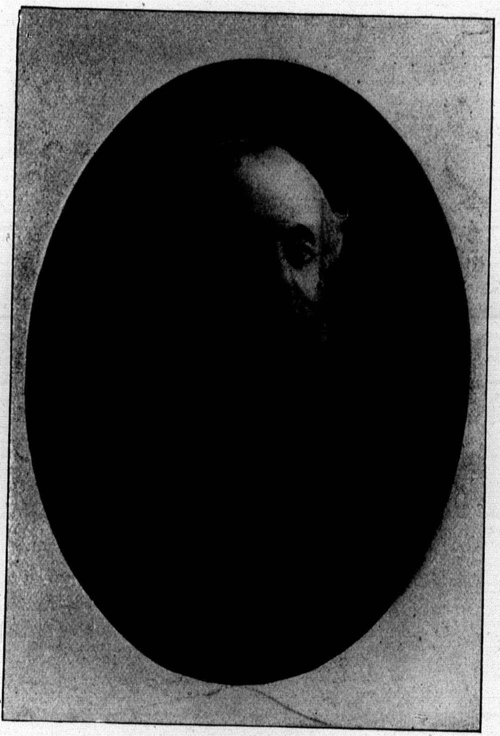


The Late Dr. T. Sterry Hunt.

But, in 1867, the confederation of the provinces opened new fields for the Survey's operations, and the somewhat small amounts hitherto granted were soon found to be inadequate to carry on the work over such greatly extended areas. In the meantime the Survey had lost one of its original members by the retirement of Mr. Murray, who at the request of the Newfoundland government had undertaken the survey of that colony. The staff had been gradually enlarged, but the great strain to which the Director had for some years been subjected began to tell upon him severely, and in 1869 Sir William Logan felt it incumbent upon him, in view of the greatly increased area to which the operations had been extended, and the interest he felt in solving certain puzzling problems of structure in the province of Quebec, in which he had for some years been especially interested, to lay aside the direct management of the Survey and to seek a successor. His resignation took effect in that year, and with this date we may close the first stage of the Geological Survey's operations. Dr. Selwyn, a gentleman of very extensive experience, not only in the Geological Survey of England and Wales, but as director of the Survey of the great colony of New South Wales, was chosen as his successor, and with this appointment we may enter upon what one may style the second period in the Survey's history.

Hitherto the work had for the most part been confined to the provinces of Ontario and Quebec. Henceforth it had to include in its scope not only the distant areas of British Columbia, the great plains of the North-West Territories, the rugged masses of the Rocky Mountains and the wide expanse of the Peace and Mackenzie rivers basins, but the Maritime Provinces of Nova Scotia, New Brunswick and Prince Edward Island as well. It can readily be seen, therefore, that the task now entered upon by Dr Selwyn was one of no small magnitude, especially when we consider that of our own great western areas our information was of the most meagre kind, not only as regarded its geological structure, its mineral wealth, its agricultural capabilities, and its natural history and climatic conditions. New and more detailed investigations had also to be undertaken in the older provinces, in connection with the metamorphic and metaliferous rocks, and in the great country lying between Lakes Huron and Superior and the Hudson and James bays. It is probably not saying too much, nor, I trust, will it appear to savor of adulation, if we state that probably no enterprise so great as the complete geological and natural history survey of a country embracing over 3,000,000 square miles, was ever undertaken by a staff so small in numbers, or carried on with an expenditure so insignificant as was attempted by the Geological Survey of Canada. And it is well within the bounds of truth, if we say that to the work of its members is due, in very large part, much of the information we now possess as to the greatness of the country's resources, both agricultural and mineralogical, between the waters of the Atlantic and the rugged wilds of Labrador on the east and the distant shores of the Arctic ocean and the boundary of Alaska on the north and west. It will scarcely be necessary to mention individual names in this connection. The various officers of the staff and their several fields of labor are too well known to require any special personal reference when addressing a society such as this.

It would be impossible in the time at our disposal to give any detailed account of the work of the Survey during the last quarter of a century over such an enormous area, and we can only summarize the result of the investigations of the several parties in the briefest manner. Thus, in the east, the carefully detailed maps of Cape Breton and eastern Nova Scotia have been presented to the public and have received the highest praise. We have now also a very good general idea of the structure of the other portions of the province, including the horizon and distribution of the great gold-bearing series which extends from Yarmouth on the west to Guysborough on the east. The structure of the great coal fields of Cape Breton, Pictou and Cumberland has been carefully studied, and the geological horizons of the ores of iron and manganese, which are of very great importance in connection with the future development of the country, have been clearly and satisfactorily determined. The geological maps of both New Brunswick and Prince Edward Island have been completed, and the complex question of structure in the southern part of the former province, which for years was of an exceedingly puzzling character, has been thoroughly solved. The outlines of the great central carboniferous basin, occupying an area of over 12,000 square miles in the province, have been carefully determined, and its presumptive value from the economic standpoint ascertained, while some of the most important work in Canada, in connection with the palæontology of the oldest fosiliferous formations, has been and is still being carried out with the greatest care.



Dr. A. R. C. Selwyn, C.M.G., Etc.
Director 1869 to 1895.

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In Quebec East, the great problem of the age and stratigraphical relations of the various members of the "Quebec group," a problem which for more than forty years has engaged the attention of geologists, not only of Canada, but to some extent of the United States and Europe as well, has, it is hoped, been placed on a satisfactory basis of settlement; while to the north of the St. Lawrence the mysteries of the great region of the Mistassini have been cleared up, and great progress made in the study of the Laurentian rocks north of the St. Lawrence and Ottawa rivers. The great wilderness country between the Ottawa and James Bay has been traversed in many directions along the great natural avenues of lake and river, by which alone this otherwise pathless area can be explored. Concerning the great extent of country about the Hudson and James bays, as well as of the great inland plateau of Labrador, we have now very clear ideas, not only of its geology and mineral wealth, but also of its fauna and flora, and of its adaptability for settlement; while much of its topography has been carefully mapped by means of instrumental surveys.

The economic problems of the occurrence of iron, gold, phosphate, asbestos, copper and mica have also been investigated and much valuable information relative to their distribution, their geological position and the manner of their occurrence has been obtained. Some of these have already appeared in the publications of the Survey or in the bulletins of the several seientific societies in Canada and the United States. In Ontario, while a large amount of detailed work has been carried on in the older and more settled portions of the province tending to the more accurate determination of the better known formation and to the determination of the economic mineral wealth, much careful work of a very high order has also been done in the area north of Lakes Huron and Superior and farther west, where some of the great questions as to the age and origin of the fundamental or lowest rocks of our systems are now in a fair way of being definitely settled. The geological relations of the copper-bearing series, of the great deposits of iron ores and of the gold-bearing rocks of the Lake of the Woods areas, and the horizon and distribution of the nickel ores of the Sudbury district have been among the questions of the greatest economic importance. In the more settled portions of the province the distribution of the gas-bearing strata, and the problems of the origin of the gas itself have been carefully studied, and the assertion of the great American gas expert, Ashburner, that no deposits of natural gas would ever be found in workable quantity in Canada, has been thoroughly exploded.

In British Columbia the work of the last twenty years has made us very familiar with the immense value of the coal fields of Vancouver, and with the inexhaustible forests which are found, not only on that island, but at many points on the mainland. The mapping of many of the gold fields of the interior has also been done, and the structure of the rock formations in the Rocky Mountain chain has been carefully worked out. The great mineral deposits of the Kootenay district have been thoroughly examined and much valuable information bearing upon their distribution and origin has been obtained. Further to the north the country traversed by the branches of the Peace River has been explored and the probabilities for successful mining investigated, while we have now ascertained very carefully the value of the coal area in Queen Charlotte Islands, and the distribution of the gold-bearing rocks and other formations in the great mountain area, lying to the east of the Alaskan boundary.

But the study of the rock formations and their associated mineral wealth does not by any means limit the work of the Geological Survey of Canada. In its operations are included the study of its fauna and flora. In the museum at Ottawa, stored away in cases and high presses, can be found one of the largest and most complete collections of plants illustrative of the history of all parts of our Dominion possible to be obtained. Much of the work of this branch of the department is not seen by the ordinary visitor, since, unlike rocks or masses of ore, dried plants are perishable things, and must not be exposed to light and open air. They must be carefully laid away and precautions taken to guard against the ravages of insects and other enemies of the botanist's handiwork. In these cases more than 100,000 specimens are stored, illustrating the distribution of the flora of the Dominion from the shores of Anticosti to the green valleys of Vancouver. The flora of the Peace River district, of the Mackenzie river, and the famous barren grounds, of the great plains and of the Rocky Mountain slopes, in the west; of the shores and islands of the Atlantic coast in the east, as well as of the country about the great inland lakes, and the interior of distant Labrador, is thus rendered available for study to anyone interested in the botany

Dr. G. M. Dawson, C.M.G., Etc.
Appointed Director January, 1895.

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of our country; and to the botanists and collectors of the Survey great credit and praise are due for the careful way in which this branch of the Survey's work has been carried on. Equally inconspicuous also with the botanical specimens are the magnificent collections illustrative of the insect life of the country, and probably most of those who wander through the corridors of the museum are unaware that such beautiful illustrations of this branch of scientific work are there stored. The ornithology, and to a certain extent also, the zoology of the Dominion are well shown by means of a good collection of the principal birds and mammals, while the various species of land and marine shells are also exhibited. Though in but few of these are the collections by any means exhaustive, sufficient has been done to show that the comparatively newer branches of natural history have not only not been exhausted, but that the results already obtained are of very considerable importance.

The division of ethnology has also received considerable attention. Extensive collections illustrating the manners, customs and institutions of the various Indian tribes which now inhabit our country have been made, as well as large quantities of the remains and relics of former races. The branches of palæontology, mineralogy and lithology, so intimately connected with the geological work, have been maintained at their usual high grade of efficiency, though the opening of the North-west Territories has introduced a new feature into the study of Canadian palæontology by the accession of great collections of fossils from the cretaceous and other closely associated formations found in that area, as well as from the older formations of the Rocky Mountain complex. The result of the fifty years collecting in this branch of the Survey's work has been to gather together one of the finest and most comprehensive collections illustrative of the life of past ages in the earth's history that can anywhere be found, a collection of such value to the scientific world, that if by chance it should be destroyed, its loss would be regarded as a great calamity by everyone interested in science the world over.

Of the internal economy of the Survey we have as yet spoken in but general terms. The collecting of facts relative to the structure and the making of surveys in the field would not possess one-tenth of their real value were no provision made by which these surveys and facts could be presented in compact and visible shape to the general as well as the scientific public. Hence the necessity for a topographical corps, whereby not only the work of the field staff can be arranged in map form for publication, but connecting surveys can be made to render these more intelligible. Then there is the careful arrangement of the museum, by which means everything deemed worthy of exhibit can be so displayed as to show to the best possible advantage the relations between the rock structure and the contained fossils where such exist, or the minerals or ores which may be therein contained; so that anyone in quest of information can most readily obtain such to the fullest possible extent and with the least possible delay. The library division also is one of importance, in which the working scientist can find the most recent helps to enable him the better to profit by the researches of his brethren in other but similar fields, and so become the better fitted to work out the problems he may himself encounter; and here it may be said that the library of the Geological Survey is probably the most complete in scientific literature of any of the libraries in the Dominion, and in as far as practicable is kept well abreast of the time as regards the current literature of the subjects concerned.

The financial management of such an institution is also a most important item in its general scheme of successful work, and the proper disposition of the funds, by which the necessities of the several widely scattered parties can be best met, calls for a wise discrimination of the needs of each and the expense peculiar to each locality to be explored; the prime object being the most judicious expenditure of the money at the disposal of the department, consistent with the highest and most satisfactory results obtainable.

I trust in the very imperfect description of the work done by the Geological Survey department, I have shown you that in the old building on Sussex street, many kinds of work, of great importance to the nation, are being carried on. The structure and contained wealth of the rock masses from the Laurentian or fundamental crust of the earth to the most recent formation of drift sand, gravel and peat, are being systematically studied and their actual value, in so far as this is possible, is ascertained. The importance of each system as a source of mineral supply, is carefully weighed, and the mode of occurrence and probable extent and value of each element of economic importance, sought out when practicable, to some extent in the field, and in more details in the laboratory. Not only are the analyses of the rocks and of the contained ores there conducted, and their probable value from many localities carefully proved, but the chemical composition of the mineral waters from the various provinces of the Dominion is carefully ascertained and their probable beneficial effects noted. Many of these have already proved to be large and important sources of revenue to the localities in which they occur, as at St. Leon, Caledonia, St. Catharines and other points. Much of this work, though presented annually in published volumes, fails to reach the general public, being by some curious process of reasoning apparently regarded as of more importance to scientific bodies and institutions of learning abroad than to those who are most directly interested in the development of the country's mineral wealth, a condition of things which doubtless to a large extent accounts for the oft repeated question, "What is the work of the Geological Survey?" In the present arrangement of publication, however, much greater facilities now exist for obtaining desired information in any particular area.

It may, perhaps, be allowable for the sake of illustrating some of the points just presented to compare the personnel and the financial outlay of the Canadian Survey with those of our great neighbor to the south, where the area of surface to be covered by its operations is not very different from our own. In the United States, however, owing to certain conditions of climate and other causes, field parties are enabled to spend a very much longer period in exploration than is possible in this country. Thus we find by comparison of the figures of the two surveys for the year 1887-88, that the expenditure of the American Survey for that year, exclusive of publication, was about half a million dollars; that of the Canadian Survey for the same date, including publication and all expenses of management, was about a fifth of that amount. A portion of this sum, amounting to about $20,000 only, was divided among sixteen parties whose operations extended from eastern Nova Scotia to Alaska, and included surveys in all the provinces, with special examinations of the country east of Alaska and the Mackenzie river basin, Hudson and James bays, and Lake Winnipeg and vicinity. In numbers the staff of exploration comprised in all, including assistants, thirty-five persons. In addition, work was carried on in the branches of palæontology, botany, chemistry, etc., the results of that year being comprised in twelve scientific reports, besides that of the director, which were published in two volumes of 1,364 pages, in addition to the bulletins on palæontology and botany. The American Survey during the same year employed in the geographical branch alone, eighty-five assistants, in addition to the chiefs of divisions, of whom there were fifteen in connection with the outside or geological work proper, and twelve for the associated branches, among whom were many of the leading professors in the different universities, men most distinguished in their special lines of work. With such a command of men and money, magnificent results may be confidently looked for, yet in the published volume for the year mentioned there are only four scientific reports besides that of the director, with twenty-four administrative reports, which correspond with the summary reports of the Canadian Survey, and describe the season's operations only as carried on by the different parties, the whole being contained in a magnificently illustrated and printed volume of 710 pages. In addition, as in the Canadian Survey, bulletins containing special reports on the work done in the various associated subjects were also published. Comparing results then, in so far as these can be ascertained, it is evident that the Canadian Survey has continued to maintain the high standard of efficiency which it has enjoyed from its very commencement and is giving full value for the amount of money expended thereon. The excellent reputation which it has borne, both at home and abroad, is due probably, fist of all, to the reputation of its founder, the late Sir Wm. Logan, and secondly to the fact that the great majority of its staff have labored to the utmost with hearts filled with a love for the subject and with a desire to achieve great and lasting results; and while it would be folly to assert that the work of the Canadian Survey, or of any similar institution has always been free from mistakes, since that would imply a degree of infallibility and accurate scientific knowledge, not yet enjoyed by mortals, it will, I think, be admitted by anyone conversant with its methods of operations that the attainment of truth in regard to the geological questions presented has ever been the chief aim of those associated in the work.

NOTES ON HYDRAULIC MINING IN BRITISH COLUMBIA.

By Dr. G. M. Dawson, C.M.G., Director Geological Survey of Canada.

[During the past summer Dr. Dawson visited the more important new works of this kind in British Columbia, of which a description was given, as well as some discussion of the geological conditions and age of the auriferous gravels, in an address to the members of the Association of which the following is a synopsis.]

Although hydraulic mining has long been practised on a small scale, particularly in the vicinity of the old gold mining camps in the Cariboo district, it is within the past two years only that really extensive operations of this kind have been initiated. Of these the most important are the Cariboo Hydraulic Company, operating on the south fork of Quesnel river, the Horsefly Hydraulic Company, on the river of the same name, and the Van Winkle Hydraulic Company, near Lytton, in the Fraser valley.

The two first mentioned companies are under the management of Mr. J B. Hobson, to whose practical knowledge and advice, based upon long experience in California, the renewed interest in mining in the Cariboo district is largely due. Both of these companies will be in full operation next spring, and it is anticipated that they will be closely followed by many other enterprises of the same kind. All these should be undertaken, however, only after a thorough preliminary examination of the character and extent of the gravels to be worked, for although the Cariboo district abounds in streams and lakes at many different levels, the expenditure necessary to obtain a sufficient supply of water with the requisite head is certain to be very considerable. In order to give an idea of the character of the operations now in progress, the following particulars relating to the Cariboo and Horsefly companies may be cited.

The property of the Cariboo Hydraulic Mining Company is situated on the south side of the south fork of Quesnel river, about three miles above the village of Quesnel Forks. It comprises several claims, and is believed to cover about 8,500 feet of an old high channel of the river, separated from the modern deep and canon-like river gorge for a considerable part of its length by an exposed rocky ridge, known as French

Bar Bluff. Near the lower end of the property, on Dancing Bill Gulch, successful hydraulic mining on a small scale and with imperfect appliances has been carried on for a number of years by a Chinese company. At a distance of about 3,000 feet further east, on Black Jack Gulch, a good deal of work had been done by the South Fork Company, but without effectively reaching the richer gravels, which are below the level of the rim-rock where this has been cut through. Short ditches have been made by both these earlier companies, and the exposures in their hydraulic pits afford most of the information obtainable as to the character of the deposits.

A ditch with a total length of seventeen miles and a capacity of 5,000 miner's inches has now been laid out by the present company and will be completed in the spring. This is to derive most of its waters from Polley's Lakes, situated in the hills to the south-eastward. It is also, I believe, ultimately proposed to bring an equal volume of water from Moorhead Lake by means of a second ditch, which will be thirteen miles in length.

At the lower, or "China Pit," the bed rock of the old channel where cut by the present river bank is believed to be approximately 134 feet above the river. The head of the train of sluices near the working face is 200 feet above the same datum, while the sand-box at the top of the bank is at a height of 489 feet; giving a head of water equal to about 289 feet, with ample fall for the dump, which is made direct into the river. Two monitors of 5 and 5½ inches diameter of nozzle respectively are established in this pit. Mr. Hobson estimates that the old Chinese company removed in all about 150,000 cubic yards of the bank, from which, it has been ascertained, $135,000 of gold was obtained, without the employment of mercury, or at the rate of about 90 cents per cubic yard. The scanty water supply available in advance of the completion of the main ditch enabled a run of only forty-seven hours to be made in the early summer. The mean volume of water employed was 2,000 inches, and the yield was 302 ounces.

The floor of the pit of the old South Fork Company is about 200 feet above the present river, and the bed-rock rim has been found in test pits at a depth of about 30 feet below this floor, while above it, on one side of the gully, is a nearly vertical face of clay and gravels about 200 feet in height. The head of water from the sand-box to the present bottom of the pit is about 246 feet ; but, as already stated, the rim rock has not yet been cut through to the full depth of the old channel. It is proposed to begin active work here in the spring.

The Horsefly Hydraulic Company's claims are situated on the Horsefly river at a distance of about six miles south of Quesnel lake. The river was notably rich in this particular part of its length, and the bars had all been worked over by Chinamen some years ago. The source of this gold was found by Mr. McCallum to be the old gravel deposit now being worked by the company.

By the hydraulic system now successfully completed, water is brought from Mussel creek, a southern feeder of the Horsefly, by a ditch and pipe-line aggregating over eleven miles and a half in length. The ditch is about ten miles long, with a capacity of 2,000 miner's inches. The pipe-line is steel, 30 inches in diameter, in two lengths aggregating 8,300 feet. There is also about 600 feet of flume. From the sand-box the water is led to the pit by two lines of 22-inch pipe, each of which is intended eventually to supply two monitors. Water is delivered from the main ditch with a head of 168 feet, and from the pooling reservoir with a head of 106 feet. The bed-rock, constituting the floor of the pit, is about 90 feet above the level of the river, and the working face (60 feet in height at its highest part), at the time of my visit, was about 560 feet back from the river bank. The dump is formed in the river itself, which is a moderately rapid stream, capable (particularly in high water) of removing a large quantity of debris.

Respecting the actual average gold content of the gravels as worked, much has doubtless been ascertained since my visit, some $13,000 being reported as the result of the last clean-up. The preliminary run made by the company was estimated to have dealt with 21,333 cubic yards of gravel. It produced gold to the value of $5,000, or at the rate of about 25 cents per cubic yard, but about a third of the area then worked had already been drifted on bed-rock by the original discoverer, rendering it probable, in Mr. Hobson's opinion, that the unworked ground would average about 40 cents. A small percentage of platinum occurs with the gold at this place.

The ground being worked by the Van Winkle Company is situated on the west side of the Fraser river about two miles above Lytton It consists of a series of terraces rising in steps from the river towards the bases of the mountains. The first of these is about 100 feet above the river, the second some 60 feet higher, while others occur at various still greater heights. The pit has taken the form of a great isosceles triangle, of which the apex touches the river, the base being about 1,200 feet distant. The yield in gold has not yet been found to be so good as the rich character of the old flat worked over here many years ago appeared to indicate it would be, but the prospecting carried on in advance of the work shows richer ground.

The water employed is brought along the upper terraces by ditch from a branch of Stein creek and then down to the work by an 18-inch pipe-line 1,500 feet long. The working head is about 350 feet and about 1,600 inches of water is employed.

The auriferous gravels at Horsefly are probably of Pliocene Tertiary age and are overlain by boulder-clay, referable to the glacial period. Those in the Cariboo Company's pits are in part inter-glacial and in part pre-glacial, but probably all newer than the Horsefly gravels. The deposits near Lytton which are being worked by the Van Winkle Company are in the main still more recent, consisting chiefly of the river benches or terraces, by which the Fraser valley is lined, and which have been formed by the gradual cutting down of the river itself after the close of the glacial period.

The geological conditions of occurrence of auriferous gravels in British Columbia, even as already known, are somewhat complicated, and as work progresses great additions to our knowledge may be expected. The circumstances differ considerably from those met with in California, because of the general action of glaciation to which British Columbia has been subjected. The older gravels, where not covered by a basaltic capping, are often buried under boulder-clay, while above the boulder-clay or between two deposits of this kind, are to be found extensive masses of later gravels. The study of the facts relating to the glacial period are therefore here likely to have an important bearing on the economic problems of the gold placers and the tracing out of the old auriferous drifts.

THE AURIFEROUS GRAVELS OF BRITISH COLUMBIA.

By JOHN B. HOBSON, M.E., Vancouver.

The auriferous gravels of British Columbia, like those of central California, may be divided into two classes; first, the shallow or modern placers; second, deep or ancient river placers. These terms indicate the characteristic difference that exists between the two classes of placers.

SHALLOW OR MODERN PLACERS.

These placers are superficial deposits of auriferous gravel and alluvium, formed by the modern streams that drain an auriferous region, and are designated as river, bar, bench, gulch, creek or ravine diggings, according to their topographical position.

The placers of the modern rivers of California are practically exhausted Those of British Columbia are not by any means exhausted.

The shallow placers known as bar, creek and gulch diggings, have been, so far as known, extensively worked since the Fraser river and Cariboo gold excitements about 1857.

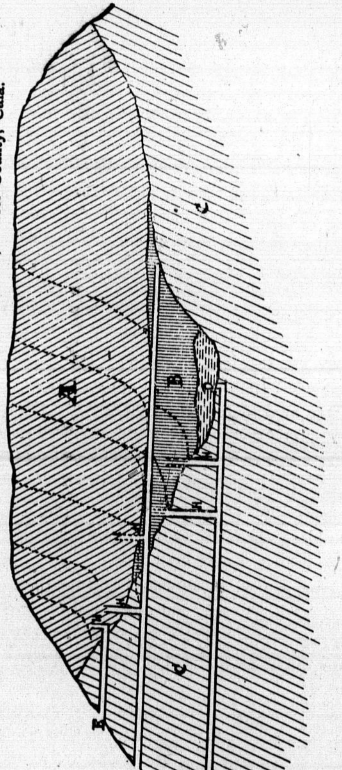
The most accessible of the above-named placers have been pretty well worked out in the districts I have examined.

But the vast accumulations of auriferous gravel on the benches along the Fraser, Quesnelle, Horsefly and other modern streams examined are practically unexplored. These can be worked by hydraulic process wherever water can be secured and all other necessary conditions are reasonably favorable.

The deep placers of the modern streams, that is to say, the auriferous gravels lying below the water-level of the modern streams, have been worked to some extent in the vicinity of Barkerville, but immense areas remain to be explored, and will in all probability be profitably worked in the future by aid of modern appliances.

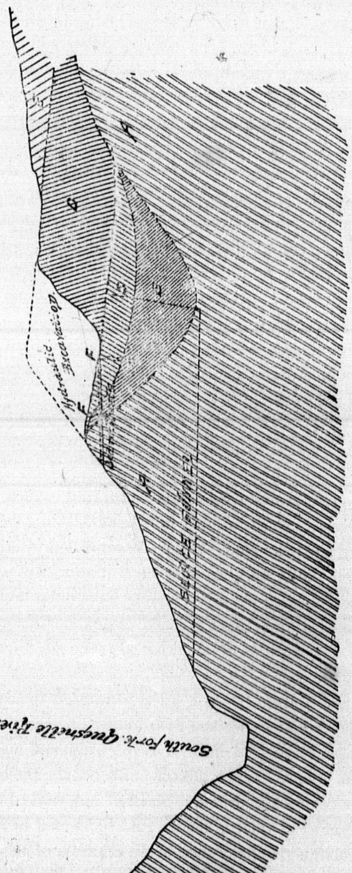
The deep modern placers can be exploited either by shaft, and worked by what is known in California as the drifting process, or by the hydraulic elevator process. In other words, a shaft is sunk to bed-rock, and the bottom stratum of auriferous gravel is breasted out, hoisted to the surface, washed in ordinary sluices and the gold recovered.

Fig. 1—Sketch Shewing Section of Gold-Bearing Gravel Deposits of Ancient River, Placer County, Cala.



A—Auriferous Top Gravel
B—Cemented Blue Gravel
C—Hard Slate Bed Rock
D—Channel of Ancient River
E—First Sluice Tunnel

F—Second Sluice Tunnel for working Top Gravel
G—Third Sluice Tunnel for working Blue Gravel
H, H, H—Shafts connecting Hydraulic Pit with Tunnels
I—Bed of American River
Dotted Lines—Hydraulic Excavation



A—Bed Rock
B—High Grade Auriferous Gravel
C—Indurated Boulder Clay
D—Low Grade Auriferous Gravel
E—Boulder Clay rearranged in Places.

Fig. 2—Sketch Showing Geological Section on Line Across Workings in the South Fork Pit, Cariboo Hydraulic Mine, B.C.

Wherever an abundant supply of water can be obtained and delivered at the mine under sufficient head or pressure, as it is called by California miners, the auriferous gravels lying below drainage can be successfully and profitably worked by the hydraulic elevator. Figure 4 represents a mine in operation by the hydraulic elevator process.

THE DEEP PLACERS OF THE ANCIENT RIVERS.

The deep placers of the ancient river system of the tertiary, as seen in British Columbia, are similar in character, but so far as I have been able to determine, far more extensive and richer in their gold tenure than those of the most favored districts in central California, where gravel deposits which contain from three to five cents per cubic yard in gold are considered rich and yield as profit from 20 to 50 per cent. of the gross output when worked by the hydraulic process.

Figure 1 is a sketch showing a geological section of an ancient river channel deposit of auriferous gravel in California, and shows the method of exploitation and working by the hydraulic process.

The top gravel A is usually free, and yields to the force of the hydraulic streams, and is easily worked out through the sluices in tunnels E, F and G.

The blue gravel stratum B is usually indurated to such a degree that it becomes necessary to disintegrate it by bank blasting before the gold can be liberated and recovered. This is accomplished by driving a system of drifts under the bank and exploding large quantities of powder therein —one hundred thousand pounds of powder have often been exploded in one blast at some of the larger hydraulic mines in California. By this means immense quantities of the richer gravels are disintegrated and very profitably worked.

The bottom stratum D is in places indurated to such a degree of hardness that it cannot be worked by hydraulic process without loss of a large percentage of the gold inclosed in the indurated mass which goes to the dump in lumps. When this condition occurs, the bottom or rich stratum on the bed-rock is drifted or breasted out, worked in stamp mills in the same manner as quartz, and the gold recovered by amalgamation. Similar conditions accompany some of the deposits of the ancient rivers of British Columbia as those illustrated in figure 1. Figures 2 and 3 represent geological sections at the Cariboo hydraulic mines.

Water is abundant in all the districts I have examined, and can be brought on to the deposits in shorter canals and at much less expense than is possible in California.

In California there it invested one hundred millions of dollars in hydraulic mining enterprises, and prior to the inhibition of that industry, on account of the alleged damage done by debris to agricultural lands and navigable streams, the annual product in gold amounted to about twelve millions of dollars, about one-half of which resulted in profits.

The auriferous deposits of California remaining unworked are estimated at 2,108,875,000 cubic yards. The gold tenure of these gravels varies from one to thirty cents per cubic yard, and the total gold content is estimated at about $500,000,000.00.

I have seen in British Columbia, included in the Yale, Lillooet and Cariboo districts, three times the area of auriferous deposits that are known to exist in the whole of the State of California.

The British Columbia gravels that I have examined, and that may be considered available for hydraulic working, yielded results varying from one cent to $1.50 per cubic yard, and as a whole average richer than any I have seen in California.

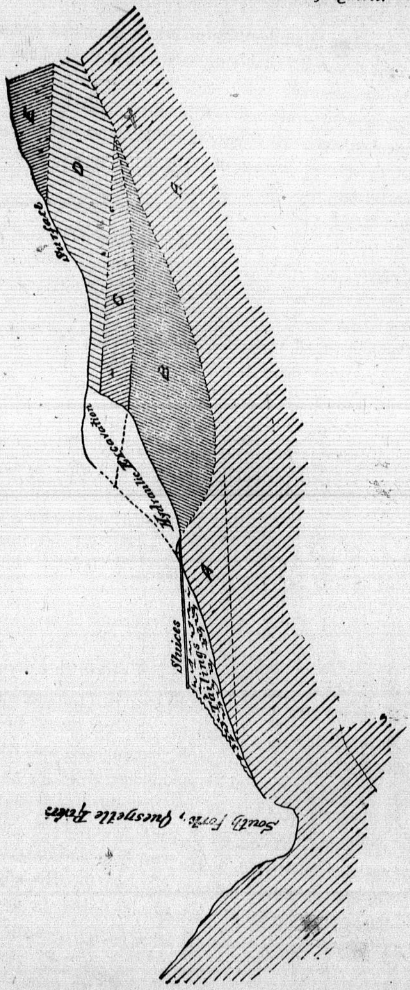
In some properties examined, I sampled streaks, some of which were on bed-rock and others 150 feet above the bed-rock, that yielded prospects varying from $2 to $36 per cubic yard. We have no such rich deposits in California.

The exploitation and equipment of hydraulic mines is expensive, and large sums of money are required to provide water supply and hydraulic plant, to get the mines opened and placed on a paying basis.

For this reason great care should be exercised by those intending to engage in such enterprises. Competent engineers should be employed to investigate the source of water supply, determine the available gradient for sluices, dump for debris and the gold tenure of the gravel. The absence or insufficiency of either of the first three of these conditions means the failure of the enterprise to prove remunerative.

A company of gentlemen in Montreal have undertaken the equipment of two large hydraulic mines in Cariboo, the Horsefly hydraulic mine and the Cariboo hydraulic mine, which will soon be on a basis for profitable production.

Fig. 3—Sketch Showing Geological Section on Line Across Workings China Pit, of the Cariboo Hydraulic Mine, B.C.



A—Bed Rock
B—High Grade Auriferous Gravel
C—Indurated Boulder Clay
D—Low Grade Auriferous Gravel
E—Boulder Clay rearranged in Places
F—Prospect Shafts

Fig. 4.—HENDY HYDRAULIC GRAVEL ELEVATOR.

I do not hesitate to predict that the day is not far distant when the gold output from the auriferous placers of British Columbia will not only surprise Canadians, but will astonish the civilized world.

I will refer briefly to some of the principles involved in the working of hydraulic mines, and to the origin of the hydraulic process in California.

The exhaustion of the shallow placers led to the discovery of the deeper deposits of the ancient river system. The shallow placers were, of course, rich like those of Cariboo, and, as they were exhausted, the miners attacked the deeper deposits to work their shallow edges. Only a small supply of water was required, and the great richness of the bed-rock stratum and concentrated edges or rims made the work profitable to individual labor, with the easily obtained and limited supply of water; but as the depth of the superincumbent mass of poorer top gravel increased, the results decreased and the individual miner was forced to abandon his effort and depart for shallower and richer fields

This was the condition of California in 1857. This is the condition of the auriferous regions of British Columbia today—the shallow placers exhausted, the deep placers unexplored. Vast areas of the best auriferous earth in the world awaiting the energy of the prospector to explore and locate, and the courage of capital to develop and place on a basis for gold production.

The gravel banks or deposits of debris and alluvium of the ancient rivers are the most favorable form of deposit for the operation of hydraulic mining, owing to the even distribution of the gold throughout the mass of gravel and the great depth of material.

As the early or pioneer miners exhausted the rich shallow placers in the ravines and gulches, they turned their attention to the deposits of the ancient rivers, working off their thin edges with the limited supply of water, but sooner or later abandoned the attempt, as the amount of the material which they could remove in a day with a small quantity of water, without pressure, would not pay; they had, however, discovered two important facts, viz.: That their want of success was mainly due to the want of a large supply of water delivered under pressure to enable them to remove large quantities of material. As before stated, miners also discovered that as the quantity or volume of water employed was increased, as also the pressure under which it left the delivery pipes, they

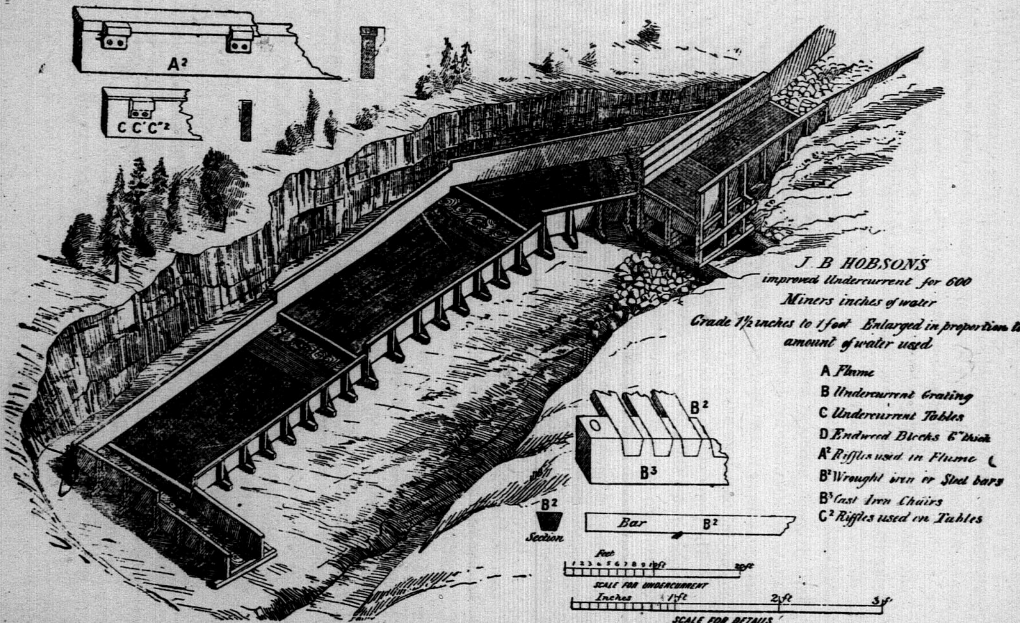


Fig. 5.—APPLIANCE FOR SAVING FINE GOLD.

accomplished better results, and that under favorable circumstances, gravel which contained only a few cents per cubic yard could be made to pay handsomely, and therefore every effort was made to secure these conditions. Out of these efforts has arisen the modern system of hydraulic mining, which I will briefly endeavor to explain.

HYDRAULIC MINING.

Hydraulic mining is accomplished by utilizing the power of water, and the gradient afforded by the fall or difference of level between the auriferous deposits and the dumps into which the debris resulting from the mining operations must be deposited.

The power of the water depending on its volume and the head or pressure under which it can be delivered at the working floor of the hydraulic excavation, it is therefore most essential that the water ditch or canal should be at a high elevation above and as near as possible to the deposit of gravel to be mined. The first condition insures a great hydrostatic pressure, and the second a reduction in the length and cost of the sheet-iron or steel conveying pipes.

It has been demonstrated that one thousand miner's inches of water can be discharged under a head or pressure of 300 feet through a 6-inch nozzle, with a velocity of about 140 feet per second, and in a volume of about 1,650 pounds during the same period of time.

Such a volume of water, in the form of a jet uninterruptedly impinging upon a bank of auriferous earth or gravel, having, as it does, about one-tenth of the velocity of a projected cannon-ball, must necessarily do great execution, and produces the caving of an ordinary gravel-bank without the aid of explosive blasting.

The greater the gradient given to the conveying or mining sluices, the greater will be the duty of the water employed to remove the auriferous material from the excavation to the dumps.

The separated gold is caught between the riffles placed in the mining sluice bottoms, and held there by the use of mercury until it becomes desirable or necessary to recover it therefrom. When the amalgamated gold is cleaned up from the sluices, it is retorted to distil over and recover the mercury and the remaining gold retort, as it is called, is melted into bars and sent to the mints for coinage.

Gold-saving appliances, called under-currents, are now in general use in California for recovering fine flour gold that could not be recovered in the ordinary riffled sluice.

Figure 5 represents an improved under-current.

As it is proposed to remove immense masses or quantities of gravel, only utilizing an infinitesimal portion of the same, it is first necessary to see that there is abundant room to dump below the mine the vast quantities of debris to result from the entire working of the mine, for if this debris was permitted to accumulate near the end of the sluices, it would soon choke and cover the gold-saving appliances. It next becomes necessary to ascertain the quantity of water available, and the head or pressure under which it can be delivered at the mine.

The amount of work that can be accomplished depends greatly on these two contingencies; it is self-evident that to remove a large amount of material composed of sand, gravel, cobbles and rock, a considerable quantity of water is necessary, and if it is not obtainable, the operations of hydraulic mining cannot be carried on successfully. The amount of water used for operating an hydraulic mine varies greatly in different localities, viz.: from 200 inches to several thousand inches daily, 500 to 1,500 inches being considered a fair volume to be discharged through one machine or giant, while the work accomplished by the quantity of water used is greater as the pressure, under which it is discharged in the mine, and the grade of the sluices for conveying away the gravel increases.

As water used by miners is always measured by the inch, and all calculations of the value of gravel are best estimated by the duty of an inch of water, it becomes necessary to fully understand what an inch of water is as well as its power to remove gravel under different conditions. The standard of measurement varies slightly in different mining districts, but the usual method of measuring water now in use in California is to discharge the water through a 4-inch opening while the water in the measuring-box stands 4 inches above the top of the discharge opening; thus an opening 125 inches long and 4 inches high will discharge 500 miner's inches, one inch being equal to a discharge of about 2,230 cubic feet in 24 hours. As an illustration of the advantage of estimating the value of a bank of gravel by its yield in gold per cubic yard, and the number of yards of gravel removed in 24 hours per inch of water used, where the water was used under different heads and the sluices under

TABLE SHOWING RESULTS OF WORKING A FEW WELL MANAGED MINES IN CALIFORNIA.

Name of Mine.	Locality.	Quantity Water used in Miner's inches.	Height of Bank in feet.	Head or pressure of Water in feet.	Grade of Sluices in inches to 12 feet.	Cubic yds. of Gravel moved per inch of Water used in 24 hrs.	Average yield in cents and fraction of cents per cubic yard.	Average yield in cents and fraction of cents per inch of Water used in 24 hours.	Cost of Mining per cubic yard in cents and fraction of cents. Water.	Labor, &c.	Total Cost of Moving per cubic yard in cts. and fraction of cents.	Net Profit per cubic yard in cents and fraction of cents.	Net Profits in cents and fraction of cents per Miner's inch of Water used in 24 hrs.	Remarks.
French Hill......	Stanislaus Co.	2150	30	70	3½	$1\frac{14}{100}$	12	13	$\frac{8}{10}$	$5\frac{1}{10}$	$5\frac{9}{10}$	$6\frac{1}{10}$	$6\frac{1}{10}$	This company owns water which costs about 1 ct. per in.
North Bloomfield.	Nevada Co.	3000	260	300	6½	$4\frac{17}{100}$	$6\frac{6}{10}$	$27\frac{5}{10}$	$\frac{74}{100}$	$2\frac{45}{100}$	$3\frac{19}{100}$	$3\frac{41}{100}$	$24\frac{31}{100}$	This company owns water which cost 3 cents per inch.
Independence Hill	Placer Co.	500	150	375	12	24	3	72	$\frac{41}{100}$	$1\frac{09}{100}$	$1\frac{5}{10}$	$1\frac{5}{10}$	36	Both these companies purchase water at 10 cents per miner's inch per 24 hours.
Big Bonanza....	Placer Co.	1500	Top Gravel 250	300	8	14	5	70	$\frac{71}{100}$	$1\frac{79}{100}$	$2\frac{5}{10}$	$2\frac{5}{10}$	35	

different grades, see the annexed table showing the results of the working of a few well managed hydraulic mines in California.

By reference to the table, it will be seen that the mine yielding the least amount of gold per cubic yard gives the largest returns to its owners, for the reason, as the table shows, that the water was delivered at the mine under the greatest head, and the sluices for running away the gravel have the heaviest grade. It is evident that the value of the gravel per cubic yard is not a good standard, and for this reason the power of a definite quantity of water and a heavy grade in the sluices have been substituted to accomplish the desired result.

If grade for sluices, dump for debris, and a sufficient quantity of water are available, it is then worth while to ascertain whether the gravel will pay to wash, and under this head it will be easy to show, by reference to many operations on a large scale, that the cost of mining and washing a cubic yard of gravel may be brought to exceedingly low figures, but it is almost impossible to say what it should contain to be remunerative, as so many elements and conditions enter into the calculations.

The price of water sold to miners in California for hydraulic mining varies from 10 to 20 cents per inch per 24 hours, and this item must always influence the result, as it is the main one, but at the same time the actual cost of water to the ditch owner is not more than from 2 to 5 cents per inch, so that the ditch owners can afford to work gravel on their own account that would not yield more than 1 or 2 cents per cubic yard, considering other conditions, such as grade for sluices and dump for debris being reasonably favorable.

It is hoped that this brief sketch, which deals only with the principles employed and not with their individual application, will give an intelligent idea of hydraulic mining, which promises to become an important industry in British Columbia.

Had I the time, Gentlemen, I would willingly enter more into details of working and equipment of deep gravel drift and hydraulic mines.

I thank you for your patience and attention, and hope to have the pleasure of meeting your Association at some future time.

"CHARCOAL; ITS BEARING ON THE UTILIZATION OF OUR FORESTS."

By MR. T. J. DRUMMOND, Montreal.

In asking the attention of a Mining Association to a paper on a forest product, I think perhaps it is best at the outset to remind you that, as, so far, charcoal is the only known fuel natural to this province for the smelting of iron ore, this important product of the mine must be governed by the product of the forest. If we cannot produce cheap charcoal, and if we cannot see a supply ahead, then any attempt to establish an iron industry in this province, on anything like an extensive scale, would mean failure. The importance of this question of the production of charcoal and its encouragement, and the conservation of woods for its manufacture, therefore, cannot well be over-estimated. Canadians have truly a magnificent national asset in their forests, and every care and thought should be given to the question of how it may be utilized.

It will be unnecessary for me to dilate on the forests of the Dominion. While the variety of trees is not as great, still the area under timber in Canada is certainly equal to that of the United States, and the woods are useful and valuable. In our own province there are probably not more than fifty or sixty species, but they have already yielded a large revenue to the country, and with proper care they will continue to do so for generations to come. In fact, with a climate like ours, our supply should be unending, as it is in every way favorable to the growth of forests, and if a proper system of cutting is followed and due care given by the Government, through a system of inspection, new forests will spring up to replace the timber removed, where the land is not put to agricultural or other purposes. To preserve these forests, and to utilize them to the best advantage to the country, should be both a national and provincial care, and, if necessary, vast districts should be set aside and reserved for this purpose, over which the Government should exercise full control.

We have forest wealth now, and so, as I have said, what we must consider is how we can utilize this to the best advantage to the nation.

In considering this, it seems to me that, as in the case of private assets, we must consider each class of wood separately, and try and find out in what way these woods can be utilized so as to return the greatest benefit in cash and labor, and in my opinion we should not be content to be simply "hewers of wood," and allow others to reap the benefits derivable from the labor that may be employed in bringing any of our woods to a higher state of finish and value, but should encourage by legislation and otherwise the manufacture within our own boundaries of whatever articles the variety of our woods may be suitable for.

If we are to advance in wealth and population, if we are to build a nation, we must be able to offer fair work and fair wages, and to do this, we must develop our natural resources, more especially in those directions that require the greatest amount of labor. When we have labor and the producing power of the earth working together, whether in agriculture, mining, or the utilizing of our forests, we are doing this, and the higher the point to which we can bring the earth's product, with the consequent increase of value through extra labor expended within our own boundaries, the better for our country. So, I reason, that if instead of shipping our forest products in practically a raw state, we can carry the process of finishing to a higher stage, then our forests will of a necessity yield us so much greater benefit. To a very large extent, the value of a forest tree is the value received for the labor expended in hewing it into square timber, sawing it into boards, or turning it into an article of furniture, and it stands to reason that the tree that was by Canadian labor transformed into furniture, has yielded more than its fellow that was exported in the form of square timber, or that a spruce tree shipped in the form of paper yields more than if it had left Canada in the form of sawn logs or even pulp. As with our soft or merchantable woods, so with the unmerchantable or hard woods. If we burn these woods to clear the land, it means dead loss, or if we use them for domestic fuel, the return is small, and if we turn them into charcoal and export the charcoal in that shape, the value to the country will not be very great, but if we use those woods in such a manner as to develop an industry that must otherwise be non-existent, then we have obtained something worth while, and so I hold that by burning into charcoal and using that fuel for the smelting of iron, the value of the cord of wood to the country becomes the value of the labor expended in producing the amount of pig-iron that quantity of wood will smelt; in other words, the value of a cord of wood for domestic purposes to the farmer would be, say $1.50 to $2.00, and would yield nothing beyond that to the country. But if that cord of wood was burnt into charcoal, and by that fact an iron industry becomes possible, then as it takes from two to two and one-half cords of wood to obtain sufficient charcoal to produce a ton of iron, so it must be plain that a cord of wood utilized in this way brings, through the labor consequent on raising the ore, flux, etc., and smelting, say from $6 to $9 per cord, according to the class of ore smelted and wood used. In making this statement, I am, of course, dealing principally with our Province of Quebec, where the conditions are such that without charcoal an iron industry cannot be commercially established, and where, with proper attention, consideration, protection and encouragement towards the utilization of what are known as unmerchantable and waste woods, insuring a long and regular supply of charcoal, a charcoal iron industry can be developed as great and as important to the province and the Dominion as that industry has been, and is, to Sweden and the United States.

Now that I have given in a general way my ideas as to the utilization of our forests, and the bearing those forests have on the iron industry in this province, I will, in as few words as possible, explain the different systems of manufacture of charcoal generally followed, giving particularly the practice adopted at the works with which I am identified

In cutting wood for pit burning, the custom in Sweden is to cut the logs in about 9-foot lengths, but in our own experience we have found it better to cut to shorter lengths for reasons hereafter given.

For kiln burning, the general practice in the United States is to cut to 4-foot lengths. Formerly the cutting to lengths as well as the felling was done with the axe, but latterly the saw has been brought into general use, with a view not only to quicker work, but to prevent waste. The value of the saw in cutting the cordwood to length is considerable, for the axe-chips represent a very material loss. The axe seldom makes a cut at an angle less than 45 degrees, so that in practice as much wood is cut away as remains in the two adjacent points, and the loss of chips in cutting to 4-foot lengths with the axe amounts to fully from 8 to 10 per cent., according to the size of wood cut.

In the Province of Quebec, when we first took up the charcoal iron industry, we found that the practice was to work wholly with the axe, and to cut to 3-foot lengths, and we saw that this must be changed, as the loss was considerable in labor through cutting to such short lengths, and the loss in chips also was naturally very great. We had a great deal of prejudice to overcome, but we are now making for kiln purposes solely 4-foot wood, and our men are using the saw for cutting to length, and we find that not only do we effect economy for reasons given, but our men are able to earn, working in pairs, with the saw, better wages than they formerly could, working singly, with the axe.

In burning into coal two systems are generally followed, viz., pit or meiler burning and kiln burning, and in the United States "retort" burning has been attempted. This is carried on, I believe, on a small scale at present, but I do not think it has ever proven to be a commercial success, although perhaps if given full trial it might be found to be more economical than it has so far proven to be.

KILN BURNING.

Two styles of kilns are generally used,—the "rectangular" and the "bee-hive." The latter has been found to be the most satisfactory, and has practically superseded the "rectangular" kiln. In our own experience the "rectangular" kilns have given us good results, both as to durability and the making of coal, but we have found them more difficult to keep air-tight than the "bee-hive," and that they also require more experience and care in handling, being more subject to cracking and opening through being affected to a greater extent by expansion and contraction. They have also to be well bound with heavy frames of wood, which are affected by weather and time and require replacing.

Our present battery of "rectangular" kilns is, however, in first-class condition, although it has been in operation about twenty-four or twenty-five years. This is perhaps mostly due to the fact that they have been carefully looked after, and repairs promptly made when necessary.

When in operation, it is necessary that the burner watch the "rectangular" kilns very closely, owing to there being a greater liability to burn down to the centre than in the "bee-hive" kilns, the form of the latter giving solidity, while the action of expansion and contraction from heat and cold is not so great, and the "bee-hive" kiln is therefore easier to keep air-tight, and for these reasons the coal produced in the "bee-hive" is more uniform.

Apart from the question of coal, the "bee-hive" kiln is much easier to keep in repair, as it is not necessary to have any wood frames or binding. The wood can also be handled somewhat cheaper and faster in the "bee-hive" than in the "rectangular," and owing to their greater liability to straining from expansion and contraction already referred to, the "rectangular" kilns require about two or three days longer to cool, and therefore cannot be "turned over" as often as the "bee-hive," and for general results the latter has been found to be the most suitable.

PRINCIPLE OF MANUFACTURING IN KILNS.

In our "rectangular" kilns, an opening is left from the front door to the centre of the kiln. This is made by piling the cordwood in such a manner that a canal of say 12 inches square is left in the middle of the kiln leading from the door to the centre. At this point a sort of crib-work is built, known as a "chimney," leading to the top of the kiln. On all sides of this dry wood (or brands) is piled so as to fire easily. A small quantity of split brands is then placed in the hole in the centre. The wood on all sides is ranked in the same manner as cordwood and is piled as closely as possible. Along the top of the kiln the lighter wood is laid, and this for two reasons. First, it is easier to handle; and secondly, the fire will run through it quicker than through the heavy timber which is left in the centre of the kiln. Then a fair quantity of light wood (or brands) is placed along the bottom and at the ends. When the kiln is closed and ready for firing, the top door is opened and a piece of oily waste is inserted by means of a long pole to the centre of the "chimney." The draft to the top of the kiln carries the fire upward and along the top, and once fairly started, the top door is closed and the air is allowed to draw down to the lower vents, three rows of which are open around the base of the kiln. These vents are operated by the burner in such a manner as to draw the heat from point to point of the kiln, and thus to "cook" the whole mass. The direction and force of the wind have a large bearing on the manipulating of the heat, and will drive it from one side of the kiln to the other,—hence the holes have to be closed and the windward side protected to prevent combustion, as otherwise the wood would become over-heated and be reduced to ashes.

The condition of the coal in the kiln when approaching the finishing point is generally determined by the color of the smoke, and sometimes by the insertion of an iron rod at various points to ascertain by "feeling" the condition of the wood or coal. This latter mode is only occasionally resorted to.

Bee-hive Kilns.—The same mode of piling and firing applies to the "bee-hive" kilns as described in regard to the "rectangular." The fire is started at the bottom and allowed to burn upwards. Once fairly started among the light or dry wood, the kiln is closed, and as the gases escape from the wood they practically supply sufficient heat to "cook" the entire mass. Care must be taken at all times to prevent too great a supply of air to the kiln, and thus cause combustion.

The properly cooked kiln should contain only the ashes made by the wood that surrounds the "chimney" with a little from the dry or light wood on the top, the combustion of which has supplied sufficient fuel to heat the mass and cause the drying and evaporation of water and gas in the whole.

What a charcoal burner must keep before him all the time is, that the wood is to be "cooked" and not burned, so that every care must be taken to prevent combustion, and sufficient heat must be introduced into the kiln or the "chimney" or canal leading to it, or by the combustion of a small quantity of light or dry wood on top to "cook" the whole mass. The light wood, of course, will be consumed, but in the meantime it should have imparted sufficient heat to the rest to draw off the water and the lighter gases.

The burning of charcoal is more or less a process which distils or throws out the undesirable gas, leaving the mass of wood charred to the centre. If this could be carried out to perfection, the coal should be solid without any breaks or cracks or tendency to fall to pieces.

Both our "bee-hive" and "rectangular" kilns have a capacity of about 55 cords, and they generally take from ten to fourteen hours to charge, according to the class of wood handled, and from five to six days to burn, which is again largely governed by the class of wood. The "bee-hive" kilns take about eight days to cool and can be easily discharged in one day. The "rectangular" kilns generally take two or three days longer to cool, owing to their being more affected by expansion and contraction. In our kiln work we use cord-wood all the way from a limb of $2\frac{1}{2}$ inches in diameter up to the trunk of the heaviest tree that is too solid or knotty to be split with the axe, so that in our practice there is practically no waste wood, as we use tops, lops and everything.

THE MANUFACTURE OF COAL IN PITS OR MEILERS.

In Sweden the coal is very largely manufactured in pits, and this has been carried on on quite a large scale also in the United States. One advantage of the pit system is that farmers and others can do coal burning on their own lands and obtain the results of the labor, and at the same time the cost of transportation is naturally greatly lessened, as forty bushels of charcoal can be transported for considerably less than a cord of wood, of which it is an average equivalent. In general results throughout the United States it would seem that the quantity of coal per cord obtained by pit-burning has not been equal to the quantity obtained in the kilns. The general average seems to be about 35 bushels per cord from pit-burning as against about 40 bushels from the kilns. In my opinion, this is very largely due to lack of care or knowledge on the part of the pit-burner, as with the same care and attention, and with a thorough knowledge of the work, there does not seem to be any good and valid reason why the results as to quantity should not be about equal Apart from this, however, in our own experience of pit-burning, the coal produced was of a better quality than that obtained in the kilns, (*i.e.*, where the work was well done). We found the coal dense and close, and practically solid to the centre, and this class of coal develops at least 15 to 20 per cent. more gas than the ordinary coal obtained in kiln practice. It will not consume as rapidly, and gives a greater and more enduring heat, and has proved itself as economical even where an equal quantity per cord was not obtained, as compared with kiln practice.

In manufacturing coal in pits, the process of firing is practically the same as that practised in kilns, a canal being made to the centre in which to insert the fire, and a "chimney" built to the top along which light wood (or brands) is placed.

The whole is then covered with eight or ten inches of evergreen branches, leaves, and sand or earth. After the fire is thoroughly started, the top or the centre over the chimney will fall in, owing to the total consumption of the wood at that point, and a supply of hard wood is kept on hand, which is driven into this hole as soon as the covering shows a tendency to fall in. After it is thoroughly re-filled, a fresh covering is put on, then vents are opened along the sides towards the base The condition of the coal inside is ascertained by feeling with an iron rod, and as the burner finds it at any point properly "cooked" he can open it and withdraw a portion of the coal, covering the balance rapidly and carefully again in the same manner as at first. This process is kept up until he knows by the color of the smoke and by the inserting of his "try rod" that the whole is properly "cooked." It is all then carefully covered in and allowed to cool and die out.

This mode of burning coal requires very careful and constant watching, owing to the liability to fire. As I have already said, the practice in Sweden is to use wood for pit purposes in 9 or 10-foot lengths, and when we took up the question of getting the farmers and others in our district to make coal in this manner, we had them follow the usual Swedish process in cutting, but from various reasons, principally owing to the density of our woods, the burning of shorter lengths has proved more satisfatory, and our best results have been obtained from wood cut in 4 or 5-foot lengths, and a portion of it split, and also by using smaller pits.

The pits which we first operated contained as much as 47 to 50 cords, but the results were unsatisfactory, the process proving too slow and too many brands being made. The coal obtained, however, was fairly good. Our burners then resorted to smaller pits containing from 20 to 25 cords of 4-foot wood. These burned faster and gave better coal. Where our men had had experience in the work, the coal was clean and solid, and as pointed out, gave better results in the furnace than ordinary kiln coal.

In pit and kiln practice, we have used the following woods:—Maple, birch, beech, soft maple, white birch, tamarac, hemlock, balsam,—and in point of value they can be reckoned in the order named. Our principal consumption has been in maple, birch and beech, with which our district abounds. In practice, in kilns and in pits both, we have found it possible to use 25 to 30 per cent. of soft wood, but for furnace purposes we prefer not to go above that as the coal made from the softer woods is more friable and will not carry a heavy burden of ore.

RETORTS.

In the United States attempts have been made to manufacture charcoal in retorts, or closed vessels, in which the wood is placed, and the charring done by external heat. In a report on this system, made by a prominent expert, he mentions that one system is to erect a furnace and supply it with a number of vertical cylindrical vessels, which are handled with a crane. These vessels are filled with wood, tightly sealed, lifted into the furnace and connected by means of nozzles with conduits leading to condensers. After the fire has been maintained a sufficient length of time to properly char the wood, the vessel is lifted out and allowed to cool, another taking its place in the furnace. In this method the retorts serve also as cooling vessels, but they must be handled, and the outlets for gases must be disconnected and closed at each change.

Another plan consists of a cylindrical retort hung from trunnions over a furnace. It is raised to a vertical position to receive the charge of wood, and reversed to discharge the charcoal into the cooling vessel, where the process is completed. The difficulty of filling these retorts and maintaining them, makes this plan undesirable.

A system largely employed in North Pennsylvania and South New York, consists of a series of cylindrical vessels set permanently in a horizontal position over furnaces. These retorts are filled with wood either thrown in, or, in improved retorts, placed in a crib which has been previously loaded. When the carbonization has proceeded sufficiently, the coal is withdrawn into a cooling tank, which is hermetically sealed, until such time when the danger of the mass taking fire is greatly reduced. Other forms have also been followed, but as far as I can ascertain, none of them have ever proved commercially successful, and the old-fashioned kiln and pit system still seems to be, for general charcoal purposes the economical, and, in fact, the only systems by which charcoal can be successfully manufactured for general commercial purposes, or at least for the manufacture of iron.

BY-PRODUCTS.

Of late years considerable attention has been given to by-products obtainable in the manufacture of charcoal, and it has been found that with a chemical plant attached to a battery of kilns, that every cord of wood can be so handled that the exact weight that went into the kiln will practically be taken out, when everything is taken into consideration. What by-products can be drawn from a charcoal kiln would be too numerous to enumerate here. In fact there seems to be very little that cannot be extracted from the wood in this way, but for commercial purposes the principal by-products, and those to which most of the companies using a chemical plant have given their attention, is the production of wood alcohol and acetate of lime, and those have been found to be, I believe, profitable, and it is very probable that within a very short time every battery of kilns will have its chemical plant adjoining, and the smoke that is now wasted will be drawn down and distilled, so that nothing will be lost. When this is done, the value to the country of a cord of wood will naturally be largely increased.

Now that I have roughly outlined the systems followed in the making of charcoal, I must ask your permission to touch on the value to the country, and to this province in particular, of charcoal making, and the principal industry connected with it, and on the difficulties in the way of its development, and to ask your consideration and assistance towards overcoming those difficulties and developing the "charcoal industries."

COLONIZATION.

In colonizing our wooded lands, the value of the charcoal industry will be readily seen. Heretofore, and with good reason, the settler looked upon the wood on his lands (from which, as a general thing, the lumberman had removed the merchantable timber) as a detriment, and he (the settler) had very little to hope for until he had made a respectable clearing, and put in seed for his first crop. If he was within one or two miles of railway communication, it might be possible for him to sell a certain amount of selected wood to cord-wood merchants. They did not take the run of the forest, nor would they accept branches or knotty sticks, or anything of that kind, so that at the outside he could very seldom afford to team the wood more than a mile or two, and even then, owing largely to the amount of waste, his remuneration was small. With a charcoal iron industry in the district, all this is changed, and the settler on taking up a piece of wooded land finds ready at his hand a crop that will yield good returns from the day he first swings an axe, whether he delivers his wood at kilns for burning, or at the nearest railway station in the form of cordwood, or whether he burns it himself, he can utilize practically everything, as the furnace companies can take practically all classes of wood grown in this province, and they are ready to accept the tops and branches, the large knotty sticks that cannot be split, and everything in the shape of sound wood. In our long winter months he can fell trees, saw them into cordwood and team to the nearest wood depot, or he can, with the assistance of his sons and what help can be obtained, burn the wood on his own farm in pits, and he can work at it all the year round if he desires, or during his slack season, and earn good wages whether he makes cordwood or coal.

When I speak of the importance of the fact of charcoal kilns or pits being able to utilize tops and branches and knotty pieces, etc., I think you will understand how very important this is to the settler when I say that as an actual fact, in the average forests, only about one-third of the wood felled is fit for merchant cordwood, and of the balance the settler can use a portion for his own purposes, but the great bulk has to be chopped into a suitable size for piling and burning, and then watched carefully in the spring, or almost as much attention given to it by a careful settler as if he was burning for charcoal purposes, owing to the danger to the surrounding forests from fire, so that the making of merchant cordwood cannot be considered as remunerative to the settler in comparison with the making of wood for charcoal purposes. Then, too, there is this burning of refuse, and I think you will understand what the danger in that is. If the settler is careless, his spring "bon-fire" means the destruction of miles of valuable timber, for the settlers' "clearing-up" fires have certainly been instrumental in causing more forest fires than anything else we know of.

Where the charcoal iron industry exists, the wood that was formerly a detriment becomes a valuable asset to the settler, and he realizes it, and knowing it to be an assurance of abundant and remunerative labor, he becomes a caretaker of our forests instead of a danger, for with good cause the owners of timber limits have grown to look upon the settler as something to be kept out if possible, through fear of the effects of his spring burnings.

Where wood can only be sold in the form of merchant cordwood, as I have already pointed out, it would scarcely pay the settler to locate farther back than say two miles from the railway line, if he was looking forward to obtaining anything remunerative for the wood he cut, but where charcoal iron industries exist the better average price obtained allows of his teaming his wood greater distances, and if he burns into charcoal he can afford to transport that material even farther.

VALUE TO THE FARMER.

The value of the charcoal industry to the farmers of the district is, of course, the same, to a large extent, as that derived by the new settler. During slack seasons they can make wood and coal on their own lands at remunerative figures, or they can arrange to work on adjacent lands, and use their horses during the winter months for teaming their own wood or coal, or that of neighbors, and where they are not desirous of working on their own lands they and their sons can find work in contractors' camps, either felling, or teaming, or burning.

The charcoal iron industry is essentially a farmer's industry, and affords, both from coal and ore, steady and remunerative labor from one end of the year to the other, if necessary, and certainly in all slack seasons. Our farmers have, unfortunately, a good many slack seasons, and I think it is largely due to this fact that farming has not been as profitable as it might be. There are so many months in the year when there is nothing for the farmer to do and he has to live during those on the results of the other months Now, if he is an industrious man, and there is a charcoal iron industry in the district, he can fill in every day of his off seasons. As I have said, in winter he can fell wood, burn charcoal, and team either on his own or neighboring lands, and in early spring-time, if he has confined himself to cutting wood during the winter, he can burn his coal then, and in the summer-time from seed-time to harvest he can find employment in the ore-fields raising ore and teaming; and in our St. Maurice district he can, in most cases, make and wash ore on his own land, and the result in that district is that both settlers and farmers are prosperous, and reports which we have received direct from the farmers themselves and from the curés of the district go to show that since the establishment of our works in the St. Maurice district the agriculturists have reaped large and lasting benefits. They have obtained plenty of remunerative labor during off seasons, and a good market for whatever produce they have raised on their farms.

The Province of Quebec, as I think was very well pointed out in a paper last year, has every natural requirement for the production of charcoal pig iron, and the value of such an industry to the province and the Dominion must be fully recognized by every one. We have the iron ore, and while we have neither coal nor natural gas, we have plenty of hard and unmerchantable or waste woods, and this fact makes it possible for the establishment of an iron industry of the greatest value, and I see no reason why such an industry should not be carried to a successful issue, as it has been in Sweden and the United States. What is wanted, however, is the assurance of an adequate supply of charcoal, both for the present and the future. To do this some steps must be taken by our Government to conserve certain woods or portions of forests so that this industry can be established on a permanent basis. How this can be done is a question that will have to be carefully thought out, but if it is done the value to Canada will be great. If it is not, then we will have wasted a very large portion of our forest wealth, for that is wasted which is not used to the best advantage, and I hold that more profit can be derived from our unmerchantable and waste woods by utilizing them and conserving them to the development of the charcoal iron industry than in any other way. If this is done the establishment of the industry is possible and certain; if it is not, then it can only be carried on in a very desultory way.

One of the principal difficulties that stand in the way of the establishment of the charcoal industry in some of the districts is the fact of large tracts of land being held by limit-holders. Limit rights were originally intended to convey an area valued for its merchantable timber alone, yet the limit-holders, even in cases where the merchantable timber has been removed, still retain possession and control, with the result that the hard and unmerchantable wood cannot be utilized. The only way by which these woods can be diverted is by actual settlement, and, as in a great many cases, the land may not be suitable for agricultural purposes, the wood, if these conditions are to exist, is practically inaccessible.

Another great difficulty is the lack of knowledge in regard to charcoal burning. Of course, so far as kiln practice is concerned, men can be readily obtained or educated to good practice, but for pit burning it is necessary that a much broader system of education than could be carried on by a private enterprise should be adopted, as a knowledge of pit-burning would be of the greatest value to our settlers and farmers in the wooded districts.

Now, these two questions are, I hold, provincial and national ones, and these difficulties should be considered and overcome by our Governments

In Sweden there are national schools for charcoal burning, which have done and are doing good work in training men and spreading information throughout the country as to the most economical systems of making charcoal, especially in pits. Both the Dominion and the Provincial Governments should follow this example and disseminate useful information on the subject among agriculturalists, especially in the wooded districts and where charcoal consuming industries have been or can be established. This should be done by lectures, papers, and in every practical manner. The practice, especially of pit-burning, should be taught in our agricultural institutions, and certainly no mining school should be without a course in charcoal burning, and when development comes, as it surely should come in a land of wood and iron, national schools should be established, as in Sweden. Our Governments have spent large sums in this way on dairy practice, and we all know that the results have been profitable and satisfactory, and I believe that if the same course is adopted in regard to charcoal-making, which is a farmer's and practically a domestic industry, the results will be also to the national good.

Steps should also be taken to prevent the locking up by speculators or others, of woods suitable for charcoal purposes, and where this evil exists, as in the cases I have referred to, it should be overcome by just changes in the present laws if necessary. I do not believe that, in the case of the limits, any value was considered or paid for, nor was it intended to convey to the limit-holders the unmerchantable woods for which lumbermen and others purchasing these limits have no use. This is proven by the fact, I consider, that at all times the Government has reserved the right to settlers taking up any portion of the land, the only reservation in favor of the limit-holder being in regard to the merchantable wood, which he is given a certain time to remove. I therefore hold that under all circumstances, and especially where the lands are not suitable for agricultural purposes, and the unmerchantable wood cannot be realized on through the settler, the Government should have the right to divert unmerchantable wood to other purposes when and where it is deemed advisable.

When an enterprise that requires this fuel can be started in any district, it should be especially encouraged by the setting aside of woodlands to insure a continued supply, and by assistance in teaching the principles of "burning" to the inhabitants of the districts, and by rebating of stumpage dues where the wood is used for charcoal purposes, and encouragement given in every practical manner within the powers of the Dominion or Provincial Governments.

The industry is, and must always be, if successful, a settler's, a farmer's, and a people's home industry, and for this reason it is especially deserving of national support and encouragement.

Our farmers should be taught and enabled to use to their own and the nation's profit everything the land has to give, and here are mighty crops wasting, burning and rotting, that properly used might, here in Canada, and especially in our own Province of Quebec, be made, as in Sweden, the mainstay of a nation.

Mr. President and gentlemen,—This is a "burning" question. Let us hope it will not remain a "burning shame," but in the near future become a "burning" success.

MINING AS AN INVESTMENT.

By Robert C. Adams, Montreal.

If one wishes to give a capitalist cold shivers, he can usually produce the effect by requesting him to invest in a mine; or if he desires to descend to the depths of humiliation he can get there speedily by taking to heart the scorn and contempt which, by word or look, often meet the solicitation to risk money in digging. Yet we learn from the last U. S. census that over one thousand million dollars is invested in the country in securing the earth's products from beneath its surface. The exact figures are $1,284,911,405. Such an outlay would not be made unless it afforded a considerable amount of profit to some of the workers. It is therefore safe to assume that the mineral producing industries are often profitable, though whether they are so on the average is a matter for question. Especially does this doubt pertain to the mining of precious metals, which, in many instances, gives *bonanza*, but in more cases yields *borasca.* A statement of some of the facts and figures relating to the gold, silver and copper mines of the United States will enable us to form some conclusions as to the pecuniary results of mining operations.

The *Engineering and Mining Journal* publishes a list of 144 dividend paying mines and 149 non-dividend paying mines. The latter have never paid a dividend, and some of the former have not paid a dividend since 1870.

Of the dividend paying mines 51 have paid over a million dollars, and 25 of these have paid more than their capital stock. Of the 51 only 27 have paid dividends since 1891. Only 13 of these have paid more than their nominal capital, and only three companies that have paid a total of less than a million, and have paid dividends in the last three years, have paid more than their capital.

The 144 dividend paying mines are capitalized at a total of $643,-000,000. If 25 cents on the dollar has been paid in, this would give of cash paid $161,000,000. Assessments have been levied to the amount of $53,000,000, making total cash paid in $214,000,000; the total of the dividends paid is $241,000,000, so that the returns would be about 13% more than the principal. But if only 10% of the share capital was paid in the profit would be over 100% on the investment beyond the repayment of capital.

Taking the whole list of 293 mines the total capital is $1,164,000,-000, and the total assessments $85,000,000 = $1,249,195,066. Total dividends are only 20% of this amount. If 25% of the capital has been paid the total dividends would be 60% of the outlay. If only 10% was paid, 118% of the outlay would have been returned. Some eminent authorities, whom I have consulted, tell me that probably not more than 10 cents on the dollar of the capital has been paid in on the average

When we consider the large number of mines that are abandoned before they are turned over to companies, and of the prospects that never become mines, but are spoiled in development, besides the great expenditure made in the unsuccessful search for minerals, we are forced to accept the common statement that more money is put into the ground than ever comes out of it, and that every dollar costs a dollar. Indeed many assert that dollars, whether silver or gold, cost at least two dollars apiece, and Mr. del Mar has stated that every dollar secured from the Comstock lode has cost five dollars. It was often said there, as in other less favored districts, "It takes the product of one mine to work another."

CAPITALIZATION OF MINES.

Of these 293 listed mines in the United States, 223 have a nominal capital of a million dollars and over, and of these 70 are capitalized at $10,000,000 and over. But the capital stock gives no idea of the amount of money actually paid in. It is customary in California to capitalize the companies at ten million dollars and sell the shares at one cent or ten cents on the dollar, or even give them away—anything, in fact, to get them into the hands of people who will pay assessments.

The U. S. census of 1880 reports 140 mines whose nominal capital is $1,019,111,250, but whose market value is $85,641,222, or about 12 cents on the dollar, but even these prices were probably inflated above the true values.

The last U. S. census gives some important data:

In 1889 the value of production of gold and silver was...	$99,283,732
The operating expenses were estimated at.............	63,451,136
Leaving a surplus of	$35,832,596

The capital invested was $486,323,338, so that the profit was about 7½% on the investment. But when the short lives of mines is considered and the consequent deterioration of capital is taken into account, this showing must be regarded as proving that mining for the precious metals does not pay on the average.

Of 6,004 mines that are known, 1,266 were idle; 1,009 were working, but non-productive; 1,610 were producing less than $1,000 per annum; 1,408 were producing less than $10,000 per annum; 437 were producing less than $50,000 per annum; 95 were producing less than $100,000 per annum; 107 were producing less than $250,000 per annum; 44 were producing less than $500,000 per annum; 28 were producing over $500,000.

SUCCESSFUL MINES.

Leading the list of the United States comes the Calumet and Hecla copper mine, which, with a share capital of $2,500,000 and paid assessments of $1,200,000, has paid in dividends $40,850,000. Then come in order the Ontario silver mine, Utah, with total dividends of $13,175,-

000; Granite Mountain, silver, Montana, $12,120,000; Quincey, copper, Michigan, $7,070,000; Idaho, gold, California, $5,489,000; Homestake, gold, Dakota, $5,237,500; Eureka Consolidated, silver and gold, Nevada, $5,112,500; Richmond, silver, Nevada, $4,359,887; Horn, silver, Utah, $4,930,000; the Tamarack, Standard and Small Hopes Consolidated have paid over $3,000,000, and the Daly, Minnesota Iron and Plumas Eureka, over $2,000,000.

California from 1848 to 1881 produced $1,163,000,000 in gold and $15,000,000 in silver.

The yield of the Comstock Lode in Nevada from 1860 to 1890 was $350,000,000, and $130,000,000 were paid in dividends. The bulk of this was produced during the first 15 years. The original purchasers of the Comstock paid $50 for three-fourths interest and bought the other quarter for an old blind horse. One of the mines, the Virginia Consolidated, paid $42,930,000 in eight years, and the California paid $31,-320,000 in five years. The original discoverers, as usual, got no benefit. This summer a car-load of ore from the Mollie Gibson mine at Aspen, Colorado, yielded 20,000 ounces of silver to the ton, or 85 per cent.; more than four-fifths solid silver.

Did time permit, similar stories could be told of mines in Australia and South Africa. An expert sent out by the Rothschilds to Witwatersrand, reports that one billion dollars in gold is available in that district, and one of the newly discovered mines in Coolgardie, Australia, is reported sold for £250,000.

Australia, in 1852, produced $79,200,000 in gold, and in 1853, $50,400,000. Two gold nuggets were found, worth $42,000 and $48,-000. In California single nuggets have been found worth up to $30,000. One claim on Carson Hill had a vein from which gold was chiselled out in big chunks, one weighing 112 pounds, a single blast gave $110,000, and the yield in two years was $2,000,000. Many miners working single-handed, washed out from $100 to $1,000 a day. Three sailors on Murderer's Creek got 11 pounds daily, and $2,700 has been washed from one pan. The Doran Mine in South Carolina yielded $300,000 from a space 300 feet long by 12 feet and 15 feet, the excavation of which should not have cost $20,000.

Canada is not without its stories of bonanzas. The early history of the Cariboo and Fraser River Districts in British Columbia abounds in stories of sudden fortunes; and the great hydraulic operations now in progress produce results that promise yields in single workings of $1,000 a day. The greatest yearly gold production of British Columbia was $3,913,563 in 1863, but this had declined to $399,525 in 1892. The highest average earnings per man in one year were $1,223 in 1875. The earnings for 1892 were $298 per man employed, or about $1 per day.

In Nova Scotia there have been some brilliant successes in gold mining, and a steadily productive and fairly remunerative industry is being carried on. The yield of gold for 1892 was 21,080 ounces, and the yield for nine months in 1893 was 14,030 ounces, representing 97,471 days' labor, or an average of nearly $3 per day per man employed. The total yield of gold was about $10 per ton of rock crushed.

In the Chaudiere District of the Province of Quebec there have been some remarkable finds of gold in the streams, and if titles could be made clear and proper methods employed some large fortunes might be realized.

The story of Silver Islet gives the greatest romance of Canadian mining. The original owners became discouraged and sold it for a moderate sum to United States capitalists. These prosecuted the development on a large scale and were rewarded by striking extensive deposits of ore that were often almost solid silver, and for a time yielded an immense revenue.

In Hastings County, Ontario, there are gold-bearing rocks that are destined to realize fortunes to investors when the chemical secret is discovered as to a means of overcoming the effect of arsenic in the amalgamation of ores.

The nickel mines of Sudbury produced, in 1892, 2,413,717 pounds of nickel and 2,203,795 pounds of copper, and one of the companies is paying a dividend of 8% per annum on a capital of $2,500,000.

SPECULATION.

As good an illustration as can be had of the chances of investment in mining shares is furnished by the history of the dealings on the San Francisco Stock Exchange. "Crown Point," in November, 1870, sold at $3 per share. On favorable reports it advanced to $1,800. Other mining shares rose in proportion and all California went wild. In 1872 the crash came, and silver stocks declined $60,000,000 in ten days. A friend of mine who could have sold out his holdings for $800,000, but who was determined to become a millionaire, ended $60,000 in debt, with a lawsuit on his hands.

In 1872 Virginia Consolidated began paying dividends of $300,000 monthly. An expert said there was $1,500,000,000 in sight in the two mines, Virginia Consolidated and California. Shares rose from $4 to $780 and were maintained with some fluctuations for a considerable time. In 1875 Virginia Consolidated produced $15,000,000 in seven months. Then came a decrease in production and Comstock values sank $100,000,000. The Bank of California failed, and Ralston's body was found in the sea. In January, 1875, the market value of Comstock shares was $300,000,000. In the spring of 1885 it was $2,000,000; in the autumn it rose to $70,000,000, and in 1890 it was $6,000,000. Stock that sold for $700 in 1875 sold for 25 cents in 1885. During the excited dealing in shares in 1872 one man made 25 millions, another 20 millions, and two others 10 millions each.

Placer and hydraulic mining is now receiving much attention. After the first outlay is made the average cost of washing one ton of gravel by hydraulic process is 3 to 10 cents, whereas the cost of mining and milling the most favorable free-milling gold is $1 to $2 per ton and is often nearer $5; and the mining and treatment of silver ores sometimes runs up to $100 a ton, and is seldom under $20. The first outlay for hydraulic mining is usually heavy, and the cost of 154 ditches in California was an average of $70,000 each, or $3,800 per mile.

As to the profits of mining in the present day, it should be said that there are numbers of small companies in California and other States that are paying from $1,000 to $40,000 a month. They are usually each controlled by a few people, who are looking for results from legitimate mining rather than from stock speculation, so there are no puffs in the papers, and one rarely hears of them. Probably the number of mining properties that are being worked by individuals or close corporations far exceeds those that are listed upon the stock exchanges.

No estimate can be made of the amount of money expended in prospecting and developing mineral properties, yet the money expended in these preliminary operations should be considered when reckoning up the profits of mining as a whole. There have been a thousand prospectors at one time ranging the mountains of the Kootenay district (B.C.), and it is safe to say that more than a million dollars has been spent in the last three years in exploring and developing the Slocan district alone, whereas the ore is only now beginning to go to market in appreciable quantities and no mine has yet repaid its outlay.

During the palmy days of California $60,000,000 were produced in one year. But 100,000 miners were employed, and the average output was only $2 per day per man, while wages were $4 and $5 per day. This shows that although many made fortunes, more made little or nothing. Mining is a lottery with a few immense prizes, numerous moderate gifts and a multitude of blanks. The losses in mining are often due to other causes than bad luck. Managers on the Comstock built mills and reduced ores at a cost of $5 per ton, but charged the other shareholders $14, which was often as much as the ore produced. Law suits and disputes about titles have been a fruitful source of the loss of time and money. One lawsuit between the Ophir and Moscow mines on the Comstock lode cost $1,070,000.

A great hindrance to profitable mining in Western Canada is the fact that while supplies can best be obtained from the United States and that the market for ores is mainly in that country, the policy of the Canadian Government has been to maintain the tariff on these supplies and to prevent the development of railway communication with the South.

The high rate of wages in the West, $3.50 per day, and the excessive cost of transportation are causes for many mining failures.

There are two classes of investors in mines. The first class is composed of those who invest, hoping for profit from the sale of the property or its products. The second class consists of speculators who buy mining shares for a rise. The investors in public companies in England are usually of this second class, and most of the companies that are promoted are organized for the purpose of gambling in the shares. The promoters employ brokers to buy and sell shares on the stock exchange until the outside public are attracted. When the prices have been forced to a suitable point, or to where it is thought they will not go higher, the original holders unload their shares.

To those who wish to speculate in mining shares, this advice may be given: Select some company that has great names in the directorate and is under the management of some well-known, successful financial firm. Do not concern yourself too much about the merits of the mine, for if you are an outsider you have no chance of learning the truth about the value of the property. Content yourself with following the lead of men who are good "boomers" and who have a strong interest in "whooping up" the enterprise. Consider that the probability is that the affair is a swindle and will eventually be a dead loss to the shareholders. Therefore, when the shares advance sufficiently to afford a good profit, do not hold on too long, but sell out before the downward turn comes.

To those who wish to invest in the legitimate mining industry for the sake of dividends from the operations, the following general rules may be given: Avoid the companies with showy names, heavy expenses of management, large capitalization, or where large amounts are paid for the property. Favor investment with men of whose trustworthiness you have personal knowledge, or whose skill in mining has been proved. When yon can "get in on the ground floor" with such men "take a flyer," if you have any spare cash to lock up and will not be distressed if it is lost. If you know some good practical prospecting miner, who is ready to explore in some district of good repute, "grub stake" him, that is put up the money for his expenses and go halves with him in his discoveries. You cannot expect to be able to form any accurate judgment of the value of a mining property unless you have a thorough familiarity with the business. If you visit the mine you will only see a hole in the ground and will know no more of its productive capacity than you did before. Your investment must be made usually upon the basis of personal confidence in the managers of the enterprise or the reports of your professional advisers

From the consideration of the facts and figures which have been mentioned, it may be assumed that mining on the average is not a very profitable undertaking, that is, more money is put into the ground than ever comes out of it. But many enterprises pay fairly well, and some of them pay enormously. It is the chance of large profit and sudden acquisition of great wealth that tempts me to invest. When a great strike is made, hundreds and thousands invest in the same neighborhood hoping for similar luck. These fortunate discoveries have been called "the devil's decoy ducks" as they draw many to the spot and often to the slaughter. It must be admitted that mining success is often a matter of luck. Some of the largest properties have been discovered by accident or have become valuable by almost the last stroke of work before their proposed abandonment. Many of the discoveries have been made by unprofessional men, and the theories of skilled engineers have often been worthless. Miners say, "the mineral is where you find it and one man can see into the ground as far as another."

When we remember that it is said that only four or five men in a hundred succeed in commercial business, we must not be too exacting as to the record of success in mining. The men who gamble in stocks or corner lots probably loose as largely in proportion as those who invest in mines and they lack the moral satisfaction of having promoted production or employed labor. Public spirited men have every patriotic and philanthropic motive to invest in mining.

England owes her supremacy to her coal and iron mines. It was due mainly to the desire to obtain the precious metals that America was discovered, and the development of the Pacific slope and the construction of the transcontinental railways is largely due to the mining industries. Australia and South Africa have been opened up largely by miners. The miner has also often discovered possibilities for the production of agricultural wealth. A mine gives work directly and indirectly to a large number of people. The man who has lost money in the actual working of mines can comfort himself with the assurance that his effort has tended to the development of his country and has benefitted hardy laborers. It has not, as is often said, been merely thrown into the ground.

The investment in railways is probably no more remunerative than the investment in developed mines, and offers fewer opportunities of brilliant success. Mining will always attract adventurous enterprise and as the tendency of the times is to conduct its operations upon a business basis, its hazards will be continually reduced.

It may be proper to ask, why is it that so large a proportion of mining enterprises are unsuccessful? The answer will be that in addition to natural risks there is added a large element of human risk; faith in nature cannot always be supplemented by faith in man. Ignorance, bad management, dishonesty, extravagance, often spoil favorable chances. The blind competition and vexatious opposition among rival enterprises sometimes ruins undertakings that by a spirit of co-operation and a reasonable combination might have been carried to success.

Instead of the present wasteful system of individual operations, there should be larger enterprises by which a whole district should be operated co-operatively under one central management, composed of the ablest engineers and practical business men, or in some cases it might be undertaken by the local or general government.

Dr. Raymond in his report on The Mines of the West, in 1869, in a criticism of the methods employed at the Comstock, so powerfully describes the cause of many mining failures, that his words are worth reproducing. He says, "One great cause of trouble is the fact that mining has not on the whole been profitable to individual adventurers. And of this fact the Comstock Lode has furnished a striking example. Nearly $100,000,000 have been extracted from that one lode within the past nine years, yet the aggregate cost to owners has been almost as much. The reason is simple. Unnecessary labor has been employed and vast sums of money wasted in extravagant speculations and litigations, and the root of the whole evil lies in the system of scattered, jealous, individual activity, which has destroyed, by dividing, the resources of the most magnificent ore deposit in the world. Thirty-five or forty companies each owning 10 to 1,400 feet along the vein, and each almost without exception, working its own ground independently; 40 superintendents, 40 presidents, 40 secretaries, 40 boards of directors, all to be supplied with salaries, or worse yet, with perquisites, or, worst of all, with opportunities to speculate; an army of lawyers and witnesses, peripatetic experts, competing assayers, thousands of miners uniting to keep up the rate of wages; these things explain the heavy expenses of Comstock mining. Aside from this immense drain of money amounting to 20 per cent. of the whole production, the labor actually performed has been, for want of united action, often useless. There have been tunnels enough run by different companies into the Comstock lode, to make, if put together, the whole length of the Sutro tunnel. Hardly one of them is good for anything to-day. The Bullion Company, which has the deepest shaft on the lode, never had any ore, but has spent more than a million dollars in prospecting, while some neighboring mines, like the Little Kentuck, have been in bonanza for long periods. Now this division of a vein which gives the rich chimney to one owner and the barren intervals to another, is not conducive to economy. The result has been that both owners waste money. All the explorations in the barren mines of the Comstock could have been executed with the money flung away by the mines that have had, for a time, rich ore."

Alluding to these operations Dr. Raymond speaks of "the mischievious feeling that mining is half grab and half gamble; that the only way to make money at it is to dig out what rich ore you can get, and then find a fool to buy the property, or failing that, to make a fool of that collective individual the public and to 'unload' yourself of your stock."

It is so generally the custom with those who write of mining to indulge in enthusiastic language and brilliant statements that I may be blamed for presenting to a Mining Convention a paper in which the boom element is so conspicuously wanting. But it may help the reputation of the mining community if we tell the truth occasionally, especially when it can do no harm, and it may help to overcome the popular prejudice as to the veracity of promoters, which is expressed in the adage, "he lies like the prospectus of a limited company."

While admitting the losses in mining, I have tried to call attention to its frequent gains, its occasional sudden fortunes, and the fascination as well as usefulness of its ventures. I have wished to point out also that a good deal of the loss might be avoided by more careful and intelligent management and especially by the adoption of the systems of combination and co-operation that are so generally being employed in other industries and which are destined to ultimately replace the individual isolated method of work.

It might be worthy of consideration also whether a mining association might not undertake some practical operations as an object lesson to the world of how mining can be successfully conducted. If all the brilliant ideas and genius that scintilate in a convention's papers could only be applied to productive work the reputation of mining might be so enhanced that it would be more sought as an investment.

THE ALBERT MINES AND CAPELTON CHEMICAL WORKS.

By Mr. S. L. Spafford, Capelton.

These mines and works are situated at Capelton, Que., and owned by the Nichols Chemical Co., of New York city, successors to G. H, Nichols & Co.

The ore occurs in the pre-Cambrian formation.

Veins are the filling of cracks or fissures; these cracks or fissures may either extend through the earth's crust and divide it for long distances, or they may reach down only to a limited depth or be confined to single strata, so veins are exceedingly various in extent. They may be many rods in width, or they may be very thin. Strata having been faulted, so veins also may have their faults and displacements. The subterranean movements that produce joints and fractures in rocks may give origin and peculiarities to veins. Faults may divide veins not only into parts that are little displaced, but into portions that are shoved hundreds of feet above or below, which of course is very perplexing to the miner.

Fissures that have been filled gradually without eruptive aid, are veins of infiltration, and those through the agency of igneous eruptions are contact veins. The latter is considered the most prominent in depth. There seems to be a diversity of opinion as regards the formation of the veins at Capelton and Eustis, but let that be as it may, the work done by the Nichols Chemical Co. and the Eustis Mining Co. have proven the deposits to be of enormous extent.

There are a large number of ore deposits in the Capelton district, all of which are found running in a north-east by south-west direction.

About 32 years ago prospecting was first commenced at Capelton, and soon after that mining operations were commenced on lot 2, range 9, and at shaft known as No. 5 Hartford, which is now operated by the Eustis Mining Co.

My notes concerning the mines will now refer specially to those owned and operated by the Nichols Chemical Co.

Their workings consist of shafts Nos. 1, 2, 3 and 4. The present depth of No. 1 is 2,100 feet on the slope of the vein, which averages about 30 degrees from the horizontal. When the above company first commenced operations sixteen years ago, this shaft was only 300 feet deep. No. 3 shaft is about 400 feet deep and No. 4 is about 700 feet deep. The longest level in the latter is a little more than 650 feet, following a productive vein all of that distance, except for about 50 feet, where a cross course disturbed the lode, forcing the vein to the left, or back into the foot that distance. The cross course causes a displacement of the vein on the horizontal, forcing it either to the right or left. It is a matter of great importance to the miner to know in which direction he will find the vein. If approaching the cross course from the west it is usually a left-hand throw, but there is no rule that can be depended upon.

The method of mining is by sinking the shaft about 8 by 12 feet in advance of the other workings. Levels are then extended on the vein and the ground is blocked out by sinking winzes or raising from a lower level to one above it. In distance apart these levels are from 65 to 100 feet, thereby giving very high and long stopes.

In No. 1 shaft the deposit has a length of about 300 feet, and varies in width from 2 feet at the ends to 45 feet at the widest place. Slides have been met with in different places. These faults merely caused displacements of the vein, the most prominent being an upthrow of 20 feet. The vein is also crossed by a very large trap dyke, which does not in any way disturb or affect the vein.

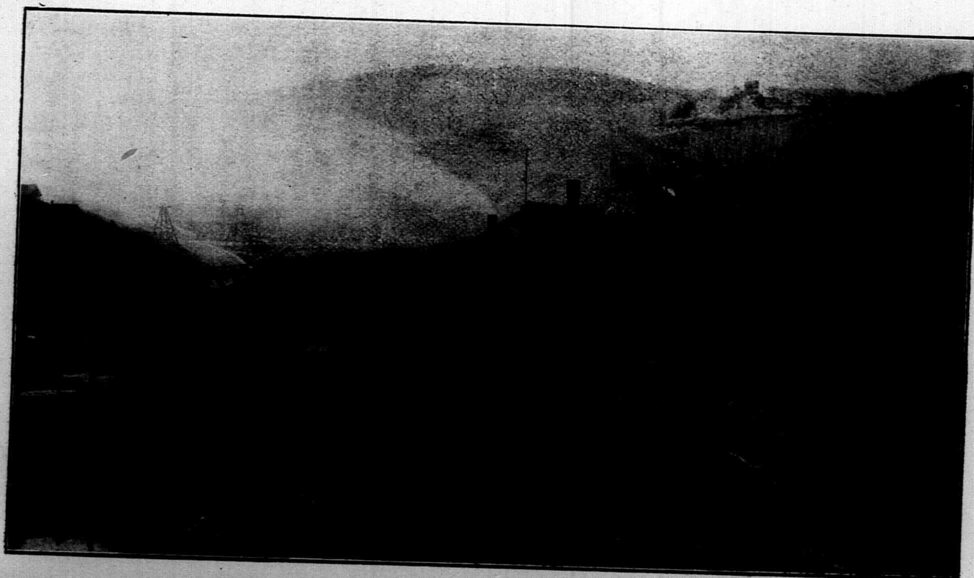
The selvage being wavy causes irregularity in the width of the vein. The dip, which is to the south-east, is very irregular also. In some places it is almost perpendicular, while in others it is nearly horizontal.

Large pillars of ore are left standing in suitable places to support the roof of the mine. Usually the ground is firm, but occasionally the heavy blasting loosens bands of slatey rock which are kept in place by heavy and very large timbers.

The bottom part of the mine is very free from water. The surface water is caught in large cisterns near the surface. The pumps used were manufactured by Guild & Garrison, of New York. The water being strongly charged with copper in solution, which is very destructive to iron, it is necessary to have the water end of the pumps made of bronze, and the piston, piston-rod, etc., made of brass. Three-inch cast-iron pipe is used for conducting the water to the surface.

The battery of tubular boilers at No. 1 shaft consist of seven, set parallel with each other. Four of them are 80 horse-power each, one 60 horse-power, and two 50 horse-power each, making a total of 480 horse-power. For steam purposes bituminous coal is used entirely.

Two air compressors, one a compound Norwalk, main 20 x 24 inch cylinder, the other an English duplex 16 x 36 inch cylinder, furnish the compressed air for drilling. There are three large air receivers, the largest being 6 x 30 feet, and the air is carried from them down the shaft



Nichols Chemical Co.—Front view of Chemical and Fertilizer Works, Capelton Que.

in 5-inch and 4-inch pipes, where it is at different points diverted in smaller pipes to the many different workings where power-drills are in operation. Ingersoll-Sergeant and Rand power-drills are used.

The hoisting engine is a double friction winding engine, 20 x 24 inch cylinder, 250 horse-power, speed 700 per minute, with two drums 6 feet in diameter; each drum has a powerful spur-wheel keyed on drum shaft, which meshes the driving pinion on engine shaft.

The hoisting-rope used on these drums is made of the best plough steel, breaking strain 30 tons. It is 1 inch diameter, has 6 strands with 19 wires in each strand and hemp centre.

Automatic dumping hoisting skips are used, which are made of heavy steel-plate, and have a capacity of 3 tons.

The machinery of the concentrating plant is driven by an 18 x 24 inch single straight-line engine, having a driving-wheel 24 inches by 10 feet.

The plant also has a 400 h. p. surface condenser, the circulating water being supplied by a compound pump, having an 8-inch suction and a 6-inch discharge.

The head house is 75 feet high. The ore discharges out of the skips on to a series of bar screens, after which the very largest pieces pass through a 15 in. x 30 in. ore-breaker. The ore of proper size for hand picking passes from the screens on to a travelling picking-table, 4 ft. wide by 32 ft., which is driven by an 8-in. belt. A few boys stand on each side of the table and pick out the rock while the table is in motion, conveying the ore and discharging it into two 6 in. x 20 in. ore-breakers, and these break it down to proper size for transportation. The fines, which include all that pass through a one-inch screen, is conveyed by elevator to a revolving screen, which separates the fines from the half-inch and larger. The latter for further sizing down is put through the Cornish rolls, which are 15 in. x 30 in., and it is then conveyed to the last revolving screen, delivering each size to their own jigs. The concentrating plant produces three sizes of ore, viz.: lumps, smalls and fines.

Shafts Nos. 3 and 4 are each equipped with two 75 horse power tubular boilers, and each has a 75 horse power friction drum winding engine. The two air compressors at No. 1 supply all of the compressed air required. The distance between No. 1 and No. 4 is about 1,500 feet.

The hoisting and concentrating machinery was supplied by Mr. Earle C. Bacon, of New York.

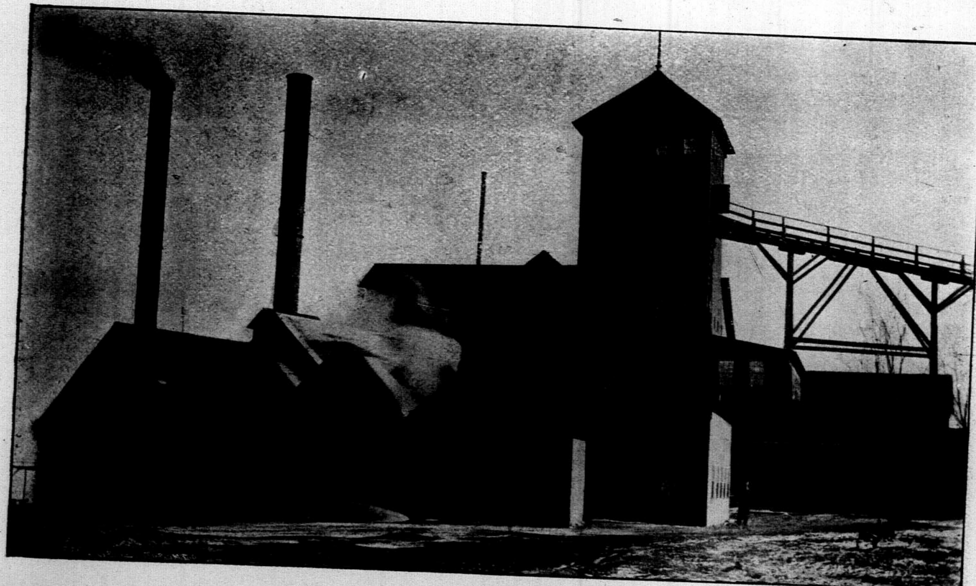
The ore is transported from the mine by wire rope tramway to the stock sheds near the Boston and Maine siding. The tramway in use was patented by Mr. Hodgson. Its construction consists of an endless wire rope, one inch diameter, and 9,400 feet long, running on grooved sheaves, 24 in diameter, which are secured on the cap piece of the bents or supports. In order to make the grade as regular as possible the bents vary from 15 ft. to 50 ft. high, and they are 100 feet apart. At each end of the line there is an 8 ft. sheave around which the rope runs. The buckets in which the ore is carried are made of wrought iron and each holds 350 lbs. At each terminal there is a fixed rail. The box heads or saddles which carry the buckets, have two small wheels on the side, and when the bucket arrives at either end the wheels ride on the fixed rails and the bucket can be filled or dumped while the rope keeps in motion. The buckets are hung on a wrought iron hanger which is secured to the box heads. The loading end of the line is about 500 ft. higher than the discharge end. The speed is controlled by a 15 h. p. engine which is geared to the pinion of driving sheave shaft. The capacity is 200 tons in 10 hours. The coal consumed at the mine is also conveyed by this tramway.

The owners of the mines have always utilized the whole ore product the first treatment being converting the sulphur contents into sulphuric acid.

Brimstone was first used for sulphuric acid making, but since cupreous pyrites has come into market, brimstone is to quite an extent driven out of sulphuric acid works. The sulphur in pyrites must driven off before the copper can be obtained, consequently its sulphur will probably always be cheaper than brimstone.

Pyrites for sulphuric acid making was first used in 1818. Considerable difficulty was experienced in lighting the kilns because it was attempted from below. It was discovered by accident that lighting them from the top was the quickest way and since then that method has been used.

It is said that in 1614 the apothecaries produced sulphuric acid by burning sulphur in moist vessels with access of air. The price of acid at that time was $6 per pound or $12,000 per ton. In the year 1740



Nichols Chemical Co.—Concentrating Mill, Capelton, Que.

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acid making was carried on near London, and the price was reduced to 45 cents per pound.

In 1746, Dr. Roebuck, of Birmingham, introduced the first lead chambers. In France the first lead chambers were erected by Holker, in 1766, while in Germany they were not introduced until the year 1820.

Chemical works were first constructed at Capelton in the year 1887. The works were designed by Mr. J. B. F. Herreschoff, of New York city. The main buildings are 175 feet long by 75 feet wide and 3 stories high. These buildings being very wide made it necessary to use the truss roof, which is covered with slate supplied from the quarry near Richmond, Que.

The kilns are constructed of fire bricks and have cast iron fronts, each burner being independent of the other. The percentage of sulphur in the ore controls to quite an extent the quantity of ore which can be burned per superficial foot of grate surface.

Usually the results are from 30 to 45 pounds per square foot in 24 hours. The ore should be used neither in too large nor in too small pieces. If the pieces are too large the sulphur would not properly burn out, and then would remain green cores in the interior of the cinders. In the other case, if the pieces are too small they prevent the proper access of air.

The oxygen of the air being transferred to sulphur dioxide (So_2) through the interposition of the acids of nitrogen and with the aid of a vapor (steam) produces sulphuric acid as a final product. The substances coming into question here, except the final product, are in the state of a gas or a vapor. For reaction it takes a certain time, therefore there must be a large chamber space given so the gas can remain for some time. The gases and acids being very strong, quickly destroy wood of any kind, so it is necessary to construct all acid chambers of lead.

The Glover Tower, which in its special structure is patented by the Nichols Chemical Co., occupies an intermediate position between the kilns and chambers. It is a rapid and economical concentrator, besides being valuable for denitrating

Pans are used for concentration of the sulphuric acid. The final products are oil of vitriol and extra concentrated or 98 per cent acid, The former comes largely into use for refining oil and the latter for mixed acid making is an important factor.

To suit the requirements of the trade the product is shipped either in carboys, iron drums or tank cars. To retain its transparentness oil of vitriol must be kept free from dirt.

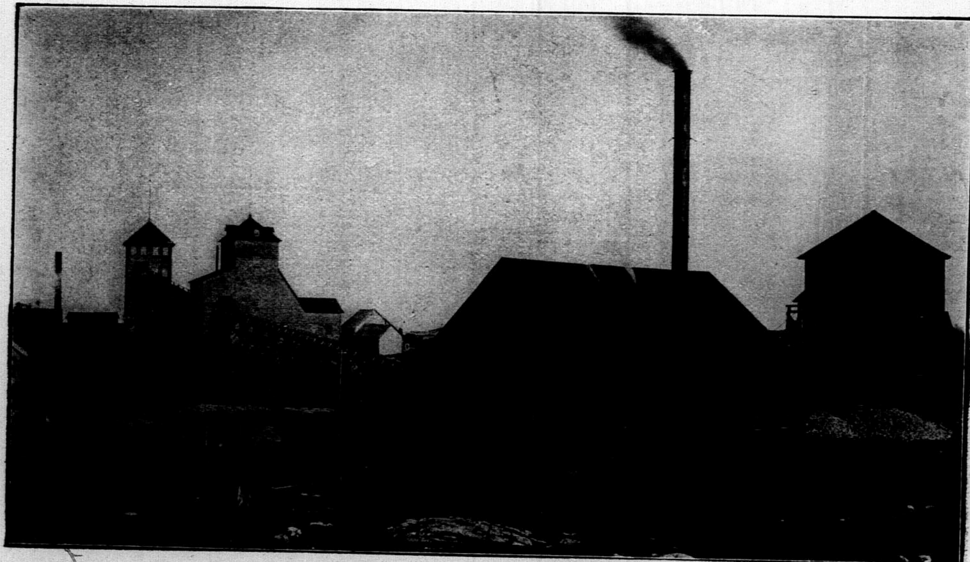
In the superphosphate industry sulphuric acid is also largely employed.

With the agriculturist, if production is to be cheap it must be rapid and plenteous. We all know the progress of unaided nature is slow, but as we are familiar with the elements essential to plant growth, the farmer may assist and hasten the natural processes Canadian phosphate which comes from the Buckingham district is used at Capelton for manufacturing fertilizers.

The phosphate is first dried, then ground to a fine powder in the Griffin mill. This mill employs in its construction the principle of a rigid roll, on a suspended shaft running against a ring or die. This rigid roll on a revolving shaft has freedom to swing outward against the die by the use of a universal joint. By centrifugal pressure there is great force brought to bear on the material being pulverized between the roll and die. This mill will grind about two tons per hour. After being ground the apatite is dissolved with sulphuric acid, after which ammonia and potash is added to make the complete fertilizer. It is then put through the disintegrator and then screened again.

We manufacture five different brands or grades of artificial fertilizers. The Capelton and No. 1 brand as superphosphates, and the Reliance, Victor and Royal Canadian are complete fertilizers. The goods are shipped in sacks of 200 pounds each, and in conformity with the law the brand and guaranteed analyses are plainly printed on each sack.

The Herreschoff water jacket smelting furnace is used for extracting the copper in the burned cinders. The capacity of the furnace is 50 tons per day. The matte produced is shipped to Laurel Hill, Newton Creek, L.I. The buildings are lighted by electricity; the mines and the chemical works each have their own dynamo.



Nichols Chemical Co.—Albert Mines, Nos. 1, 2 and 3 Shafts, Capelton, Que.

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MINERAL WATERS.

By Mr. Jas. T. McCall, Montreal.

It may appear at first sight as if my subject was hardly within the range of those usually dealt with by the Quebec Mining Association, and I venture to think that very few miners in taking out licenses for mining, prospecting, or in purchasing mining rights on any property, would include a spring of mineral water among the valuable deposits they expected to find. A little reflection, however, will show us that natural mineral waters have been a source of great wealth and prosperity to those countries, and more particularly to those districts, in which they have been found. Springing up from the depths of the earth, charged in the most natural manner, and in the most delicate proportions with those chemical substances that give tone and vigor to the human system, these mineral springs must be regarded as of great value, to be placed on a level with gold and silver, iron, copper and lead, asbestos and mica deposits, which have been considered as forming the great mineral wealth of this province.

We all realize, I think, of what immense importance a supply of pure water is to any town or city. Blessed as we are, with a plentiful supply of fairly excellent quality in Montreal, we are not brought face to face with the difficulties which some other cities in Canada,—Toronto for example,—have had to contend with. In reading over several papers in connection with my subject, it was noteworthy to find what a strong stand a great many eminent physicians take on this point. They shew that to an impure water supply can be traced the great epidemics of cholera, typhoid fever, diphtheria, as well as those lesser diseases which distress suffering humanity. Most of us will remember the experience of the city of Hamburg during the cholera epidemic on the continent two years ago. It was the contaminated water of the Elbe, the source of the drinking supply of that city, that was responsible for the devastation made among its inhabitants. The same can be said of the great majority of towns on the Continent of Europe. The dangers surrounding a journey through a foreign country, such as Italy, Germany or

France, or other Continental States, are manifold, on account of the impure water supply, and to all who purpose making such a trip, let me advise them never to drink ordinary water. If their principles will allow of it, let them drink beer or wine, but if they must drink water, let it be bottled mineral water. A recent writer referring to the saying, "See Naples and die" claims that this originated through the dreadful water of that city finding so many victims.

The drinking of mineral waters for medicinal purposes dates very far back, and the famous wells of England used to be the fashionable resort of the wealthier classes during the eighteenth century. After a season of gaiety and high living in London, the fashionable ladies and gentlemen went down to Bath or Buxton, or some other similar well, to have a course of the waters to wash away the ill humours and bad blood that had resulted from their previous style of living. This is now changed to a large extent, and the fashionable world go to the Continent, where such baths as Homburg, Baden-Baden, Carlsbad, etc., are thronged with people in pursuit of health.

It will thus be seen what a source of wealth these springs and baths are to the districts in which they are found.

Our Association is at present purely a Quebec institution, and I will not, therefore, refer to points outside of it; my object now is to point out that we have in this province a vast wealth of mineral waters, as fine, if not finer, than any to be found on the Continent of Europe or in the United States.

My chemical knowledge is not sufficient to enable me to give you a scientific division of the various kinds of mineral waters found in this Province, but for my present purpose it is sufficient to divide them broadly into two kinds, medicinal and table waters. The division is not a very accurate one, for table waters are and must be of very great medicinal value, but the distinction is easily understood.

Let me first of all draw your attention to the medicinal waters, by which I mean those whose chemical ingredients are of so strong a taste or odor, or present in such quantities as to make their functions more especially medicinal than otherwise Nearly every district has mineral springs of some kind, be they sulphurous, alkaline, or saline in their composition, but very few have ever attained to more than a local celebrity.

Among these I would mention the following most important :

Richelieu Water—a well owned by Mr. J. A. Harte, of Montreal. This is an alkaline water of great medicinal value in cases of acidity of the stomach. Its taste is not such as to make it unpalatable, although it is pretty high in salts.

Varennes—This is a strong saline water, of the same nature as St. Leon.

Abenakis—This is a strong saline water.

St. Genevieve—This spring is also owned by Mr. Harte, and may be considered a fairly strong purgative.

The Caledonia Springs are in the Province of Ontario, although pretty close to the Province of Quebec, so they are not within the scope of my paper, although in passing I would mention that there are three wells there, saline, sulphur and gas. This water has obtained considerable celebrity on account of its medicinal qualities, and the hotel at the Caledonia Springs is regularly frequented during the summer months.

I have brought up some specimens of these waters found in the Province of Quebec, and will be very glad to submit them to you for the purpose of testing.

The most famous of these, at least the one that has been brought most prominently before the notice of the public, is the spring at St. Leon. This is situated near Louiseville, on the Quebec section of the C. P. Ry. The principal ingredients are :

Chlor. Sodium, Chlor. Potassium, Chlor. Magnesium ; Bi-carb. of Lime, Bi-carb. of Magnesium, with Lithium and the Iodides and Bromides of Sodium.

These are present in such quantities as to warrant us in classing this as a fairly powerful water. (These are of course modified by other chemicals, such as bi-carbonate of iron.)

Prof. Baker Edwards, in writing in connection with the analysis, says :—

"This rare water combines marine chlorides, bromides and iodides, also rare alkalines, lithium, barium, strontium, very powerful alterative metals, their actions modified by the chalybeate, carbonates of iron and magnesium, all super-saturated with carburetted hydrogen gas so as to protect them from alteration by oxidation or air. Nothing rarer could be conceived."

The medicinal value of this water has been long recognized, and it has been reported on very favorably by a great number of well known physicians, especially for the relief of disorders in connection with the kidneys or intestines.

The St. Leon Water Co. have a large hotel at the Springs, and it is a favorite resort of Montreal and Quebec people, and is especially patronized by the French.

As far as I have been able to find out there are very few of the mineral waters of the Province that may be classed distinctively as "table waters." A table water must first of all be palatable. We are all quite willing to take medicine when we require it, but when we are well we like what we drink to be pleasant to the taste While this water must therefore be sweet to the taste and pure, in order to make it valuable, it must contain those rare minerals in such delicate proportions as to make the water a valuable tonic, and a corrective of the acidity of the blood, which is so often the result of the modern style of living.

A foreign water which has attained a world-wide celebrity on account of the possession of these qualities is Apollinaris, which is drunk over the entire world, and in enormous quantities.

A more recent spring of a similar quality is the Johannis water, which is now being pushed very vigorously, and which appears to contain all the elements of a first-class mineral table water.

The most recent discovery of a Canadian water of this description, is that known as "Radnor" water, and it is to this spring that I wish more particularly to draw your attention in this paper.

The spring, which is located at Radnor Forges, Champlain County, Quebec, was discovered on 8th September, 1893.

The circumstances which led to the discovery are worthy of mention. During the early part of the year 1893 the General Superintendent of the Canada Iron Furnace Co. reported that there was an outbreak of what seemed to be a "skin disease" among the children of the village and neighborhood. The trouble seemed to be so general, that, in his opinion, there was some good cause for it. The Company at once instituted a thorough investigation, sending Dr. W. H. Drummond to Radnor Forges to look into the matter. After a very full investigation he reported (his report being concurred in by the late Dr. Archibald Campbell) that, in his opinion, the trouble was to be attributed to the water supply, which at that time was obtained from the ordinary village wells. Samples of water were taken from almost every well in the village, and a thorough analysis made, with the result that the water was found to be heavily impregnated with iron, and affected by other impurities, the result of analysis bearing out the doctor's opinion. A matter of note in connection with the investigation was that the Rev. Curé Prince of the adjacent village of St Maurice, stated that during 28 years he had noted at least four outbreaks of skin disease, and these at intervals of four or five years.

After completing the above investigation, and finding that the waters of the subsoil could not be improved upon, even by piping water from a reasonable distance, the company finally decided to bore an artesian well. Operations were commenced in the centre of the village park. Borings were made at that point to a depth of about 354 feet, the strata through which the drill passed being first subsoil, then limestone, and thence into gneiss rock, a granite similar to that of the Highlands of Scotland. At a depth of 100 feet a strong flow of water was secured, which on analysis proved to have so much lime and chloride of sodium that it was looked upon as unfit for domestic purposes. This spring was finally closed at a depth of 354 feet, and although the officers of the company were much disheartened by this, and by the fact that all former attempts at sinking artesian wells in that vicinity had proved failures, it was decided that one more attempt should be made. A location was selected on the company's property some distance away, at which the drill was set to work, with the result that at a somewhat greater depth in a valley, an extraordinary strong flow of water was found, apparently of great purity, its mineral qualities being from the first very marked but at the same time agreeable to the taste.

The strata through which the water passed were first subsoil, then somewhat porous shale rock, and lastly gneiss rock, similar in physical structure to that of the first location, but much darker in color. The shale is reported to have been very light, whilst the gneiss rock from which the water actually springs, is very close and hard.

A four inch wrought iron pipe was driven down into the gneiss rock, and through this the water flows to a height of about five feet above the surface of the ground. Strong pressure is indicated by the fact that from this four inch pipe the water can be lifted to a total height of twelve feet three inches through a one inch pipe.

The quality of the water seemed so good that the officers of the company decided to at once have a complete analysis made by the most competent authority in Canada, and Mr. J. T. Donald, Professor of Chemistry, Bishop's College, Montreal, was selected to make the analysis. From the very first Prof. Donald was favorably struck with the quality of the water. His report was as follows:

MONTREAL, June 14th, 1894.

"I hereby certify that I have analysed the sample of Radnor water received from the Canada Iron Furnace Company, Ltd., and find the following results in 10,000 parts of water.

Chloride of Sodium	14.354
Chloride of Potassium	.211
Sulphate of Sodium	.210
Sulphate of Magnesia	1.262
Bromide of Sodium	.080
Bicarbonate of Sodium	1.697
Carbonate of Lime	2.940
Carbonate of Iron	Traces
Silica	.145
In 10,000 parts of water	20.899

"This analysis shows that Radnor water is of the same class as Apollinaris and German Seltzer. Like those, it contains no excess of sodium chloride and carbonate of lime, and again, like these, it contains the valuable ingredients in such proportions that its use as a table water overcomes constipation and acidity of the stomach in a gentle and pleasant manner. And it is most important that the valuable sodium bromide, which is entirely wanting in the German waters named, exists in appreciable quantity in the Radnor water, making it a most desirable tonic."

(Sgd.) J. T. DONALD.

This report was at once submitted by the managing director to the best authorities in Germany for their report. The following letters will show what a good opinion was formed of the water by the best experts in Germany:

Dr. E. Schott, of Frankfort-on-Main, Germany, a physician of high standing, writing under date June 23rd, 1894, says:

"The analysis of this water is very like Apollinaris, which it surpasses in its percentage of chloride of sodium, which is artificially added to the Apollinaris water to make it keep.

"We have in Radnor water an agreeable drink, which can be used every day as a sort of beverage, but which also in cases of dyspepsia, typhus and kidney disease can be used with a beneficial influence, thus one is certain in drinking this water to have the advantage of not being affected with the harm-giving substances which are frequently to be found in ordinary drinking water"

Dr. Julius Lowe, Chemist of Frankfort-on-Main, the great German expert on Mineral waters, says, under date June 21st, 1894:

"In comparing the analysis of Radnor water with the analytical results of the springs of Seltzer and Apollinaris, I find that the Radnor contains in quantity many of the ingredients which are to be found in the Seltzer and Apollinaris water. The Radnor exceeds the Apollinaris water in its percentage of chloride of sodium, which is added to the Apollinaris water artificially.

"Supposing there is a sufficient yield of your springs it deserves, according to its composition, your whole attention, as far as value is concerned, and it justifies the expectation that the water of this spring can compete successfully with Seltzer and Apollinaris."

With regard to the actual flow, experiments with standard measures show the natural flow to be slightly over 30,000 gallons per day. Certainly the pressure is very great, and there is no reason to suppose that by putting on a steam pump the flow could not be increased *i.e.*, if it was found necessary to exceed the natural output,

The best test as to the permanency of the spring is that from the date of the discovery, 8th September, 1893, the water has not even for an instant showed a diminution of flow. Prof. Donald and others when interviewed in regard to this matter stated that this is about as good a guarantee of permanency as can be given.

As to the "keeping" qualities of the water, it may be mentioned that some of the water taken from the spring in its natural state has been kept in a glass for over a year, and it is as sweet to-day as when taken from the spring. The water being entirely mineral in character will "keep" without the slightest difficulty.

Since the discovery of the spring, and the use of the water by the people of the village, no sign of the sickness and trouble referred to has been seen. The water is in daily use in all their houses, and is known to be of the highest value in all cases of indigestion, rheumatism, etc.

The water placed on trial thus far has given the greatest possible satisfaction, and no better proof of its admirable qualities can be found than by testing it by the side of any of the most popular table waters. The delicacy, purity and flavor of "Radnor" water when thus compared leaves no qnestion as to its quality.

Now, in conclusion, let me say that it is one thing to discover a spring of fine mineral water, and quite another thing to make people buy it and drink it. It is like a patent medicine, give it a good name, make it well known, and people will very soon ask for it. The splendid success that has been attained by such well known waters as Apollinaris, Johannis, and others, shows what can be obtained by persistently presenting to the public the merits of your spring. Make yourself sure by careful analysis and experiments that you have got the right thing, and plenty of it, and then spare no pains to let the public know this fact, and you will reap an abundant reward. There is at present room for a mineral water of the same nature as Apollinaris, for it would appear that there is actually more demand for it than can be supplied direct from the original spring.

I venture to prophesy for "Radnor" water a world-wide fame, founded on the merits of the water itself.

REPAIRS TO ROCK DRILLS.

By MR. JOHN E. HARDMAN, S.B., M.E., Halifax.

I have perused Mr. Sangster's paper with much interest and have looked in the discussion which followed for some categorical statement which would show the actual cost per month (or per year) per drill for repairs, or for renewal of parts. Not finding this, I propose to give some figures, which are the result of three years working of a Rand drill plant at the mines of the West Waverley Gold Co., Ltd., Waverley, N.S.

The number of drills in the plant is five, three being No. 2 L. G., and two No. 3 L. G. During the last year a 32 Slugger (the equivalent of a No. 2 Little Giant) has replaced one of the No. 2 L.G.'s, and I shall make reference to this substitution later.

Of this number of drills three have been in constant use, at an average, the aim being to always have one drill of each number in the shop in perfect repair, so as to substitute it without loss of time, in case of any accident to a working drill below.

The total cost of repair parts during this period of three years ('92, '93 and '94) has been $275.05 or an average per drill per year of $30.65. But at the end of these three years there is but one drill in the lot of five that is fit for service. At a careful estimate about $18.00 would be necessary to make this drill serviceable for another year; so that to the amount of $275.85 should be added, *at the least*, the cost of four drills, say $800.00, making a total of $1,075.85. To be yet more accurate we must add a portion of the cost of the fifth drill, which is serviceable for a time yet, say $150.00, making a cost of $1,225.85 for five drills for three years, or $136.20 per year per drill.

In view of these figures it certainly would appear that Mr. Blue's suggestion that the manufacturers should sell the drills at "something like 25 or 50% on the cost," and then send them, after six or eight months' use, to the scrap heap, is the most practical and economical from the user's standpoint. For it must not be forgotten that the above figures do not include the labor of the blacksmith or machinist who removes the broken or worn parts and fits the new ones, and cleans and oversees generally the drills of the plant; only the first or market cost of the repair pieces, and of the shop in reboring, etc., etc., are included in the figures given.

As a matter of convenience (which may also be interesting to some members of the Association), I have had calculated the cost per drill per year for each of the various renewal parts we have been required to use.

Name of Part.	Cost per Drill per Year.	Name of Part.	Cost per Drill per Year.
Piston packing rings........	$0 55½	Slide valves..............	$0 22
" springs.....	0 13⅓	Valve seats...............	0 50
Ratchet..................	1 00	Rockers...................	1 44½
Pawl.....................	0 59½	Rocker pins...............	0 89
Pawl springs.............	0 08	Throttle valves...........	0 72
Pawl studs...............	0 14	Feed screw................	0 39
Rotating bars............	1 22¼	Jamb nut..................	0 02
Rotating nuts............	1 11	Feed nut..................	1 95
Buffer yoke..............	0 05½	Shells....................	3 88
Cylinder buffer..........	0 11	Split stuffers............	0 66
Chuck bolt nuts..........	0 22	Step clamp bolt...........	0 44
Chuck keys...............	0 33⅓	Arm clamp bolt............	0 42
Chuck bushings...........	4 22	Hose end fittings.........	1 29

In this list it is seen that "chuck bushings" easily stand first, with "shells" a good second. An explanation of this is not easy; many of our chuck bushings at first were very brittle and broke easily. Since getting a better bushing the wear must be attributed largely to the sharp cutting quality of quartz dust. Mr. Geo. R. Smith's remark that the life of a drill depends largely upon the operator and also upon the rock to be drilled, will be endorsed by every drill user.

As an instance I may allude to an installation of Rand drills put into one Oldham mine some few years ago, the repairs to which have amounted to less than $10.00 per drill for the whole of that time. The difference between the cost of these repairs and those at Waverley is chiefly due to the difference in the nature of the rock encountered. It is also due in part to the fact that we work at a higher air pressure in Waverley than in Oldham, the gauge underground in Waverley reading 90 lbs., while at Oldham the average pressure did not exceed 70 lbs. per square inch. The high pressure in Waverley was a necessity, as the drainage pumps of the mine are operated by compressed air.

The most effective agent in reducing the cost of repairs to drills has been the adoption of the rule of charging all repairs against the contractors or miners operating each drill. At the end of each month the repair bill is scrutinized closely by the management and items unquestionably due to wear and tear are assumed by the company; items due to carelessness or recklessness are charged to the men operating the drill.

In reference to the remarks of several gentlemen regarding the quality of oil to be used, I might say that in gold quartz mining the use of oil has almost to be prohibited, at any rate it has to be minimized, as the oil is most detrimental to subsequent amalgamation in the mills. At the suggestion of Mr. Halsey, who was connected in the matter, the experiment was tried of using a compression grease-cup on the drill. It was found that although lubrication of the valve was perfect, the grease failed to properly lubricate the cylinder, and after attempts to use glycerine and plumbago had also proved abortive, we were compelled to return to a light machine oil, and to use the greatest care and supervision in its use on the drill. But we have never found the wear on the cylinders to be a principal item, and in this respect cannot consider Mr. Sangster's idea of bushing as of prime importance.

Something over a year ago we substituted a 32 Slugger for one of the No. 3 Little Giant drills, hoping thereby to diminish the number of renewal parts.

Our experience with the Slugger has been most satisfactory, so much so that we have substituted two more Sluggers in place of "Little Giants." We find that the Slugger No. 32 working under our high air pressure is a more economical machine, and one that is fully as effective in hard ground, and we have also had the satisfaction of seeing our bills for new parts materially reduced. In my experience of 17 years I have never worked a more satisfactory air drill than the Rand 32 Slugger.

THE IMPORTATION OF MINING MACHINERY.

THE SECRETARY again called attention to differences of interpretation by Custom's Collectors of the law respecting the free admission of mining machinery. In the Province of Quebec, for instance, he was informed by one of their members that silvered copper plates for a gold mill had been held for duty, notwithstanding that for a number of years these plates had been admitted free in the Province of Nova Scotia. The Ontario Government imported recently two Sullivan prospecting drills from Chicago and the duty had been charged, notwithstanding a provision of the law which specially provided that diamond drills be admitted free. The Cumberland Railway and Coal Co. had brought in, for use at their Springhill collieries, a very heavy and specially designed colliery pump, from Jeansville, Pa., of a class or kind not manufactured in Canada, but the duty was collected under protest. The New Glasgow Iron, Coal and Railway Co. had also been compelled to pay under protest duty on their coal washing plant, machinery not manufactured in the country. Some difference of opinion existed in the Department of Customs respecting the meaning of the Act, it being claimed that in this instance a coal washing plant was not, in the strict sense of the word, mining machinery, but he understood that a ruling had been given by the Department of Justice which admitted all machinery and appliances for mining and treating ores and minerals to be within the jurisdiction of the Act. Some action should be taken to bring the matter again to the attention of the Department, and he would move that the President and Secretary, with Messrs. H. A. Budden, H. Drummond, J. Burley Smith, S. L. Spafford, R. T. Hopper, J. J. Penhale, Capt. Adams and S. P. Franchot be a deputation to interview the Minister of Trade and Commerce and the Controller of Customs.

MR. R. T. HOPPER said his company had brought in a crushing plant not manufactured in the country; they had to pay duty, and it had never been refunded. He seconded Mr. Bell's resolution.

MR. PENHALE—The only list in the hands of the collectors was one furnished by the Jenckes' Machine Co. of Sherbrooke, which embraced everything under the sun.

CAPT. ADAMS moved that the Committee appointed by the last motion be requested to bring before the Government the question of admitting all mining machinery free into the Province of British Columbia for a limited period. In making the motion he pointed out that the present law had been framed before mining in British Columbia had assumed its present importance, and consequently so far as that province was concerned the law was practically a dead letter. Mine owners could not import their machinery from the Province of Quebec, and they had to import it from the United States. Mining was largely conducted by American capital and American machinery, and if it were not for the present law more capital would be forthcoming from Americans for mining purposes. Capt. Adams' motion was seconded and agreed to.

THE QUEBEC MEETING.

THE SECRETARY moved that the next meeting of the Association be held in the City of Quebec and that the following be a Committee of Arrangements :—Hon. George Irvine, Q.C., Mr. James King, M.P.P., Mr. Lawrence Lynch, Mr. C. H. Carriere, and Mr. J. T. Dyer.

The motion was agreed to.

A vote of thanks to the contributors of papers and to the chairman terminated the proceedings.

SUMMER MEETING.

CHATEAU FRONTENAC, QUEBEC.

27TH AND 28TH JUNE, 1895.

The opening session was held in the Chateau Frontenac, Quebec, on the evening of Wednesday, 27th June, the President in the chair. A number of delegates were present from the Ontario Mining Institute, while the Mining Society of Nova Scotia was represented by its President, Mr. R. H. Brown, M.E., Sydney Mines, C.B., and Mr. David McKeen, M.P., Glace Bay, C.B.

The proceedings opened at eight o'clock, when the Secretary read the minutes of previous meeting.

NEW MEMBERS.

The following were elected to membership :

Mr. James Foley (Petroleum Oil Trust Ltd.), Montreal.
Mr. W. T. Bonner, (Babcock & Wilcox Boiler Co.), Montreal.
Mr. Lawrence Lynch, (Johnson's Asbestos Co.), Quebec.
Mr. D. G. Loomis, Sherbrooke, Que.

STUDENT MEMBERS.

The following were duly elected student members :

Mr. F. H. Bacon, McGill College, Montreal.
Mr. A. Boyer, Polytechnic School, Montreal.

Amendment to Constitution and By-Laws.

The President gave notice of motion of amendment to Constitution and By-Laws, changing the number of meetings during the year to two instead of three as at present.

Delegates to Canadian Mining Institute.

The following were appointed delegates to the Federated Board of the Canadian Mining Institute:

Mr. John Blue, President.
Mr. George E. Drummond.
Mr. L. A. Klein.
Mr. John J. Penhale.

Fall Meeting Postponed.

On motion the autumn meeting was postponed, and the next meeting of the Association will therefore be held in Montreal in January 1896.

This concluded the business session.

The President having left the chair, the Hon. E. J. Flynn, Commissioner of Crown Lands for the Province and an honorary member of the Association, was unanimously voted to preside over the open session which was convened immediately on the conclusion of the business meeting.

Address by the Hon. E. J. Flynn.

Hon. E. J. Flynn—I desire to express my pleasure at being present at this meeting, and also my sense of the honor done me in asking me to take the chair. I have had previous experience of a meeting of this kind, having been present at the convention which took place in January, 1894, in the city of Montreal. I must congratulate the Mining Association of the Province of Quebec on the good fortune that it has had in convening here in the old city of Champlain, the representatives of the various mining associations of the Dominion of Canada. From discussion comes light, and you have met here for the purpose of discussing some topics connected with the mining industry. The subject of mining is a vast subject, and one with which it would be utterly impossible to deal at one meeting of this kind. I notice, therefore, that on your programme for the present occasion you have given great prominence to one topic—that of phosphate mining, which is to be treated from three or four points of view. The practical aspect of the question is one which is certainly deserving of your attention and consideration as well as that of the governments of the Provinces and of the Dominion of Canada, for, as you are well aware, the phosphate industry has for some time past been in a languishing condition, owing to circumstances over which neither those more immediately interested nor the government have any control. Now, I see a new idea has been thrown out—that of having for the product of our phosphate mines, a home market. This idea is in keeping with the policy which prevails throughout the Dominion of Canada, that of preserving, protecting and developing natural resources which exist in the several Provinces, and in none in a higher degree than in the Province of Quebec. (Applause) I desire to endorse this idea of a home market for our phosphate. It is part of the policy of the Government of Quebec to develop the agricultural resources of the Province, and I regret that Hon. Mr. Beaubien, who is the Minister more particularly charged with that branch of public affairs, is unavoidably absent from this meeting, as he would, if possible, have taken a deeper interest in the subject under discussion than I do myself. My own department in the government covers the woods and forests, the inland fisheries, and the mines of the Province, and the policy of protection and development which it has been my aim to enforce in the administration of these portions of the Provincial domain is the same policy, I am glad to see, which is to be propounded here in connection with the phosphate industry. There is no doubt that the matter is one of great public importance, for it would be an undoubted benefit to the people of Quebec if our phosphate could be used as a fertilizer in those parts of the Province where, as is well known, the soil is in very great need of having some of its elements restored, of which it has been deprived by the cropping of many years.

The question of how phosphate should be applied as a fertilizer is one which I hope will be discussed by the gentlemen who are to speak. I have seen it stated that great differences of opinion exist as to whether phosphate can be utilized as a fertilizer without having first been converted into superphosphates by treatment with sulphuric acid. It has been proposed to use simply the crushed phosphate, without any preliminary treatment, but in a report issued under the auspices of the government it is stated that nothing had yet been found to satisfactorily prove the value of this method. This is a very practical aspect of the question, and as administrator of the Crown Lands Department I should be glad to have some enlightenment on the point, with the view of assisting in the promotion of the phosphate industry.

I shall listen, gentlemen, with great pleasure to your deliberations, and I trust that much good will follow from your meeting, not only in the greater diffusion of knowledge and enhanced value of our mines, but in the stimulus which will be given to the agricultural interests of the Province. I may express the hope also that you will be able to combine pleasure with usefulness, and that when you leave the old historical city of Quebec, you will take with you the happiest reminiscences of your sojourn here. (Loud Applause.)

THE USE OF ELECTRICAL APPARATUS IN MINING.

By Mr. W. F. Dean, Montreal.

I shall be obliged to omit altogether apparatus operated by battery or magneto currents, such as bells for signalling, telephones and blasting apparatus, the operation of which is now pretty well understood, and confine myself to electric lighting and the electrical transmission of power, paying more particular attention to such apparatus as is most likely to prove useful to members of this Association.

I wish to take up and explain, first of all, several fundamental principles in electric transmission, either for lighting or power, a knowledge of which is necessary to a clear understanding of the subject. The first and most important of these is that for transmitting a certain amount of power at a certain voltage or pressure, with a certain loss in the wire, the cost of copper increases as the square in the distance.

A recent paper by Mr. Irving Hale gives the following example: If for transmitting 100 horse-power one mile at 500 volts, with 10 per cent. loss in line, the wire costs $2,000, it will cost for transmitting the same power two miles, under the same conditions, the square of two, or four times $2,000, or $8,000, and for ten miles, 100 times $2,000, or $200,000. The reverse of this law is that for a certain power, distance, and loss in line, the cost of wire is inversely proportional to the square of the voltage. For instance, if it costs, as explained above, $200,000 for wire to transmit 100 horse-power ten miles with 10 per cent. loss at 500 volts, it will cost at double that voltage, or 1,000 volts, one-quarter as much, or $50,000, and at 5,000 volts (ten times the voltage) one-hundredth as much, or $2,000. Thus the same power can be transmitted with the same loss, ten miles at 5,000 volts, for the same cost of wire that is required for one mile at 500 volts.

When inventors first began to realize the commercial importance of incandescent lighting, one of the most difficult problems was to produce a lamp of sufficiently high voltage to bring down the cost of conductors to a reasonable figure. Edison's discovery of the high-resistance filament solved the problem and made it possible to use a voltage of about 110 for distributing purposes. Even this was found inadequate for large areas and he afterwards devised the three-wire system, in which two dynamos are connected in such a manner that while the total voltage of the system is 220, the lamps being connected to a third or neutral wire receive only 110. By this means the voltage is doubled and the cost of copper accordingly reduced to one-fourth, or practically, taking the central wire into consideration, to not more than three-eighths. This system is in use in nearly all large cities, both on this continent and in Europe. Later, attention was directed to the alternating system, which has been rapidly adopted in cases where the lighting is scattered, or where long distances have to be covered. A brief consideration of the properties of alternating currents will show why it is better adapted for this work. If the electro-magnetic impulses that form an electric current are propagated continuously in one direction, the current is said to be continuous, but when they alternate in direction at a more or less rapid rate, then the current is said to be alternating. The alternating current enables us to take advantage of an effect called induction, which is only exerted when the current is suddenly broken or changed in direction. Thus if we wind two separate coils of wire on an iron bar, and pass a direct current through one coil, no effect is produced in the other coil except at the moment of turning on the current, but if an alternating current is used instead, a current is at once produced and maintained in the second coil. By a very simple law the pressure or voltage of the two coils are in proportion to the number of turns in each. Thus, if the primary coil is supplied with current of 1,000 volts, and the secondary coil has one-tenth as many turns, the pressure in the secondary will be 100 volts. Such a device is called a transformer, and its use enables us to employ practically any voltage necessary for economy in transmission and reduce it to a low pressure at any desired point for use in lamps or motors.

The alternating current machine may be built to give directly a pressure up to 2,000 or 3,000 volts and in certain types as high as 5,000 volts. If this is insufficient for the purpose, the voltage may be still further increased by the use of transformers described above. By the proper proportion of the primary and secondary coils, the voltage may be raised to any pressure which can be safely transmitted over ærial lines.

Having thus described as briefly as possible the principles of electric transmission, and the different forms of current that may be employed, I will now take up in detail the different uses to which electrical apparatus may be applied:

Electric Lighting.—Electric lighting for mines and auxiliary works offers the same advantages that are now so generally recognized as appertaining to this method of illumination for other uses. Its steadiness, freedom from heat, and the ease with which it may be distributed, places it far in advance of any other artificial light. When once installed, the expense of operation is inconsiderable, especially when operated in connection with a complete electrical power system. The type of apparatus will be determined entirely by the conditions in each case. If the distance to which the lights are transmitted is small, a direct current dynamo of 110 volts will be the most satisfactory. In deep mines, however, and in cases where the source of power is at a considerable distance from the workings, the cost of conductors at this pressure becomes prohibitive, and it is necessary to use some method in which the voltage can be increased. By the use of two dynamos connected on the Edison three-wire system previously explained, the cost of conductors can be reduced to about three-eighths the amount required by the two-wire system, assuming that the third wire is made the same size as the outside wires. It is also possible to use a single dynamo of 220 volts, but this has its disadvantages, as it is necessary to use two lamps in series, and any accident to one of a pair puts the other out of use as well. For very long distances the alternating system at 1,000 volts pressure, or higher if necessary, may be used, the voltage being reduced by means of transformers to about 100 volts at the lamps.

Whatever type of dynamo is selected, should be placed in a dry position, free from dust, and if possible an independent foundation of brick or stone should be provided. An endless belt will always give the best results, as lacing produces a momentary flicker in the lights at each revolution. In all cases the steadiness and to some extent the life of the lamps is dependent on uniformity of speed.

The switchboard containing the necessary instruments and controlling devices, is preferably of slate or marble, but as the expense of such a board is quite an item, a skeleton framework of hard wood, well shellacked, may be made to answer every purpose. From the switchboard the wires are led to the distributing point, which should be as nearly as possible in the centre of the district to be lighted. If the work is above ground, the method of installing the lines and lamps will not differ from the usual practice. If, however, the wires are to be carried underground, a much higher insulation must be maintained, and the work must be carried out in every respect with the greatest care.

For all mines where nitric acid does not occur, lead-covered cables with rubber insulation are found to be the most suitable. The most satisfactory supports for lead cables are malleable iron brackets, but the method of securing them to the walls or roof must be determined entirely by the situation. On these brackets are placed glass insulators of the deep groove pattern and the cable is in turn secured to these. All cut-outs and switches should be placed in malleable iron boxes and the cable should be led into these through hard rubber bushings. No attempt should be made to use key-sockets for the lamps. Keyless sockets of porcelain or hard rubber should be used, or special fixtures similar to those designed for marine work. It will always be found to be economy in the long run to use only the highest class of insulation in underground work, and to have all fittings installed in such a manner that the chance of interruption to the service is reduced to a minimum.

Transmission of Power.—I do not know that it is necessary for me to point out the advantages of electrical transmission of power for mining. It is in many cases so self-evident that it requires no demonstration. It is seldom indeed that minerals are found in the most convenient place for their extraction from the earth. The necessary transportation of coal or other fuel makes the cost of operating any machinery excessive, and prevents the use of labor-saving devices which would be adopted if the problem of cheap power were solved. In fact the absolute necessity of obaining power often forms one of the most serious problems to mining engineers.

Direct current apparatus has for a long time been used for this purpose, and for comparatively short distances has proved itself satisfactory in every way. Motors have been applied to hoists, pumps, diamond drills, air compressors, ore crushers, stamp mills, and almost every form of mining machinery. It was soon found, however, that with the direct current, the voltage was limited to about 500 to 800 volts, and at this pressure it was impracticable to cover very long distances. Until a comparatively recent date, the alternating current could not be successfully used for motor work. The only motors available were of the synchronous type, so called because they run at the same speed or in a certain proportion to the speed of the generator. When operated on single-phase circuits, they are not self-starting, but must be brought up to their normal speed by an independent source of power. The load is then carefully applied by a friction clutch. If the work to be done is for a moment in excess of the capacity of the motor, they get out of step, as it is called, and stop. They also require a separate machine as an exciter to energize the field. It will thus be seen that their use for general power purposes is limited. By the introduction of what is known as the multi-phase systems all difficulties have been overcome and alternating current motors are now manufactured which are equal to the best direct current motors in efficiency and starting torque, and which have the additional advantage of having no commutator or moving contacts of any kind.

The three-phase system, which has so far been more generally adopted than its rival, the two-phase, may be best described as a combination of three separate alternating currents in which the reversal occurrs at different times. The result is that the impulses which produce the rotation are at no time entirely interrupted. This system was first used at the Frankfort Electrical Exhibition held during the summer of 1891 in Germany, where the power was transmitted from Lauffen to Frankfort, a distance of 112 miles.

One of the first plants installed on this side of the Atlantic was at Hartford, Connecticut, which has been in operation since November, 1892. The machines in use here are about 400 horse-power capacity, one being used as a generator and the other as a motor. The motor is used to drive street railway generators. Both are wound for low voltage, the pressure being raised at the generator end to 7,000 volts, and transmitted over the line, which is eleven miles in length, at this voltage. It is then reduced by means of transformers to the same potential as at the generator.

Following the Hartford plant, the plant at Redlands, California, was installed. This installation is a typical one for general central station work and supplies motors and arc and incandescent lamps. It was started on September 7th, 1893. After this practical start the adoption of the system was rapid both in the west and in the east, some of the principal plants now in operation or under contract being at Taftville, near Norwich, Conn.; Concord, N. H.; Columbia, S. C.; Portland, Oregon; Santa Rosalia, Mexico; Sacramento, Cal.; Pelzer, S.C.; Park City, Utah; Pachuca, Mex.; Silverton, Col.; Traverse City, Mich.; Norway, Me.; Gouverneur, N.Y.; Rochester, N.H.; Bel Air, Maryland; Austin, Texas; St. Hyacinthe, P.Q.; Dowagiac, Mich.; Sparta, Wis., and East Poland, Me.

Of these the plants at Santa Rosalia and Pachuca, Mex., Park City, Utah, and Silverton, Col., are exclusively for mining purposes. The Pachuca installation is the largest of these and offers a typical example of a three-phase transmission plant on a large scale. At the generating station are placed five three-phase alternators of 400 horse-power each, directly coupled to a Pelton water-wheel operating under a head of 700 feet. These machines generate current at a comparatively low potential of 700 volts. This current is led to transformers wound for a ratio of 1 to 15, thus raising the pressure to 10,500 volts. The line, which consists of three wires, No. O, B and S gauge, extends first to Real del Monte, a distance of 67,400 feet, or a little less than thirteen miles. Here is situated a transformer sub-station where the potential is reduced to 2,000 and 500 volts. The current at 500 volts is used to operate the machinery for two mines in the immediate neighborhood, while the 2,000 volt current is led to the Escobar and Barron mines, a distance of 4,400 and 11,000 feet respectively. The high potential line is then continued to Pachuca, a distance of 21,600 feet, where another sub-station is located supplying current through transformers to five mines in that vicinity. A third sub-station is located at San Rafael, 15,840 feet farther on, the total distance from the source of power being over twenty miles. It is expected that enormous economies will be effected by this plant over the old system of operating machinery by coal.

At Silverton, Col., we have definite data as to the saving affected by power transmission.

In Mr. Irving Hale's paper describing this plant, which has a total capacity of 400 horse power, he states that the saving will not be less than $36,000 per year. The distance in this case is about three miles.

Aside from the direct saving effected by the use of electric power, which in many cases is sufficient to more than pay for the plant the first year, it is often found that the greater ease of operation and small repair account still further increase the balance in favor of electricity. Electric motors offer advantages over other forms of power for almost every description of mining work.

Electric Hoists.—To hoisting, for example, the motor is peculiarly applicable. A hoist does its heaviest work in starting its load. A steam hoist having two engines with cranks at right angles can only be depended upon at this time for one-half of its rated capacity, as one of the engines may be on a dead centre. An electric motor, on the other hand, has no dead centres, and a heavy current in excess of the normal, can be turned into the armature for a few moments without danger.

This important advantage is of great value, and gives electric hoists a greater capacity, other things being equal, than a steam hoist. The simplicity, too, is very apparent; instead of two link motions, we have a simple reversing switch, and the only parts subject to wear in the motor are the two bearings and the commutator. In the alternating motor the commutator is eliminated, giving an ideally simple motive power.

Electric Pumping.—The advantages of electrically operated pumps may be summed up briefly as follows. Saving of room as compared with Cornish pumps or other systems requiring a separate pump-shaft. The possibility of placing them in the most advantageous situation and connecting them to the sources of power, without heavy expense. Ease of control from a distance and independently of each other. The type of pump best adapted to electric driving is the triplex, which gives an even resistance to the rotary motion of the motor. They are built in almost every form required in mining operations. Centrifugal or rotary pumps are also well adapted to electric driving, and may be used where it is only required to raise the water to moderate heights.

Electric Haulage.—Remarkable successful results have been obtained in the application of electric haulage to mines, and it is now recognized as the ideal system for handling mine products. The first cost is somewhat more than a rope haulage plant, but the cost of maintenance and repairs is considerably less. Any locomotive system is more flexible than rope haulage, as the lines can be easily changed or extended. The construction of the electric locomotive admits of adapting it to the local peculiarities of the mine, and may be made for very low entries and for little or no overhang beyond the ~~rails~~. Where the service required is simply the transportation of ore or materials on the surface, a standard street railway truck may be equipped with any particular type of car body required for the work. This may be used to tow a number of trail cars if necessary. Where it is desired to handle standard railway cars without a second handling of the material, locomotives of different capacities have been designed.

Electric Drills.—I am aware that electric percussion drills are not as a rule very well thought of by mining engineers in this country. They were originally placed upon the market without proper tests and before they had been perfected as a commercial piece of apparatus. Extravagant claims were made for them and the results were for this reason all the more disappointing. For the past two years the company with which I am connected has been engaged in perfecting the electric percussion drill, and their satisfactory working, wherever placed, is the best proof of our success. No change has been made in the principle of the drill. The iron plunger is given a reciprocating motion by two electromagnets in the drill body, to which a pulsating current is supplied by a specially designed generator. The mountings are in every respect the same as the standard air or steam drill. The improvements made have been in reducing the heating of the coils and in devising an insulation which could not be injured by the rough usage which a rock drill is called upon to withstand. While this may seem a small matter, it practically makes the difference between an experimental piece of apparatus and a commercial tool.

Electric drills offer peculiar advantages when the location of the work is often changed or where the source of power is at a considerable distance. They are more efficient and operate with less loss in transmission than steam or air drill. In place of expensive and troublesome pipe lines, a flexible cable easily changed in position is all that is required.

Miscellaneous Power Work.—In addition to the uses mentioned, electric motors may be applied to almost any form of mining machinery, the problem of their application being a mechanical rather than an electrical one. Special uses in connection with his own work will doubtless occur to any practical mining engineer. One object of this paper has been particularly to point out the great advance which has been made in transmitting power over long distances. What can now be easily accomplished in this respect would have been difficult, if not impossible, even so recently as two or three years ago, and it is of the greatest importance that mine operators, using any considerable amount of power, should carefully investigate this matter. The saving of a large part of the expenditure for fuel would mean in many cases increased dividends, and in some cases would doubtless bring the balance of profit and loss account to the credit instead of the debit side.

PHOSPHORIC ACID IN AGRICULTURE.

By Frank T. Shutt, M.A., F.I.C., F.C.S., Chief Chemist, Dominion Experimental Farms.

When the achievements of science during the present century come to be written up, I am firmly of the belief that, notwithstanding the useful and brilliant discoveries in electricity and physiology, and the marvellous engineering feats of the age, it will be found that chemistry has, during the past ninety years, contributed more towards the necessaries and luxuries of life, more towards the economy and comfort of living, the civilization and progress of the world, than any other science, natural or physical. Agriculture is the oldest of the arts, but it is only within the most recent time that she has become a science. The science of agriculture dates from the day when the art of farming began to be studied from a chemical standpoint, and chemists sought by analysis to learn the composition of plants and animals, to understand the nature and sources of plant food and animal requirements, and to comprehend the manifold changes that matter undergoes when those changes are brought about by plant and animal life. That day is in the recollection of some that are still living

Deeply interesting as the history of the birth and development of agricultural science is, it is not my purpose to consider it to-day, even in outline. I shall rather content myself by stating one or two of the fundamental truths of agricultural science, for the knowledge of which we have to thank chemistry. Their realization may help us to understand more clearly the question we are to consider today—Phosphoric Acid in Agriculture.

First, then, chemistry has established the fact that plants require food for the maintenance of their life, and for their development and reproduction. Their increase in weight is due to the assimilation of food materials, the assimilation being the result of the exercise of certain vital functions.

Secondly, it has been ascertained that this food is obtained by plants (which, of course, include all farm crops), partly from the atmosphere and partly from the soil. With respect to the former, nature always supplies an abundant quantity; but of the latter—the soil-derived food the intelligent farmer must see to it that his crops are furnished with liberal amounts in available forms. Fertile virgin soils are storehouses or banks in which are laid up vast supplies of material to be converted by the agency of vegetable life into valuable food products for man and beast. Such stores, however, are not inexhaustible. Every crop harvested must necessarily lessen the amount of plant food in the soil. Science affirms, and practice corroborates the statement, that the continuous harvesting and selling of crops off the farm without any concomitant return of those elements extracted by the roots of the crops, invariably and inevitably lead to diminished yields, and finally to soil exhaustion of such an extreme character that farming is no longer profitable. Chemistry, then, in agriculture, forces home this truth, "*Ex nihilo nihil fit.*"

Science and practice have shown that of the soil-derived elements of plant food it is generally necessary to replace only three, in order that fertility may be maintained. The other constituents, though equally indispensable, are usually present in sufficient quantities in the soil for ordinary farm crop requirements. The three constituents here referred to are: Nitrogen, phosphoric acid and potash, and are known as the "essential elements of fertility." Manures and fertilizers are, therefore, plant food suppliers, and receive their value primarily, according to the amounts of these essential constituents that they contain. Their chief function is, therefore, to furnish available nitrogen, phosporic acid and potash in the soil These elements of plant food are here named in the order of their commercial value and agricultural importance.

To speak briefly of nitrogen, we have to chronicle most valuable assistance rendered by chemistry to agriculture in the recent discovery that the legumes have the power of appropriating and assimilating the free and uncombined nitrogen of the atmosphere. The leguminosæ include clover, pease, beans, vetches, etc., and as far as is at present known, are the only plants that have this important and valuable power. It would be foreign to our subject to discuss how this assimilation takes place; but I may be allowed to point out that the more extensive growing and feeding of leguminosæ upon Canadian farms will prove the cheapest and most permanent method of enriching impoverished soils in that very important element, nitrogen.

Concerning potash, it is only my purpose to mention that we have in Canadian wood ashes a valuable home source of this constituent. We, as an agricultural people, have not yet come to the realization of the fact that in selling our wood ashes across the line we are parting with a birthright for a mess of pottage. Our supply of wood ashes is rapidly diminishing, and the day is not far distant when we shall have to replace the potash so lost to our soils by the salts from the Stassfort mines.

THE OCCURRENCE OF PHOSPHORIC ACID IN NATURE.

It might well be argued that since phosphoric acid is essential to the life of plants, and since vegetable life is so widespread, the presence of this constituent in the soil is well-nigh of universal occurrence. Phosphoric acid, chiefly as phosphate of lime, is found in many rocks, in feldspar, granite, gneiss, syenite, trachyte, dolerite, diorite, dolomite, etc., the percentoge running from .09 to 1.7. The disintegration and decomposition of rock materials are among the chief factors in the formation of soils. It is thus that the mineral basis of soils are obtained; and hence, it is a very simple matter to account for the presence in them of phosphoric acid. The older rocks, it has been shown, are richer in this constituent than those of later origin. Knowing, therefore, the character of the originating rocks, we are able to form an estimate of the soil's richness in this element.

THE PERCENTAGE OF PHOSPHORIC ACID IN SOILS.

Most authors quote two-tenths of one per cent. as the average amount of phosphoric acid found in a good fertile soil. They further state that one-half that amount probably represents phosphoric acid in soils of ordinary fertility, while very rich and exceptional soils possess from .3 to .5 per cent.

The subjoined table gives the percentage of phosphoric acid in 40 surface soils and 16 subsoils, obtained in the various provinces of Canada as indicated.

PHOSPHORIC ACID IN CANADIAN VIRGIN SOILS.

No.	Province.	Locality.	Surface or Subsoil.	Character of Soil.	Per Cent. of Phos. Acid.
1	British Columbia.	Ladner's Landing....	Surface..	Alluvial loam........	.27
2	do	Chilliwack...........	Subsoil..	Heavy clay..........	.13
3	do	Squamish Valley.....	Surface..	Sandy loam.........	.20
4	do	Alberni..............	do ..	Clay loam...........	.08
5	do	1st Bench, Exp. Farm, Agassiz...........	do ..	Clay and sand........	.23
6	do	2nd do do	do ..	do	.13
7	do	Orchard, do	do ..	do	.18
8	do	do do	do ..	do	.25
9	do	Pitt Meadows........	do ..	Alluvial loam........	.48
10	do	do	Subsoil .	Yellow sandy........	.13
11	N. W. T......	Walsh Flats.........	Surface..	Clay loams..........	.17
12	do	do	do ..	do	.16
13	do	Tilley	do ..	Sandy...............	.13
14	do	do	do ..	Sandy...............	.17
15	do	Vermillion Hills......	do ..	Undecomp'd rock mat.	.16
16	do	do	do ..	do do	.18
17	do	Yorkton..............	do .	Black sandy loam.....	.20
18	do	do	Subsoil .	do do	.09
19	do	Calgary..............	Surface..	....	.17
20	do	Saskatoon	Subsoil .	Clay................	.10
21	do	Tp. 22, R. 26, W. 2..	do .	Calcareous clay.......	.12
22	do	2 & 3, 34, 35, Tp. 29, R. 24, W. 2........	do ..	do ...	.11
23	Manitoba........	Sec. 31, Tp. 4, R 1 W	Surface.	Dp. blk l'm vir. pra. s'l.	.27
24	Ontario	Muskoka............	do .	Loose sandy loam	.26
25	do	do	do .	Sandy loam.	.10
26	do	do	Subsoil .	do	.17
27	do	do	Surface..	Light grey sandy loam	.17
28	do	do	Subsoil	....	.08

No.	Province.	Locality.	Surface or Subsoil.	Character of Soil.	Per Cent. of Phos. Acid.
29	Ontario	Russell	Surface.	Grey sandy loam	.21
30	do	do	Subsoil	Light yellow sandy	.10
31	do	do	Surface.	Grey sandy loam	.09
32	do	Walkerville	do		.12
33	do	Muskoka	do	Sandy and light	.17
34	do	do	Subsoil	do	.17
35	do	Port Arthur	Surface.	Grey sandy loam	.14
36	do	Lot 14, Con. 10, Brunel Tp., Muskoka	do	Clay loam	.16
37	do	Muskoka	Subsoil		.09
38	Quebec	Arthabaska	Surface.	Sandy loam	.16
39	do	do	Subsoil		.17
40	do	do	Surface.	Black muck	.22
41	do	do	Subsoil	Grey sandy	.31
42	do	St. Adelaide de Pabos.	Surface.	Red sandy	.04
43	do	do do	do	do	.07
44	do	St. Clet	do	Dark grey sandy loam	.32
45	do	do	Subsoil		.29
46	do	St. Ignace du Nominin-[que	Surface.	Heavy clay loam	.18
47	do	do do	Subsoil	do do	.18
48	do	St. Peter Joliet	Surface.	Black clay loam	.27
49	do	do	Subsoil		.28
50	do	Maria, Bonaventure	Surface.	Yellow soil	.18
51	New Brunswick	Restigouche	do	Pale yellow soil	.08
52	do	Sackville Marsh	do		.15
53	do	do	do		.17
54	Nova Scotia	Cumberland	do	Sandy	.06
55	do	S. W. Mabou	do	do	.09
56	P. E. I	Kings Co.	do	Light sandy loam	.09

These results have been collated from the annual reports of the Chemical Division of the Experimental Farm, in which may be found the complete analyses of the soils as made in our laboratory at Ottawa.

The samples examined by no means represent the "Provincial character" of the soils; that would be impossible with such a limited number of examples. They are, however, fairly representative of tolerably large areas of uncropped and unmanured lands in the various provinces.

The percentages above recorded may be regarded as those of "total" phosphoric acid; being determined after treatment of the soils with hydrochloric acid, according to the method as suggested by the Association of Official Agricultural Chemists of the United States. I shall not discuss these data in detail, but attention may be called to the high phosphoric acid content in the soils of alluvial origin from British Columbia, and in the virgin prairie soils of Manitoba. We obtain as an average of the above table, the following percentage of phosphoric acid:

Surface soils (40)	.17
Subsoils (16)	.15

Assuming the weight of the surface soil to a depth of nine inches over one acre to be 2,600,000 pounds, we find an average amount in that area of 4,420 pounds of phosphoric acid. In the surface soils of alluvial and prairie origin, the amount of phosphoric acid would be still larger, more especially when we consider the greater depth of these soils.

CONDITION OF PHOSPHORIC ACID IN SOILS.

The natural phosphoric acid of the soil does not exist for the most part in a condition available for plant use. It is there present as the phosphates of lime, iron and alumina—compounds practically insoluble in water.

While, therefore, we have in ordinary soil analyses, data regarding what may be termed the "total richness" in phosphoric acid, such analytical data, as usually obtained, do not furnish us with information respecting the availability of that phosphoric acid for plant use. Plants require their food in a soluble condition or in one that they can render such by the acid exudation of their roots. Hence the fertility of a soil cannot be measured entirely by the totals of its constituents. Thus, as has been pointed out, many farm soils containing an amount of total phosphoric acid equivalent to two tons or more per acre, have had their yields vastly increased by the application of 2 or 3 hundredweights of superphosphates containing, say, from 30 to 50 pounds of soluble phosphoric acid.

The following table gives the weight of phosphoric acid taken from the soil by farm crops per acre. The amounts stated have been calculated from reliable chemical data and computed average provincial yields. With good farming the yields here quoted would be from one-third to two-thirds greater:—

WEIGHT OF PHOSHORIC ACID TAKEN FROM THE SOIL BY FARM CROPS PER ACRE—AVERAGE.

	Pounds.
Wheat, 20 bushels, grain—Grain and straw...	15.7
Barley, 25 bushels, grain—Grain and straw...	14.0
Oats, 35 bushels, grain—Grain and straw.....	15.6
Corn fodder, glazing—11 tons..............	32.5
Timothy and clover—1½ tons dry...........	15.0
Turnips (10½ tons of roots)—Roots and tops.	27.3
Mangels (10 tons roots)—Roots and tops....	28.0
Carrots (8½ tons roots)—Roots and tops....	21.8
Potatoes (3 tons tubers)—Tubers and haulm .	14.5

We thus see that the average annual phosphoric acid requirements for farm crops is somewhere in the neighborhood of 20 pounds per acre. We might, therefore, infer—providing the natural phosphoric acid of the soil were even in a fair degree available—that an addition of superphosphate would be unnecessary and unprofitable. Such, however, as already stated, is not the case. The explanation is, that the phosphoric acid of the soil, although frequently present, as regards amount, in ample quantity for crop use, becomes but very slowly available This latter process is brought about by the solvent action of the soil water containing carbonic acid and the solvent action of the acid sap in the plant rootlets. I repeat, therefore, that soil fertility is dependent rather upon the percentage of available plant food than upon its total percentage. Soil exhaustion is principally the loss, by rapid succession of crops, of the store of immediately available elements in the soil. Our purpose in manuring is to replace them there in such conditions that they may at once be made use of by plants.

SOLUBILITY OF PHOSPHATES.

With respect to the solubility of mineral phosphate in soil water, Warrington says: "One part of pure tricalcic phosphate dissolves in 6,788 parts of water saturated with carbonic acid." Some experiments made in our laboratory at Ottawa, on the solubility of the finely ground phosphates, resulted in showing that phosphoric acid equivalent to .05% of tricalcic phosphate had been rendered soluble when 5 grammes were treated for 3 hours with 150 c.c. of water through which carbonic acid was kept bubbling. Previous calcination of the ground phosphate increased its solubility, when treated as in the foregoing experiment. In one trial phosphoric acid, equivalent to .45 per cent. of tricalcic phosphate, had passed into solution. From these data it is evident that neither the particles of phosphate rock originally present in the soil nor as added in the form of ground apatite, can furnish, *per se*, at any one time, more than very small quantities of available phosphoric acid.

We may now inquire as to the solubility of the soil phosphoric acid in the sap exudation of rootlets, since it is by this means that plants are largely able to appropriate the mineral matter of the soil. Dr. Bernard Dyer, in a paper on the available mineral plant foods in soils, published in the journal of the Chemical Society, England, March, 1894, gives, among many other interesting data respecting the condition and amounts of plant food in soils, the results of his lengthy investigations to determine the degree of acidity of root sap. Dr. Dyer examined a large number of agricultural and garden crops, taken during the season of active growth. He made in all about 100 determinations, examining representatives of 20 natural orders of plants. His method of procedure I need not here explain, but his conclusion is of the greatest import. The average "sap acidity" for the roots of the 20 orders is .91 per cent., expressed as crystallized citric acid. Dr. Dyer concludes that these determinations "appear to be sufficient to indicate that the ratio of the soluble free acid in the roots of plants and the moisture contained in them—which is here called sap acidity—probably generally falls within, and not very far within, one per cent. crystallized citric acid." Citric acid was chosen by Dr. Dyer "partly on account of it being an organic acid, and in that sense kindred to other root sap acids, and partly because it is the acid generally used by those who have attempted to determine available phosphoric acid in manures by means of weak acids."

Dr. Dyer then proceeded to determine the amount of mineral plant food in the soil soluble in 1 per cent. citric acid solution, and by this means obtained a knowledge, more or less accurate, of the quantities of the phosphoric acid and potash—which quantities would represent the "immediate fertility" of the soil. The determinations were made on samples from the celebrated experimental farm of Sir John Lawes (at Rothamsted, England), with whom for over fifty years Sir Henry Gilbert has been associated in original agricultural research. For forty years in succession barley had been grown upon the plots from which the soils were taken. An exact account of its yields in straw and grain, as well as of the fertilizing constituents applied, has been kept. In all, 22 samples of soil were examined. The results are of such intense interest that I shall insert Dr. Dyer's table of results:—

PHOSPHORIC ACID DETERMINATIONS IN SAMPLES OF BARLEY SOILS FROM HOOSFIELD, ROTHAMSTED.

MANURE APPLIED EVERY YEAR SINCE 1852. (For Quantities see Pages 143 and 144.)	Percentage of Sulphuric Acid in Fine Soil, calculated on Dry State. Total Phosphoric Acid.	Phosphoric Acid dissolved by 1 per cent. solution of Citric Acid.	Total Phosphoric Acid.	Phosphoric Acid soluble in 1 per cent. solution of Citric Acid.
			lbs. p. acre	lbs. p. acre
1. O. No manure	0.099	0.0055	2503	139
2. O. Superphosphate	0.182	0.0463	4601	1170
3. O. Potash, &c., (no phosphates)	0.121	0.0100	3059	253
4. O. Superphosphates, potash, &c	0.189	0.0538	4778	1360
1. A. Ammonia salts	0.097	0.0060	2452	152
2. A. do and superphosphate	0.173	0.0425	4373	1073
3. A. do and potash, &c., (no phosphate)	0.102	0.0081	2579	205
4. A. do superphosphate and potash, &c	0.182	0.0500	4602	1264
1. A.A. Nitrate of soda	0.104	0.0067	2629	170
2. AA. do and superphosphate.	0.165	0.0350	4171	909
3. AA. do and potash, &c., (no phosphates)	0.104	0.0082	2629	207
4. AA. do superphosphate and potash, &c	0.179	0.0475	4525	1201
1. AAS. Nitrate of soda and silicate of soda	0.106	0.0071	2680	180
2. AAS. Nitrate of soda and silicate of soda and superphosphates	0.180	0 0475	4550	1201
3. AAS. Nitrate of soda and silicate of soda and potash, &c., (no phosphates)	0.105	0.0112	2654	283
4. AAS. Nitrate of soda and silicate of soda superphosphate and potash, &c.	0.169	0.0479	4272	1211
1. C. Rape cake	0.158	0.0187	3731	442
2. C. do and superphosphate	0.229	0.0636	5408	1503
3. C. do and potash, &c., (no phosphates)	0.152	0.0214	3590	505
4. C. do superphosphate and potash, &c	0.203	0.0563	4794	1330
7^1. Farm yard manure for 20 years, unmanured for last 18 years	0.134	0.0206	3332	512
7^2. Farm yard manure for 38 years	0.176	0 0447	3669	932

These figures are very significant as pointing out the comparatively small amount of available phosphoric acid to the total amount present. As remarked by Dr. Dyer, the ratio of the total phosphoric acid contained in the plots receiving no phosphates, to the phosphoric acid in the plots receiving phosphates, is a small one, viz: 1 to 1.7; whereas, the ratio of the available phosphoric acid contained in the plots receiving no phosphates to that in the plots receiving phosphates, is a comparatively large one, viz: 1 to 6. Speaking of the phosphoric acid soluble in 1 per cent. solution of citric acid, he says:—

"We find that the average percentage thus found in the eight plots receiving no phosphates was 0.0078; in the eight soils that received phosphates, it was 0.0463. These percentages are in the ratio of nearly 1 : 6. The difference in the percentages of phosphoric acid soluble in dilute citric acid is thus comparatively overwhelming."

A consideration of these data, in conjunction with the yields obtained, affords an argument of the very strongest character in favor of judging of a soil's fertility by its available plant food rather than solely by the "total" percentages of its constituents, and further, we have in these results of Dr. Dyer, coupled with the yields of barley, of Sir Henry Gilbert, emphatic confirmatory evidence of the immense value of the application of soluble phosphates. Other factors (season, mechanical condition of soil, &c.), being satisfactory, experiments show that crop yields are directly dependent upon the amounts of available constituents in the soil, prominent among which is phosphoric acid.

We may, therefore, inquire as to the sources from which this phosphoric acid can be supplied. They may be classified as follows:—

1. Bones—and their products.
2. Guanos.
3. Mineral phosphates, including Canadian apatite, Spanish, Norwegian, South Carolina, Florida, French and Algerian phosphates and coprolites.
4. Superphosphates.
5. Thomas-phosphate or basic slag.

To discuss the relative merits of these from an agricultural standpoint is of course impossible in the present paper. Suffice it to say, that the one great Canadian source of phosphoric acid is in the vast deposits of apatite found chiefly in the Province of Quebec. We shall, therefore discuss, first, our mineral phosphate in its finely ground condition, and secondly, as converted into superphosphate. Some data have already been given as to the solubility of raw phosphate in soil water, that is, water that we may suppose contains carbonic acid. Further results are, that, according to Williams, one part of finely ground phosphate dissolves in 140,840 parts of carbonic acid water, and according to Bisshof, 1 in 393 000. It will be noticed that while these co-efficients of solubility are widely divergent—which is evidently due to difference in methods of determination and in the fineness of the ground phosphates—they all show a very low degree of solubility in carbonic acid water. We may, therefore, conclude that neither the phosphate rock particles either added to or originally present in the soil, can furnish, as the result of the solvent action of the soil water, at any one time, more than very small quantities of available phosphoric acid. We are evidently not yet in a position to assign definitely a place in the scale of agricultural values to finely ground phosphates. No doubt the experiments now going on here and elsewhere will before long throw light upon this subject. Finely ground phosphate undoubtedly adds to the store of the soil's phosphoric acid that it will in time become available, but it is equally evident that in the majority of instances it will well repay to previously convert it into a soluble form. In this connection, it is well to remember that the profit in farming largely depends npon the rapid conversion of plant food into vegetable products, which can only be done when such plant food is present in the soil in tolerably large amounts, and in immediately available conditions. I have always advised, as being more economical and profitable, methods and fertilizers which tend to immediately increase the yields, rather than those which may be looked upon as permanently improving the soil. At the same time, it is worthy to note that phosphoric acid, unlike its sister, essential nitrogen, does not easily leach or waste in the soil. It is an accumulative fertililer, very little passing off in the drainage water.

It has already been stated that the acid sap of rootlets is an important factor in soil food assimilation. We have also seen that Dr. Dyer has shown that the acidity of this root sap is equivalent in solvent power, on the average, to a one per cent. solution of citric acid. Following up the work already quoted, Dr. Dyer ascertained the solubility of various phosphates in this solvent. He found that 15.81 per cent. of the total phosphoric acid of finely ground Canadian apatite was rendered soluble by treatment in the cold with a one per cent. citric acid solution, when the proportion was one part of phosphate to 200 parts of solvent. His tabulated results are of interest, and I therefore take the further liberty of quoting them :—

CITRIC ACID EXPERIMENTS.

Strength of citric acid in solution . . . 1.0 per cent. solvent material = $\frac{200}{1}$

	Per cent. of Total Phosphoric Acid.
Canadian apatite	15.81
Spanish phosphate	10.73
Aruba "	29.99
Belgian "	3.08
Somme "	30.36
" "	30.51
South Carolina phosphate	38.06
Another deposit of same	34.46
Cambridge coprolites	33.31
Raw Redonda phosphate	9.21
Calcined Redonda phosphate	16.06
Bone meal	100.00
Steamed bone flour	89.66
Basic slag or cinder	72.84
Peruvian guano—	
Pabellon de Pica	97.50
Punta de Lobos	76.67
Lobos de Afuera	87.23
Huanillos	74.16
Fish guano	91.46

My own results obtained in the laboratory at Ottawa, using 1 per cent. citric acid solution in the proportion of 1 part of phosphate to 100 of the solution, showed that, when treating a finely ground phosphate containing, approximately, 25 per cent. of carbonate of lime, 6.2 per cent. of the total phosphoric acid was rendered soluble.

Dr. Dyer concludes, "As a matter of fact we know that finely ground mineral phosphates do afford an available, if not an economical, source of plant food, their value being determined mainly by fineness of grinding and specific hardness."

The experimental fertilizer plots at the Central Experimental Farm, Ottawa, are under the charge of Mr. Saunders, the director. In his report for 1893 he gives the data of the previous six years' trials with various fertilizers on the yield of different farm crops. He concludes regarding raw phosphate as follows:—"The crops given by plot 4 in all the series seem to show that mineral phosphate untreated, no matter how finely ground, has little or no effect as a fertilizer, and that the effects observable where nitrate of soda and wood ashes are used in conjunction with the untreated mineral, are probably due entirely to the action of these added fertilizers. There is, however, no doubt that the mineral phosphate, when treated with sulphuric acid and rendered soluble by being changed to the superphosphate, is a most valuable addition to the fertilizing constituents of the soil.

"It would appear that, when the finely ground mineral phosphate is intimately mixed with barnyard manure in an active state of fermentation and composted for several days, better results are obtained than would be expected from the proportion of manure used, and it is probable that under these circumstances some portion of the mineral phosphate is rendered soluble by the action of the ferments in the decaying manure."

Various experiments have been made in our laboratory at Ottawa since 1893 towards a means of cheaply and effectively converting the phosphoric acid of ground phosphate into soluble and available forms, by means of sulphate and bisulphate, and carbonate of the alkali metals. The first report on these experiments, already referred to, is contained in the report of the Minister of Agriculture for 1893. It is there shown that the fusion of one part finely ground phosphate with the bisulphate of soda renders soluble a large proportion of phosphoric acid. Thus, in one instance, phosphoric acid equivalent to 38.49 per cent. of apatite had been so converted. I may be allowed to quote from that report my conclusions as to the solubility of the phosphoric acid after ignition with the sulphates and bisulphates of soda and potash:—"I infer from these results (1) that any soluble phosphoric acid that may be formed during the ignition of the mineral phosphates with the sulphates of soda and potash immediately recombines in the presence of water to form tricalcic phosphate, and (2) that the ignition of the mineral phosphates with the bisulphates of soda and potash produces, according to circumstance, more or less soluble phosphoric acid.

"This latter conclusion is a very important one, since it is possible that, by using the by-product sodium bisulphate, an economical method for the treatment of mineral phosphates may be devised. It is scarcely necessary to add that such a process would prove of great value to Canada and Canadian agriculturists. Before an affirmative statement can be made regarding the commercial success of this method for converting and utilizing our phosphate, the cost of the raw materials and of the treatment, as well as the price obtainable for the manufactured article, must be taken into careful consideration."

Since that date, further work has been done, but has not yet been published. These latter experiments comprise the following :—

(*a*) Heating together finely ground phosphate with sulphate of soda and treating the residue with 2 per cent. citric acid solution. The results showed that phosphoric acid equivalent to 35% to 37% of the phosphate had been dissolved by this solvent.

(*b*) Ignition of the finely ground phosphate with sodium bisulphate and treatment of the mass with 2% citric solution. In this case 50% of the apatite was found to have been rendered soluble in the acid solution.

The by-product that was used in these experiments contained only a small proportion of bisulphate—the large part being sulphate of soda. It did not yield, therefore, as large an amount of soluble phosphoric acid as when a pure bisulphate was used.

These experiments, the results of which I have condensed, were made before the appearance of Dr. Dyer's paper. Consequently I was not then aware that 1% citric acid represented the acidity in root sap. My solvent was undoubtedly too strong to give results which allow us to say that the percentages of phosphates above stated are such as are rendered immediately available for plant use. Nevertheless, we may safely draw the conclusion that ignition of the finely ground phosphates with sulphate of soda, as well as with the by-product, bisulphate of soda, does convert a considerable amount of phosphate into a form *much more readily available* than the phosphoric acid in the untreated material.

I intend to repeat these experiments, using 1 per cent. citric acid solution for the treatment of the ignited mass.

(*c*) The third series of experiments in this investigation conducted by us, afford data regarding the effect of igniting finely ground phosphate with wood ashes and carbonate of potash. A mixture of wood ashes and finely ground phosphate was heated together and the mass subsequently treated with water. In the aqueous extract, phosphoric acid equivalent to 1.25 per cent. of the phosphate was found. The residue after treatment with water, was left over night in a 1 per cent. solution of citric acid; this brought into solution phosphoric acid equivalent to 3 per cent. of phosphate. As the duplicate experiment in this trial closely agreed, we must infer that simple heating with wood ashes does not appreciably improve the solubility of the phosphoric acid in the mineral phosphate.

In the next experiment sand was added to the wood ashes and ground phosphate before ignition. This method was not found to increase the percentage of available phosphoric acid over that found in the preceding experiment.

Trials were then made by fusing together carbonate of potash and finely ground phosphate. Treatment of the mass with water dissolved phosphoric acid equivalent to 6.5 per cent, of phosphate, and the subjection of the residue to the action in the cold of 1 per cent. citric acid further dissolved phosphoric acid corresponding to 43.00 per cent. of phosphate.

From these experiments, I conclude that ignition with wood ashes does not materially increase the availability of the phosphoric acid in apatite, but that ignition with carbonate of potash does so very materially. If commercially any of the processes that comprise heating ground phosphate with the sulphates and bi-sulphates or carbonates of soda or potash are practicable, undoubtedly we should have a means of readily rendering more or less immediately available much phosphoric acid now locked up and well-nigh useless to agriculture.

I may point out that if the potash salt were used in the fusion, the resulting fertilizer would contain in addition to the available phosphoric acid, another element of almost equal importance to farm crops—viz: potash.

SUPERPHOSPHATES.

It is scarcely necessary for me on the present occasion to do more than very briefly refer to the universally recognized importance of superphosphate as a supplier of available phosphoric acid. Its method of manufacture need not now concern us. Briefly, by means of sulphuric acid the apatite is decomposed, a phosphate of lime, soluble in water, and sulphate of lime being formed. It is important, however, to remember that from various causes, superphosphate is apt to revert in the soil or simply by keeping the percentage of reverted phosphoric acid reducing that of the water soluble phosphoric acid. Reverted phosphate of lime is due to the formation of a compound intermediate between insoluble tricalcic phosphate and the water soluble monocalcic phosphate, and is produced by the action of undecomposed phosphate or by the presence of iron and alumina in the raw material or of these constituents or lime in the soil When reversion is caused in the soil by excess of lime, the deterioration in value, from an agrcultural standpoint, is not nearly as serious as when caused by iron or alumina. The value of reverted phosphoric acid is a question of great dispute. Reverted phosphate is of vastly greater value than the insoluble tricalcic, but does not appear to be quite equal to that of the water soluble (monocalcic phosphate).

Superphosphate has been found the very best source of phosphoric acid for crops whose early growth must be hastened and for those whose season of growth is not an extended one. Thus, in the case of turnips, its application may advance the growth of the crop to such an extent that the plants are able to successfully resist the ravages of the turnip fly. For cereals, and especially barley, in conjunction with nitrogenous manures, it is specially valuable. In a fertilizer for pastures, potatoes, mangels and other root crops it is also a most useful ingredient.

Available phosphoric acid in the soil has the tendency to bring about early maturity of the crop. As the season of growth advances, the phosphoric acid migrates, accumulating in the seed. It is thus that the soil is particularly impoverished in this constituent when the custom of growing large areas of grain and selling their products off the farm is persisted in.

With regard to the rate of application of superphosphate, no definite amount can be stated as being the most economical for all crops and all soils. As a special fertilizer for fruit trees and orchards, it must be supplemented more particularly by some form of potash in addition to nitrogen. Roots also require liberal quantities of phosphoric acid, but for cereals superphosphate gives the best return when applied with available nitrogenous manures.

With barn-yard manure, 100-300 pounds of superphosphate per acre will be probably the quantity most profitable to use. For special and intense farming, 300-500 pounds per acre may be applied together with a nitrogenous or potash fertilizer, as the case may require. As plant food varies so much in amount in different soils, and as plant requirements also vary greatly, it is impossible to lay down any hard and fast lines for universal guidance. Let us remember that any excess of phosphoric acid applied, is not likely to be lost, for it is not, like nitrogen, easily leached from the soil. Further, all farm crops require phosphoric acid and there are few of our cultivated soils in the older provinces of Canada that would not have their crop yields increased by an application of phosphoric acid in an easily available form.

LOSS OF PHOSPHORIC ACID TO THE DOMINION IN EXPORTS OF AGRICULTURAL PRODUCTS.

Very briefly, and in conclusion, I purpose stating the approximate annual out-go of phosphoric acid in our agricultural exports, a loss which should be made good if the original fertility of our virgin soils is to be maintained.

By means of the statistics given in the Returns of Trade and Navigation for the Dominion, for 1894, and knowing the percentage of phosphoric acid in the products, I have compiled the following instructive table :—

ESTIMATED TONS OF PHOSPHORIC ACID IN PRINCIPAL AGRICULTURAL EXPORTS IN 1894.

	Tons.
Cattle	800
Sheep	170
Bacon and meat	230
Wheat	2,200
Barley	120
Oats	360
Peas	870
Cheese	770
Hay	1,050
Bones	1,200
	7,770

This amount, to be replaced, would require 51,800 tons of superphosphate containing 15% phosphoric acid.

We manufactured last year fertilizers to the value of.	$244,469 00
And imported to the value of	16,978 00
Total	$261,447 00
And we exported fertilizers to the value of.........	31,413 00
	$230,034 00

This at a valuation of $30.00 per ton represents 7,667 tons, and if we suppose such fertilizers to contain, on an average, 10% phosphoric acid, these 7,667 tons will contain 766.7 tons of phosphoric acid. Deducting this amount from the total out-go for 1894:—

7,760
767
6,993

Practically, 7,000 tons of phosphoric acid is the amount our soil was impoverished by in 1894—truly a very significant amount. In these calculations I have not taken into account the phosphoric acid exported in our wood ashes and lumber, no small amount.

It is, therefore, evident that our Government, through its officers, does well to call the attention of its farmers, for their own profit as well as for the welfare of the country at large, to the necessity of applying more phosphate to the land. The development of the phosphate mining industry and superphosphate manufacture must therefore undoubtedly prove beneficial to our Dominion and is worthy of all encouragement.

PHOSPHATE'S FUTURE.

By ROBERT C. ADAMS, Montreal.

The apparent extinction of the Canadian phosphate industry has led many to regard it as dead and buried, beyond any hope of resurrection. A consideration of some facts and circumstances may warrant the hope that the mining of apatite will again revive, and that it will yet assume the prominent position in Canada's production that it was once expected to fill.

The principal causes of the decline of the industry were :

1. The fall in prices, due to increased production in other countries, notably in Florida, and also to the general depression of the agricultural interests.

2. The high cost of apatite mining owing to the uncertainty of its occurrence, and the expense of selecting or "cobbing" it.

3. The loss in weight and the frequent rejection of shipments that failed to analyse up to the guaranteed quality.

4. The lack of a home market.

As to the first cause, the fall of prices,—two remedies are already in sight. Phosphate producers the world over have been impoverished by the low prices, and are either lessening their output, or are combining to secure higher figures. The increasing value of agricultural products will bring prosperity to the farmer and naturally lead to a larger demand for fertilizers and better prices. It is quite reasonable to expect a considerable advance in the price of phosphates in the near future.

Secondly.—Although apatite cannot be expected to occur in more favorable modes than it has done in the past, it is better understood and there will not be the wild waste of money in fruitless search under improbable chances of success. Mechanical and chemical means of separation may lessen the expense of cobbing and secure a more uniform quality. Methods have been patented by which the phosphoric acid is taken into solution from the pulverized rock and is then precipitated ; a process which if successful would make a vast saving in the labor of selection and the cost of transportation, as only the pure product need be shipped. Mechanical separation by specific gravity has met with some success ; and a combined chemical and mechanical process may be found to be available, as it is said that fluids can be compounded having a specific gravity of 3·5, which would float away all lighter substances. As the specific gravity of apatite is 3·2 jigging in two fluids, one under and one over its gravity, might secure an effective separation. These facts skilled experts must determine.

Thirdly.—By grinding all the phosphate and shipping it in bags and barrels there would be less loss in weight and more accuracy in sampling for the determination of quality.

Fourthly.—As to the home market, there is a certainty that it must arise. Agriculture is the basis of a country's prosperity and fertilizers are the basis of agriculture. It is estimated that every year a million and a half tons of phosphate are taken out of the soil of the United States by its food crops. Every net ton of wheat contains about 16 lbs. of phosphoric acid, and the average soil contains about 68·6 lbs. to the acre or just enough to supply the phosphate to 4·16 tons of wheat. In process of time the fertility of the soil is exhausted unless the ingredients that have been extracted by the crop are returned to it. A complete fertilizer is said to be composed of phosphate, potash, and ammonia, but the greatest of these is phosphate. Vast areas of land in eastern Canada that were formerly rich producers of grain are now barren for lack of being supplied with plant food. A judicious use of fertilizers would restore vitality to the soil. The worn-out cotton lands of Georgia, by the use of artificial manures, were raised in twenty years from a value of $3 per acre to $30 per acre. The same transformation might take place in Quebec could knowledge and enterprise be combined to apply the remedy. Every ton of phosphate that can be produced in Canada is needed on her own soil, and should be sold for use here instead of being transported thousands of miles and often sacrificed in competition with inferior foreign products, or through losses by those tricks of trade that are so notable a feature of modern commerce.

A few years ago, after Col. North and others had made immense fortunes in nitrate, a writer in the London Times, in an article upon phosphate as a fertilizer, said: "To adopt a homely simile, the nitrate is like a glass of spirits, while the phosphate may be compared to a plate of beef." This caught the British fancy and did a good deal to stimulate investment in Canadian phosphate lands on the part of some who thought that, to follow out the simile, phosphate kings might become as much richer than nitrate kings as beef was superior to spirits. Under this stimulus extravagant prices were paid for lands, and rash and unwise methods of operation were attempted, all of which contributed with the falling market to the ruin of the industry. But the fact remains that phosphate is the most valuable plant food that is known. The lands of the settled portion of eastern Canada are exhausted and phosphate is the principal tonic needed to restore their vitality. The use of phosphate constantly increases throughout the world. England and Germany are using ever-enlarging quantities, and in the United States every year more than a million tons of fertilizers are made, of which phosphate is the chief ingredient.

How shall this home market be created? The first means is the education of the farmers. The distribution of a knowledge of the results obtained by the careful tests made at the experimental farms would tend to give confidence in the use of such fertilizers as were recommended. The agricultural societies should be encouraged to spread information and help experiment. Missionaries should be sent to the waste places to preach the gospel of fertilization by which the wilderness may rejoice and blossom as the rose. The Government may rightfully engage in this work of enlightment.

A difference of opinion exists as to whether it is a correct policy for the Government to give direct pecuniary encouragment to industries. The majority of the people have decided in favor of a national policy, which has enabled anyone who manufactured any article, be it pickles or pig-iron, to go to Ottawa and secure either a protective duty or a bonus, or both. If this is the policy of the country, surely it can in no case be so well applied as in the promotion of agriculture, the staple industry of the land, upon which its prosperity mainly rests. While there are about 300,000 people in the Dominion engaged in mechanical and manufacturing industries there are nearly 800,000 occupied in production from the soil. The occupiers of land number 620,486, of whom 524,806 are owners and only 92,708 are tenants. So large a land-owning class implies the intelligence essential to successful cultivation of the soil, and there can be no more hopeful field for the inculcation of useful practical knowledge pertaining directly to the welfare of the people, than among the sturdy agriculturalists of Canada. As long as the Government sees fit to bonus or protect industries employing a few hundred workers, the 600,000 farmers of Canada have a right to ask for consideration, and in no way can they be aided to prosperity better than by assistance to the intelligent use of cheap and effective fertilizers. If the Government would devote a sum of money to the spread of knowledge about fertilizers, and to the encouragment of the mining and manufacturing of phosphates, it would be of greater benefit to the country than the same amount of money applied to any other industrial pursuit, be it what it may. There is no proper conception as yet in Canada as to the great value to be obtained from the judicious use of artificial fertilizers, and if the Government is to be in any sense paternal it should consider its primary duty to be to increase the productiveness of the soil.

By the establishment of fertilizer manufactories and the consequent creation of a home market for phosphate, a great stimulus would be given to the cheap production of apatite Many farmers have deposits of phosphate upon their lands or in their neighborhood. They are often willing to put in their spare time in winter in mining, even if it only yielded them wages of 50 cents a day. In the early period of phosphate mining in Canada a large output was obtained from this source, but the difficulties of foreign shipment, or unsatisfactory dealings with middlemen, discouraged these efforts. With a ready market at hand for small quantities a great many people would turn their attention to the mining of apatite, even at the present low prices, and this work in some cases would certainly lead to the discovery of large deposits that would pay handsome profits. Although the average cost of phosphate may be said to be $8 or $10 a ton, it has often been the case that a bunch of 100 tons has been taken out at a cost of not over $2 a ton. The fortunate farmer who should strike this bonanza would make more profit from it in one month than the other products of his farm would yield him in a year. This success would stimulate others to work and thus enlarge the output.

One favorable feature in the future prospects for Canadian phosphate mining and fertilizer manufacturing is the facility for cheap freights to the far west. It is a remarkable fact that nearly all the phosphate mines of Canada are so situated that their products can be water-borne to market with only a short land haulage. The Lievre, Gatineau, and Ottawa rivers, and the Rideau canal can float the mineral to the St. Lawrence at either Montreal or Kingston, from whence the returning grain barges and schooners would transport it to the west at almost ballast rates of freight. The phosphates of Carolina or Florida to reach the same points along the shores of the great lakes must pay freight rates to the railroads greatly in excess of the rates by the water route. This saving, added to the superior value of Canadian apatite, might overcome the competition due to cheapness of production at the south, and as the use of fertilizers extends in the west as it is bound to do, Canada may become the chief source of supply for that great region which for a thousand miles adjoins the Canadian waterways.

One of the greatest means of increasing the production of phosphate would be to prove that in its crude state, finely ground, it is effective as a fertilizer. At present the custom is to mix the phosphate with an equal weight of sulphuric acid, by which means it becomes soluble in water and is termed superphosphate. It is due to the acid that the objectionable odor exists. This process increases the cost of the fertilizer to the farmer two or three-fold. Many experiments go to show that the raw phosphate is effective, especially when mixed with stable manure, or when applied to crops that do not require a very quick stimulant. Mr. W. H. Bowker, the eminent fertilizer manufacturer, while arguing for the general superiority of superphosphates, says: "There may be places where insoluble phosphates can be advantageously applied, as upon land covered with fruit trees or devoted to grass. Perennial plants, like grasses and trees, no doubt extract phosphoric acid more readily than annual plants, owing to their numerous and well-developed roots. Winter grains, especially wheat, from the long time it occupies the ground, and its growth in the fall, may also be benefitted by an insoluble or partially insoluble phosphate." As this admission applies to four-fifths of the cultivated land, it indicates the possibility of an extended use of crude pulverized phosphate.

Another reason for expecting a revival of Canadian apatite mining is the fact that in a great many instances it is associated with phlogopite,—mica of amber or silver-grey color. This mica was formerly worthless, and many phosphate pits were abandoned on account of the prevalence of this mineral. Now that its use as an electrical insulator has become general, selected lots of mica can be sold for $100 a ton, and many properties which would not pay if worked for phosphate alone, or for mica alone, may be made profitable by the production of the allied apatite and mica.

Our reasons for hopefulness as to a revival of the Canadian phosphate industry are based, then, upon the expectation of a rise in prices; better systems of mining and selection; shipping in the pulverized condition; the opening of a home market; the availability of the great western market by means of cheap water freights; the increasing use of phosphate everywhere; the certainty that phosphate of lime is the best fertilizer known; the assurance that Canadian apatite is the richest known available source of phosphoric acid; the efforts already made by Government, through the experimental farms, and by agricultural societies to gain knowlege of plant food; the hope that more effort will be made to spread this knowledge; the hope that the government may find effective means to encourage the industry; the use of pulverized phosphate as a fertilizer, thus securing a very cheap article, in which the buyer might feel more confidence than in a mysteriously manufactured article chiefly remarkable for its bad smell; and finally the possibility of mining, with the phosphate, mica as a by-product and getting two results from one effort. Added to all these is a sentiment that in these days of altruistic development may not be altogether unworthy of consideration by a body of men so noted for humane ideas, and for a devotion to ethical culture as are the mining men of Canada.

All men want to make money! Most men care not how they make money! Some men want to make money in useful ways. The latter are not content to gain their profits by ministering to the luxury, folly, or vice of mankind, they have the philanthropic sentiment as well as the greed for gain. They do not wish to thrive by selling silks, wines, jewellery, rum, tobacco, patent medicines, or lottery tickets. They prefer to deal in coal, iron, grain, cattle, and the common necessaries of life, and they desire to have the sentiment of rendering real service to their fellow-men, while they are at the same time earning their livelihood or gaining a fortune. The production and manufacture of fertilizers gives a field for operation that for beneficence cannot be surpassed, and in other countries these industries have proved to be the source of large fortunes.

There is an oft-quoted passage of Dean Swift's in Gulliver's Travels which is worth repeating in this connection: "And he gave it for his opinion that whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind and do more essential service to his country than the whole race of politicians put together." This idea should encourage capitalists with humane sentiments or corporations with souls, if any such exist contrary to proverbial slander, and they surely do, to engage in this useful occupation of the production of fertilizers. Whatever may be said as to the scent which they give to the air, they are unsurpassed among manufactured products in the odor of morality and the flavor of beneficence.

In view of all these physical facts and moral influences may we not encourage hope for the future of phosphate?

CANADA—A NATURAL MANUFACTURING CENTRE FOR FERTILIZERS.

By Mr. Henry Wigglesworth, New York.

Fertilizers in the empirical sense of the term, have been used by agriculturalists as far back any records go. The earliest writers speak of the beneficial results derived from certain substances when put on the soil, at a period when the scientific knowledge of the cause was unknown; and that improved fertility resulted from the application of certain soils or marls, was at least known in the earliest days we can read of. Manure is spoken of in the Old Testament, and was unquestionably used commonly in the earliest days.

But the true knowledge of these strange properties, the underlying principle that marks the opening of the new era of scientific agriculture was left unexplained until 1862, when Baron von Liebig in Germany, and Sir John Lawes in England, explained the laws of nourishment that govern the growth of plants.

The light thrown in 1862 is the whole basis of our modern methods in agriculture. The laws formulated at that time stand now more clearly than ever, to guide the agriculturalists in farming, and the fertilizer manufacturer in compounding the necessary nourishment to sustain fertility in the soil.

Liebig explains so well the foundation of the theory that it may be well to quote this summaay of his laws:—

1. "A soil can be termed fertile only when it contains all the materials requisite for the nutrition of plants in the required quantity and in the proper form.

2. "With every crop a portion of these ingredients is removed. One part of this portion is again added from the inexhaustible store of the atmosphere; another part, however, is lost forever, if not replaced by man.

3. "The fertility of the soil remains unchanged if all the ingredients of a crop are given back to the land for fertilizing.

4. "The manure produced in the course of husbandry is not sufficient to permanently maintain the fertility of a farm. It lacks the con-

stituents which are annually exported in the shape of grain, hay, milk and livestock."

The rapidity with which the world at large made use of this knowledge shows how fully it was appreciated, and how much it was required. It was clear, fertilizers must have a different value from manure. The one must be a mixture of a number of chemical or organic compounds which, when complete, would form a perfect plant food. The other, while possessing in a small degree fertilizing qualities, is more of a mechanical assistant which by lightening and making porous, warming and protecting the soil, would do much that a fertilizer could not do.

Manure is a bulky and heavy material at the best, more than half water, and being only a residue, does not feed the soil with those elements which the crop extracted.

A fertilizer is a complete concentrated plant food, and its only equivalent would be to return to the soil in the form of ash, all the sheep and cattle and stock that feed on the land, and all the grain which is reaped from it.

The manufacture of fertilizers dates from this period. Even now it is an industry hardly thirty years of age. In England the product is still known as artificial manure. In the Southern States the term guano is very commonly used.

Guano has been known and used largely to augment farm-yard manure before Liebig's day; but its importation became so stimulated by the more advanced knowledge of its use, that by 1872 the beds were practically exhausted.

Chemical fertilizers had been making their appearance in Great Britain and the continent of Europe in every agricultural centre; and as guano became scarce the production of superphosphate increased. Accurate statistics cannot be quoted to show how rapidly fertilizers were made use of, but the development of our phosphate mines is a good guide.

Canada has always had some dominant spirit, pointing the way and telling of its great natural stores of wealth, and as far back as 1848, Dr. T. Sterry Hunt described the great extent of our apatite deposits; but it was 1871 before mining operations of any importance commenced in the phosphate districts.

Statistics of the output of the Canadian mines hardly come within the scope of this paper. The history of apatite mining only concerns us at present where the manufacture of fertilizers influences or throws light on the subject.

Until 1889, almost if not the whole output of Canadian apatite mines went either to Europe or the States; a plain truth painfully realized by all interested in the Buckingham mines. To the influence and exertions of the Hon. Judge Hall, of Montreal, but at that time member of Parliament at Ottawa, representing Sherbrooke, belongs the chief credit for a new régime in the industry. He had been for years working to get some suitable and enterprising company interested in Quebec as a centre for manufacturing fertilizers. He was sure of the field, and worked as Mr. Hall, and a man of strong convictions can. It was necessary to have the aid of some chemical manufacturer. Had it been sufficient to grind the rock and mix it with other fertilizing ingredients, the task would have been more easy, but sulphuric acid to render soluble the phosphate of lime, of which apatite is composed, was required in large quantities, and that demanded a very large outlay. Some strongly capitalized concern must be found. G. H. Nichols & Co., of New York—now known as the Nichols Chemical Company—had since 1887 been supplying the entire Canadian trade with sulphuric acid from the works they had erected at Capelton, in conjunction with their mining interest there. In 1889 the Hon. Mr. Hall was successful in persuading Mr. W. H. Nichols, the president of the company, to erect and start works for dissolving the apatite, and manufacturing fertilizers generally. They agreed at the same time, to undertake the introduction and sale of the fertilizer throughout the Dominion, a task that they were very loath to enter, and which had largely deterred them from making a start earlier.

In the spring of that year the first and only manufactory of fertilizers was inaugurated at Capelton by G. H. Nichols & Co. Fertilizers were but little known in Canada; they had been purchased in small quantities from the United States by a few farmers in the Eastern Townships. The Government of Quebec had also imported, some years previously, a shipload of guano for general distribution at cost price, but it proved almost impossible to give it away, for among the French-speaking portion of the population fertilizers were absolutely unheard of.

The difficulty of introducing anything so new can therefore be imagined. The Government in the face of their guano experience, and losses sustained at that time, felt indisposed to do anything and did nothing. Only the natural centre and the rich endowments of nature for establishing such a business made it impossible. "The means that Heaven yields must be embraced and not neglected." The Hon. Mr. Hall felt this, and rendered great personal aid at all times.

The lower grades of apatite lay around the mine useless and unsaleable. The possibility of marketing this 60 per cent. phosphate induced the mining company to offer it at a very low figure. The railroads also saw a great future in transporting this material, and made low freight rates. Sulphuric acid was manufactured on a large scale from the pyrites ore mined at Capelton, and was produced at a low cost. With cheap apatite, cheap sulphuric acid, cheap labor, and low transportation rates, superphosphates could be manufactured and sold at low cost to the farmer, and they were. From the very outset in 1889 superphosphate analyzing from 8 to 10 per cent. of available phosphoric acid, which is equal to twenty to twenty-five per cent. of soluble phosphate of lime, was turned out and sold from the Capelton works at almost half the price 15 to 20 years of American competition had forced it to in the States. There the price was, and is now, little less than $20 a ton. The "Capelton" grade was offered at $10 per ton.

Agents were established in every centre of importance; pamphlets, circulars and letters were distributed in French and English to suit the districts as required. Salesmen familiar with the country and good linguists traversed every likely centre, from Windsor, Ontario, to Halifax, N. S. The subject was made interesting to everyone, and there was no excuse for not hearing of the great benefits derived from the use of a reasonable quantity of fertilizers. The most stubborn opposition could not have forced down the production and growth of fertilizers in Canada. The natural centre made itself felt. Farmers knew they were benefitted it. Metaphorically speaking the cheap raw material for their manufacturing was a boon to be quickly invested in.

The first year's sales were sufficiently encouraging so that in 1890 there was built and established a large factory sufficient, as was supposed, to satisfy the demand for some years. In the following year, however, it became necessary to double one department of the works.

From this time the home consumption of apatite entered into the statistics of the output of the Canadian mines. A desirable condition of things, for you can hardly expect to satisfy foreign buyers with what there is no faith in at home. In five years, from 1889 to 1894, the sale of fertilizers increased ten-fold. The larger part of this tonnage distributed itself over Quebec where the lands were more exhausted than in Ontario, but a large amount was shipped to Ontario, New Brunswick, Nova Scotia, and Prince Edward Island. The Nichols Chemical Co. now have a capacity at Capelton of about 30,000 tons complete fertilizers per annum, but if the demand warranted, it could dissolve 150 tons of ground rock per day.

Dissolving apatite is important and bears largely upon the question of the future of this rock's position in the markets of the world. At one time it was hoped grinding would be sufficient to render available its nourishing elements; but years of experiments have made certain, that results are too slow to satisfy immediate wants in unfertile soils.

A ground phosphate rock is to all practical purposes useless as a fertilizer. The tricalcic phosphate which represents from 60% in low grades to 80% in high grades, must be decomposed by sulphuric acid into the soluble or mono-calcic phosphate. Then the phosphoric acid which Mr. Shutt has spoken of in such a convincing way will become available. Rendering soluble the phosphate of lime is the most expensive as well as the most troublesome part in manufacturing. It helps none that Charleston and other nodular phosphates can easily be dissolved, apatite is of entirely different origin. It belongs to the oldest geological period, it is altogether harder to crush, more troublesome to grind, more difficult to dissolve, than any nodular phosphate known or used. It is this that has given apatite the name it has, among consumers; for it is only too widely known among manufacturers.

At first each factory supposed in their case with superior knowledge and more modern plant, better success would be met with; but the best that can be done leaves it a more expensive raw material to work with than other competitive phosphates.

This is really a very serious obstacle confronting the miner of apatite, but on the other hand, he has a very much higher grade of phosphate rock to work upon. It is necessary for him, however, to use every modern contrivance and device to mine and cobb, and prepare the rock for the market in the most economical way possible. The expensive transportation between Buckingham and Montreal must also be reduced to a minimum.

Apatite can be used by the manufacturer, and used economically; indeed, did we not understand the nature of apatite, and had it defied our attempts to dissolve it, the method must soon be learned, for the South Carolina beds which are at present furnishing the larger portion of the world's supply are estimated to last only about 20 years.

The Nichols Chemical Co. have never yet, in their Canadian works, used one ton of anything but apatite mined in the Buckingham district. They would use it in their works in the States, if it could be purchased at a relatively low figure. They have analysis to show that apatite can be dissolved with a residue of one per cent. of insoluble phosphoric acid, a result quite equal to any work done in Charleston or any American phosphate rocks. Their regular work averages between one and two per cent. insoluble phosphoric acid, and such a low percentage left undissolved is considered satisfactory work by those who use the softer and more tractable Carolina phosphates. No one will find fault with apatite who obtains these results. It can be done, without doubt, but as stated, costs more in every stage. For this reason, those interested in the apatite mined must devise means to sell at a lower figure per unit than softer rocks fetch. It is reasonable to expect this with the knowledge that the manufacturer entails more expense by using it. At a lower price per unit apatite would be a more attractive phosphate than the softer rocks, for its high grade would attract, and be an incentive to attain economical results.

Last year the Buckingham mines produced less than any year since operations were thoroughly established there. The output was less than than half the tonnage of 1884—ten years previously. It is a serious state of affairs and requires us to look it in the face. In South Carolina, with a lower grade, but softer rock, the output keeps increasing steadily. There has not been time to ascertain the total tonnage, but 750,000 tons would be a fair estimate for 1894. This would be sufficient to make two millions of tons of complete fertilizer. A million tons, at any rate, are sold in the States. Canada's consumption of fertilizers bears no comparison whatever with this. When it does we shall turn out from the Buckingham district from 300,000 to 400,000 tons per annum. Do the parliaments of Quebec and Ontario, as well as Nova Scotia, New Brunswick and Prince Edward Island realize what this means? The western provinces are hardly concerned yet.

The progress of the world depends upon the food supply of the world. The food supply must be proportional to the fertility of the soil. While we come into the world with nothing, and can take nothing out from it, we live on our grand-fathers. Every one of us consume and expend the stores nature has taken ages to accumulate, and in Canada we look on, doing nothing, while Nature's stores are being steadily drained, our farming land fast becoming barren, and the average crop of all produce generally decreasing.

Throughout Ontario, there is an intelligent and level-headed class of farmers. The well tilled soil and clean farms bear evidence of the higher standard sought after, and yet Ontario (Canada's garden) produces an average yield of wheat less than half what it is possible to raise with the intelligent application of fertilizers. Sir John Lawes, on his experimental farm at Rothamstead, Eng., has grown wheat for thirty-eight years running without rotation, but with the use of fertilizers, and the average yield over the entire period of thirty-eight years is 36½ bushels of wheat weighing 59½ pounds to the bushel. Ontario's average yield is 17½ bushels per acre. Sir John Lawes, in the 46th year of his experiments, continuing the cropping without rotation and using fertilizers without barn manure of any sort, reports a yield of 35½ bushels of wheat, weighing 59¼ pounds per bushel. In other crops it proves the same way. The average yield in Canada, where we have statistics to make comparison, makes a very bad showing alongside the average crops produced in Great Britain generally, and in Germany where high-class farming has now become general.

"It is a condition, and not a theory that confronts us," and well deserves the consideration of this Association. Are not we competing with Russia, India, Australia and the United States to supply the Old World with grain, cattle, horses, butter, cheese, and farming produce of every sort? How can we hold our own unless the fertility of the soil is sustained? Progress, not retrogression, must be our watchword. It is not only that the crops are decreasing, but the standard of quality cannot be kept up The weight per bushel, and the nourishing qualities in the grain can easily be detected by any farmer where the grain has been grown on a barren or in unfertile soil. Sunshine is not enough; nourishment is absolutely essential to a growing crop. Our ability to supply the world must be made known by increased average yield and improved quality. There is every natural condition to assist. Railroad and shipping facilities can certainly not be complained of. We have also got the most marvellously rich deposits of phosphate that have ever been discovered, to manufacture fertilizers, and to improve the quality of our farm lands. These phosphates are practically unlimited. Those who have studied their occurrence most carefully see no possibility of exhausting them. If all the population of Canada were employed there, mining for years, the extent of the deposits would not be laid bare.

Nitrogen of ammonia, another of the essential ingredients is also at hand in abundance. The destructive distillation of coal in Nova Scotia for the production of gas will yield enough ammonia for an indefinite time. Sulphate of ammonia is now manufactured from the waste liquors of the Montreal works, but some of the liquors are exported to the States where they are more willing to pay for them than we are.

Tankage azotine, dried blood and other nitrogenous materials that are excellent basis for assisting the fertilizer manufacturer—all products of the abbatoirs—are made quite extensively in Canada, but are exported to the States, as there is no home market.

Salts of potash alone, of all the necessary ingredients for sustaining plant life, remain undiscovered in Canada. It happens that our soils are still rich in this element, because there has been so much timber burned while clearing the land. Kainit, or some of the other salts of potash, may be discovered before the supply is exhausted. Meanwhile, we are no worse off than our neighbors, who have to import it in large quantities from Germany.

It must be evident that Canada has singular natural endowments to carry on the fertilizer business. That there has been great progress in the last few years is plain, but we are still far from the high standard European farming has long ago attained. We ought to consume one thousand times the quantity of fertilizers at present sold throughout the eastern provinces; and then the phosphate industry of Buckingham would be in the thriving and progressive state it ought to be in now.

The Government of Japan found it necessary to come to the front in assisting the introduction of fertilizers. Mr. Earle C. Bacon, one of the members of the Association, and a familiar face to the most of us, designed for the Japan government an extensive fertilizer factory, which is now said to be in operation. Every nation has probably, in one way or another, subsidized agricultnral investigation and that which would tend to advance scientific methods of farming. There is great need of assistance in Canada if we are to continue furnishing food supplies to the Old World.

CANADIAN PHOSPHATE AND FERTILIZERS—HOME MANUFACTURE AND HOME MARKET.

By Mr. J. Burley Smith, M.E., Glen Almond, Que.

Canada, possessing inexhaustible deposits of the richest known phosphate of lime, with all the necessary materials for manufacturing superphosphate at home, has, for many years merely exported this invaluable mineral, to the deprivation of her own agriculture, and to aid in glutting the overstocked markets of the world. And to-day all the phosphate mines of Canada are shut down, and an industry, which, under proper conditions, might have been not only a flourishing mining but also an enormous manufacturing business, employing thousands of men in its various branches, has been allowed to die a natural death; and the phosphate mining districts, where, for many years, thirty to forty thousand dollars of foreign capital were spent every month in hard cash, have now to reproach, not the foreign manufacturers, who can buy their raw material cheaper nearer home, but Canada herself and her capitalists, who have not only not invested capital in the working of her phosphate mines, but have failed to see that the possession of such a mineral was the nucleus of a mighty manufacturing industry, not only for home consumption and the benefit of home agriculture, but for export to foreign countries as a manufactured fertilizer.

Without doubt Canada could at the present time, with her wonderful resources, manufacture superphosphate so cheaply as to compete with any manufacturing centre abroad, but the beginning should be for home consumption, and in this direction a demand is certain to spring up.

Once show our farmers that by spending a small sum in artificial fertilizers they can increase the yield of their farm produce many times in excess of the sum so spent, and they will not fail to avail themselves of this knowledge, and the home demand will follow as a natural result.

The province of Quebec could, alone, with advantage, use the superphosphate manufactured from all the phosphate of lime raised in Canada, taking the best figures of annual production, viz: 27,000 to 30,000 tons per annum.

In travelling through many of the older settled parts of Ontario and Quebec, more especially the latter, one is struck with the great irregularity of crops, one half a plot often being rich and the other half poor, and only too frequently no crop worth speaking of at all. There is no denying the fact that the Canadian farmer, generally, has either not yet felt the want of, or has not yet been educated into the use of artificial fertilizers; and the general neglect to use even the farm-yard manure which appears to be considered more often as an impediment on his farm than a recuperative agent, shows that he is not familiar with the principles of reproductive economy in agriculture, a fact which is further emphasized by the small proportion of produce raised compared to the enormous area of land occupied.

The system of farming has been, and is now, to take out all that can be got, sell everything for cash and move away.

Mr. G. H. Turner, of Burgess, Miss., says in one of the numbers of the *American Fertilizer*:

"The soils of America have been wantonly despoiled of their virgin freshness, and robbed of their exuberant fertility, by the old 'three-shift' or chop-down, wear-out and move-away system; the soil tillers selling everything available off the land and putting nothing back; moving westward (as fast as they had got what they considered the 'cream' of the soil) until there was no longer a 'west' to go to; and in their migrations westward, they oftentimes left behind them all that made life worth the living—friends, society, good and convenient markets, good roads, and oftentimes woods and water—for what? For the sake of cultivating for a few more short years, virgin soil; and to postpone the evil moment as long as possible of paying the altogether too long deferred debt that they owed to dame nature, in the way of returning to the soil a modicum of that fertility (in the shape of manure and chemical fertilizers) that had so ruthlessly been removed from the soil by the various crops grown thereon, but sold as cash crops off the farm. The era of chemical fertilizers is here; there is no dodging the question nor disputing the facts in the case; it is here, and it is here to stay."

The same may be said of much of Canadian North America. The constant exodus of her sons shows that the old homesteads are not prolific enough, under present conditions, to do more than support the old folks, and that though the acreage is large enough to employ the additional labor, the elements of fertility are wanting. The phosphoric acid has been taken out from the land and none returned to it.

The avidity with which Canadian farmers are learning all that can be taught them in the making of cream, cheese and butter, shows that both eyes and ears are open; and that their, world-famed reputation in this direction has not been without its encouraging effect; and they are ready for fresh knowledge.

"The era of chemical fertilizers is here" and let us hope "it is here to stay." The splendid Government Experimental Farm at Ottawa is an open book for all to read, but that is not enough. The knowledge obtained by intelligent chemical experts there must be proclaimed from the house-tops and from the street corners.

The good work of Prof. Robertson in lecturing on milk, cream butter and cheese, etc., must be followed up by lectures on fertilizers. How, and in what quantity they should be used, their cost, and the kind best adapted to the different natures of soils and crops, with full information as to how they can be purchased.

Thus demonstrating how the land can be induced economically to yield more and still continue fertile.

Lectures must be given at the frequent meetings of the various local agricultural societies. Practical instruction in simple style must be sown broadcast, and an intelligent and appreciative people will quickly mark, learn, and inwardly digest the facts laid before them. The result will be a demand for fertilizers, improved and more regular crops, and the constant well-being of our farmers.

A new home manufacture will be developed, a dormant mining industry will again flourish with increased vigor, great numbers of miners and laborers will find regular employment, and this time the industry will come to stay.

Situated on or near the banks of river du Lievre, which runs through Buckingham and the neighboring townships, are the well known phosphate mines, now unfortunately idle, The Emerald, The British Phosphate Co., The Little Rapids, The North Star, The High Rock, Glasgow, The French Phosphate Co., Union, etc., to say nothing of the enormous areas of unworked phosphate lands on both sides of the river. And the river itself, formerly alive with steamboat, tug and scow, freighted with rich cargoes of mineral, is now silent and deserted save for a daily passenger steamer.

Three miles from the mouth of the river du Lievre stands the picturesque town of Buckingham notable for its magnificent water power, a portion only of which is utilized to drive the great lumber mills of Messrs. J. MacLaren and Ross Brothers, leaving a splendid surplus for other manufacturing trades, which must, sooner or later, make this promising town hum with the busy whirr of machinery.

The Buckingham branch of the Canadian Pacific Railway passes through the town and has its depot on the wharves of the river du Lievre, a little above the falls, where, a year or two ago, the phosphate mined up river was brought down by boat, loaded into cars, and conveyed to Montreal by rail, and thence shipped for use in the fertilizer manufactories of Great Britain, Germany and elsewhere, whose manufactured product in the shape of superphosphate found its way back occasionally even to Canada and the United States.

By a happy combination of circumstances and the ability to recognize and use them many a man has amassed an enormous fortune.

Observe the happy combination of circumstances here.

Buckingham town possesses abundant water-power which is available for grinding, pulverizing, and separating the phosphate ore and working the machinery of a manufactory generally, and the town is situated at the junction of the Canadian Pacific Ry. with the river down which the mineral is brought from the mines.

The two most important elements in the manufacture of superphosphate are phosphate and sulphuric acid. It is known that we have abundance of phosphate and the sulphuric acid could either be made on the spot or purchased elsewhere very cheaply. For a long time brimstone was the raw material almost exclusively nsed for producing sulphuric acid and was imported chiefly from Sicily, but it is now known that pyrites, or the sulphide oi iron, is equally good and much cheaper where chemically pure acid is not required.

It is also well known to those who have searched for and mined phosphate that pyrites is exceedingly abundant in a phosphate district, and if sought after as a mineral to mine, instead of, as hitherto, to avoid, except as an indication of other minerals, no doubt it could be obtained in very large quantities indeed. Some time ago a boring test in a phosphate mine passed through a deposit of iron pyrites fifteen feet thick, which, being of no value then was simply left and avoided. But supposing this were not taken into consideration; sulphuric acid is manufactured already at Capelton and could be delivered at Buckingham as cheaply as at superphosphate works anywhere.

The cost alone in freight of shipping phosphate to the superphosphate manufacturers of Great Britain and Germany averages not less than five to six dollars per ton; the cost of freighting the phosphate down the river du Lievre to a factory at Buckingham would certainly not exceed, all round, seventy-five cents to a dollar a ton.

To lessen the heavy freight charges to Europe manufacturers stipulate for the highest grade of phosphate, viz.: 80 to 85% first grade, and not less than 70% for second grade, in order that all extraneous matter, such as pyroxene, feldspar, waste mica, pyrites, etc., should be eliminated before leaving the mine.

To achieve this involves a very expensive system of mining; in the first place, great care must be observed in blasting the mineral so as to keep it separate from the associated rock, then the crude mineral has to be sorted, screened, picked, and again sorted, by a great number of men and boys, and it is only by using the greatest care that the maximum of each grade can be reached; too often at a cost which has precluded any chance of profit to a mine owner.

Owing to the almost uniform specific gravity of the associated minerals, with the exception of pyrites, no perfect mechanical method has yet superseded hand separation, which has probably cost more than the actual mining or winning of the mineral.

But from various experiments made by the writer he is confident that this can be accomplished successfully when once the experience of specialist machine makers has been brought to bear on the subject, and providing that the cost of operating the machinery be minimized by the economical use of water power,—the item of steam machinery being a very serious one at each mine, Although the difference in specific gravity is so slight as to render sedimentary separation difficult, still there is a difference which makes the process, though slow, not impossible, and the various atoms have peculiarities in shape and moving tendency which, taken advantage of by special machinists, cannot fail to result eventually in a perfect automatic method of separation.

If a manufactory were established at Buckingham—than which no more suitable locality could be found—nearly all the required separation would be made at the manufactory there, as the cost of freight from the mines being so slight would not preclude the carrying of a certain amount of extraneous matter, thus affecting an important economy, both in mining and manufacturing, at the very beginning.

Not only could the Canadian raw material be delivered at the manufactory here at from five to six dollars per ton cheaper than it could to European manufacturers (because of the freight and handling charges which now exclude it from those markets), but a lower grade mineral would be sufficient, therefore the aggregate yield from each mine would be proportionately greater and cost less, as there would be little or no waste, and a great economy would be effected in the winning and handling.

The works at Buckingham being situated close to the Canadian Pacific Railway, the finished fertilizers could be distributed to consumers at rates which must defy the competition of any imported article.

The town of Buckingham, alive to the advantages of having such an important manufactory established in her midst, and a revival of the great phosphate mining industry, which contributed so much to her rise and prosperity in the past, will doubtless come forward with the offer of an adequate bonus, or help in some shape or other to accomplish such a desirable consummation.

It may be confidently expected also that the Government, ever ready to aid Canadian agriculture and foster her infant manufactures, will take measures to encourage and assist this two-fold industry, which is assuredly of national importance.

DISCUSSION.

MR. R. W. PRITTIE—I feel repaid by Mr. Shutt's able paper for having come all the way from Toronto to attend this meeting. When I was in England some thirteen years ago, an old gentleman showed me a grape-vine from which he sold £200 worth of grapes every year. He told me he was feeding it with "something from Canada," and I have little doubt he was using Canadian superphosphate A gentleman at Richmond Hill was telling me the other day that he uses Canadian superphosphate on his fruit farm of sixteen acres, and he always has a good crop and can sell his berries and small fruits for a cent a box more than his neighbors. I think it is the duty of the Government to do more effective work in the future in developing the phosphate industry than they have done in the past, and when I go home I shall write to the Minister of Agriculture and give him my views on what I have heard to-night.

HON. MR. FLYNN—In what shape is phosphate utilized in other countries? Have they ever tried it in the ground form?

MR. SHUTT—The finely ground phosphate has practically no market. What has come in of late years is Thomas slag, a by-product in the manufacture of Bessemer steel. Great heaps of this accumulate at iron-works, and it was found to contain phosphoric acid in a form which was partially available for plants, and so it has been largely made use of on the continent of Europe. It seems to stand intermediate between finely ground phosphate and superphosphate. It is to a certain extent available, but not so much so as phosphoric acid. England uses superphosphate more particularly, while Germany uses a great deal of Thomas slag, and phosphate which comes from Algiers and other countries.

So long as money is lying in the bank not gaining interest, it is of no value to anybody, and just so with plant food in the soil. It is only when it is bearing interest that it is of value, and we may look upon crops as the interest. The whole science of farming may be summed up as being the conversion of mineral constituents into vegetable products, which are afterwards food for man and beast. The more rapidly we can accomplish this the more quickly do we get returns upon our capital.

With regard to any action which may be taken by this convention as to urging any mode of action upon the Government, I think it is well to begin at the beginning. In my opinion the first duty of the Government is to do the teaching. Let them by means of pamphlets, lectures, etc., issue such instruction as to the uses and value of superphosphate as the people are in a position to intelligently put into practice. Let them show the farming community that it will be to their advantage to use superphosphate as a fertilizer, and the effect upon the phosphate industry would soon be very marked.

MR. A. W. STEVENSON—The commercial aspect of the question is in danger of being lost sight of. The poor farmer in Manitoba, for instance, who cannot get more than ten or fifteen bushels of wheat per acre, realizes a return of from \$6 to \$9 per acre; how much can he spare out of this amount to buy fertilizers? He is very badly handicapped besides, having to send his product to market in England, and having to pay freight on the fertilizer from Quebec.

MR SHUTT—Canada cannot compete in wheat growing with some of the countries in South America. The salvation of Manitoba is the dairy industry. The unskilled labor of South America enables them to produce wheat cheaply, but our labor is expensive, and we must put it into a channel where it will yield us a profit. The people of Manitoba are beginning to see this, and they are going largely into the dairying industry now. Besides, their soil is not in the same condition as the soil in the older provinces of Ontario and Quebec. It contains a larger percentage of phosphoric acid, and it will be some years before there will be any great necessity for fertilizers there.

MR. JAS. KING, M.P.P. for Megantic—I profess to be more of a miner than a farmer, and join with the chairman in regretting that circumstances would not allow the Minister of Agriculture to be present, as I am sure that he would have taken a great interest in the papers that have been read. It is part of the policy of the Department of Agriculture to have gentlemen going about the country giving lectures on agriculture, and I think for the furtherance of the apatite industry it would be important to have among them men with personal experience in the use of superphosphates, it would have a great effect on their agricultural audiences. As a rule, an agricultural audience has a great horror of theory, but if you could bring forward a man who has made use of superphosphate or fertilizer of any kind, and who is able to say it has been of great use to him, you could carry conviction to the mind of agricultural hearers on that point. I said I was not a farmer, but we happen to have a home-farm on which we have had occasion to use superphosphate from Sherbrooke. Our farmer, who is a conservative man and does not like new notions, is willing to admit that he considered this superphosphate much cheaper than any manure he could get in the neighborhood, and he was in a position to get manure from farmers and others in the vicinity at a very low cost. He said he found a very marked improvement as a result of using the fertilizer, in comparison with the effect produced by ordinary barn-yard manure. Evidence of this sort I consider valuable. I am quite sure that if the Government could make it clear to the farmer that he could put $10 or $20 a year into these fertilizers with advantage, the consumption of them would largely increase. Speaking generally, I may say that within the last four or five years, farmers have taken heart in this province. Their returns from creameries, etc., have enabled them to look much more favorably on a farmer's lot than they had been able previously to do. (Applause.) I think they are now encouraged to take up modern methods of increasing the yield of their farms.

I regret the unavoidable absence of our old friend, the Hon. Mr. Irvine. We all understand the reason, but we know that his heart is with us, and that the Association has always had his support. At the same time, with the Commissioner of Crown Lands in the chair, the General Mining Association of Quebec is in its natural position with reference to the Government. It is fitting that the gentleman charged with the administration of the mining resources of this Province should frequently meet and come into conference with the men who actually do the mining. Speaking for myself and the miners generally, I feel that the official head of the mining department has been most anxious to work with us in every way within his power. (Hear, hear.) This fact has given great support to the feeling of security with which mining is carried on in this Province under the Government regulations. (Applause.)

MR. G. Y. CHOWN—I beg to suggest that the convention memorialize the Governments of Ontario, Quebec and the Dominion to disseminate amongst the farmers information dealing with the nitrogenous potash and phosphoric elements in manure.

MR. THOMAS W. GIBSON—The papers which have been read have been very interesting and valuable, in particular that of Mr. Shutt, who has given us a comprehensive and lucid survey of the whole field. If I might add a word, it would be that, in applying fertilizers it is necessary to consider (1) the necessities of the soil and (2) the requirements of the crops to be grown. A fertilizer which would be of great use on one soil might not be suitable to another. For instance the application of superphosphate to a soil already containing an excess of lime might be of little benefit, while such a soil might be in great need of manure containing nitrogen or potash. Certain crops require generous supplies of phosphoric acid, and for these superphosphate is an ideal fertilizer; others must have more of nitrogen or potash, and hence arises the necessity for choosing the fertilizer with the view of furnishing as nearly as possible the element or elements of nutrition required. We in Canada are for several reasons much behind European countries in the use of artificial manures, and there can be little doubt that it would be of great benefit to the agricultural industry if their employment could be extended. No doubt the Provincial and Federal Governments can do something to this end, and by means of researches at the Dominion and Ontario experimental farms, something has already been done. The most feasible method of governmental assistance would seem to be by supplying information to farmers on the proper use of fertilizers and the benefits to be derived from them. I am inclined to doubt the wisdom of giving anything by way of a bonus to manufacturers, and this would be unnecessary if a market could be created for their product. The way to create a market for superphosphates is to convince the farmers that it would pay them to use it. Let reports and papers such as that read by Prof. Shutt be printed in handy form, not buried in the obscurity of a blue book among other papers on entirely different subjects, and let these be generously distributed among the farmers. This seems to be the best possible way of extending the market for superphosphate.

Mr. B. T. A. Bell moved that a vote of thanks be heartily accorded to Mr. Wigglesworth and Prof. Shutt, who were not members of the Association, for the excellent papers they had furnished.—Carried unanimously.

Hon. Mr. Flynn—The thanks of the meeting are certainly due to the gentlemen who have read the papers here to-night. Mr. Dean has given us an admirable account of the development of electricity as applied to mining, a subject which I have no doubt is bound to come to the front in a very short time. The papers read on the phosphate question dealt with the subject from various standpoints. They were all excellent, but I think I only express the sentiments of all present when

I congratulate Prof. Shutt in particular upon the able and complete manner in which he has presented the question. (Hear, hear.) I agree that the best way to popularize the idea of using fertilizers is to educate the people up to the point of appreciating their value, and it occurred to me while listening to Prof. Shutt's paper that it would be of great advantage to the farming community if it were published in pamphlet form and distributed as widely as possible. Speaking as the Commissioner of Crown Lands and as a member of the Government of Quebec, I am convinced that the question of extending the phosphate industry is now ripe for Government encouragement. It must be admitted that our lands are in need of fertilizing, and the moment you can show to the Governments of the Provinces and the Dominion that superphosphates is an excellent fertilizer, that moment it becomes the duty of the several Governments to encourage those who are prepared to work the phosphate mines and convert the output into fertilizers. To do this is only in harmony with the policy of these Governments, and so far as the Government of Quebec is concerned, I feel that all that is required is to bring the matter to the notice of the Minister of Agriculture, and I believe a most favorable response will be experienced. (Applause.) The Dominion Government has larger means at its command, and with the Experimental Farm has a larger field to work in, and why should the Dominion and the Provinces not have one policy in this matter? Why should they not work together to establish the industry and to create a home market, which, when created, would cause the business to be self-sustaining, and do away with the necessity of any further encouragement? Mr. Gibson has said that he was not inclined to view with favor the proposal to grant a bonus to the manufacturer. Well, it is a question for consideration how the industry should be encouraged. Would it pay at the present time to manufacture superphosphate? Until you get the people of the different Provinces to accept this fertilizer and the industry becomes self-sustaining, should there not be some helping hand? We are acting on this principle every day. In Quebec lately we granted a bonus of one cent per pound on butter in order to place it on the English market, and we also give aid to the beet sugar industry. I admit that action of this kind belongs specially to the sphere of the Dominion Government, and I am expressing my own personal opinion, not necessarily that of the Quebec Government, when I say that I believe the moment is now opportune to move in the direction indicated with regard to the phosphate industry. (Applause.) The Governments of the Dominion and the several Provinces cannot do better than apply a portion of their money in this useful manner. I feel that I would be doing a good thing if by such a policy I could cause the mines in the Ottawa region, now lying dormant, to be worked, and in such a case I can tell you I do not anticipate any trouble as regards the question of royalty. (Laughter.) I read the other day that in South Carolina, whence phosphate is exported in considerable quantity, they have had some trouble about royalty. Now, there is no royalty in the Province of Quebec, and I think I can promise you that there will be none in the future. (Cheers.) The development of the phosphate industry would enhance the value of the phosphate lands still belonging to the Crown, and in this way I would be enabled to add to the revenue derivable from this part of the public domain. I may without indiscretion tell you that in my next report I shall have the pleasure of showing an increased income from mines in spite of the general stagnation throughout the Province and country. Mr. Wigglesworth in his paper treated the subject from the manufacturer's point of view. It seems to me that what Mr. Smith has said commends itself to every unbiassed mind. Why should not the phosphate be converted into superphosphate at the place where it is extracted from the ground? Why should not the lighter article be carried to the heavier, rather than the heavier to the lighter? Gentlemen, I believe that with an enlightened public opinion on the one hand which would welcome superphosphates as a fertilizer, and proper governmental assistance on the other, there is a great industry to be established which would redound to the benefit of the country as a whole. We have met here to promote the welfare of our common country, and if this should be the outcome of our efforts we shall have achieved a worthy end. (Loud applause.)

The meeting then adjourned *sine die.*

EXCURSIONS.

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On Friday morning the members and their ladies were entertained by Mr. James King, M.L.A., and Mr. Lawrence Lynch, to a caleche drive, visiting the many sites of historic interest for which the ancient city is famous. At the end of this delightful outing the members were driven to the Union Club, where cake and wine were served.

In the afternoon the members and a number of prominent citizens were the guests of Messrs. Carrière, Laine & Co. in the steam yacht "Vega," visiting the Chaudiere Falls, Falls of Montmorenci, and the large engineering establishment of the firm at Levis. Before returning to Quebec, the Hon. E. J. Flynn and His Worship Mayor Villeneuve gracefully acknowledged the courtesy of Messrs. Carrière, Laine & Co., and congratulated them on the success of their engineering enterprise Mr. C. H. Carrière, Mr. James King, M.L.A., and Mr. Lawrence Lynch, members of the local committee, were then duly "bounced" to the strains of "They are jolly good fellows." On Saturday many of the members took advantage of the special rates given to the Association and visited the Saguenay *via* Lake St. John, while others who could not afford time for so long a journey, ran out by rail to Ste. Anne de Beaupré.

SPECIAL MEETING.

OTTAWA.

14TH NOVEMBER, 1895.

A special meeting of members of the Association owning and operating mica mines, was held in the Russell House, Ottawa, on Thursday afternoon, 14th November. There was a large attendance, Capt. R. C. Adams, Vice-President, in the Chair.

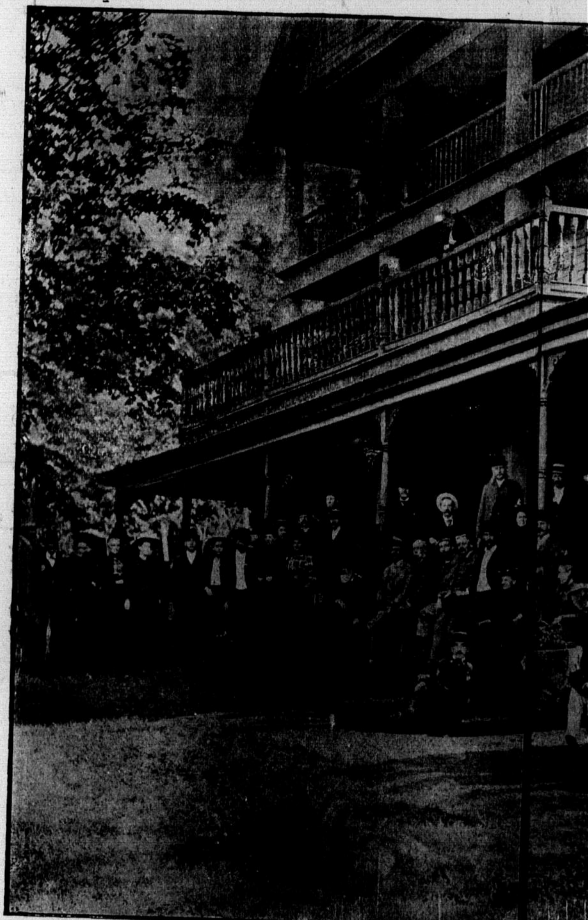
A general discussion took place on the advisability of establishing a uniform standard of grades and prices, the following being appointed a committee to report ways and means: H. Baumgarten (Canadian Mica Co. Ltd.) Ottawa; T. G. Coursolles (Wallingford Mica Co.) Templeton; Lewis K. MacLaurin (McLaurin mine) Templeton; Don C. Watters (Lake Girard Mica System) Ottawa; S. P. Franchot (Villeneuve Mica Co.) Buckingham; W. F. Powell (Clemow & Powell) Ottawa; W. Davidson (Vavasour Mining Association); R. L. Blackburn (Blackburn mine) Ottawa, and B T. A. Bell, editor *Canadian Mining Review*, Ottawa.

Group taken at McGill College, Mo

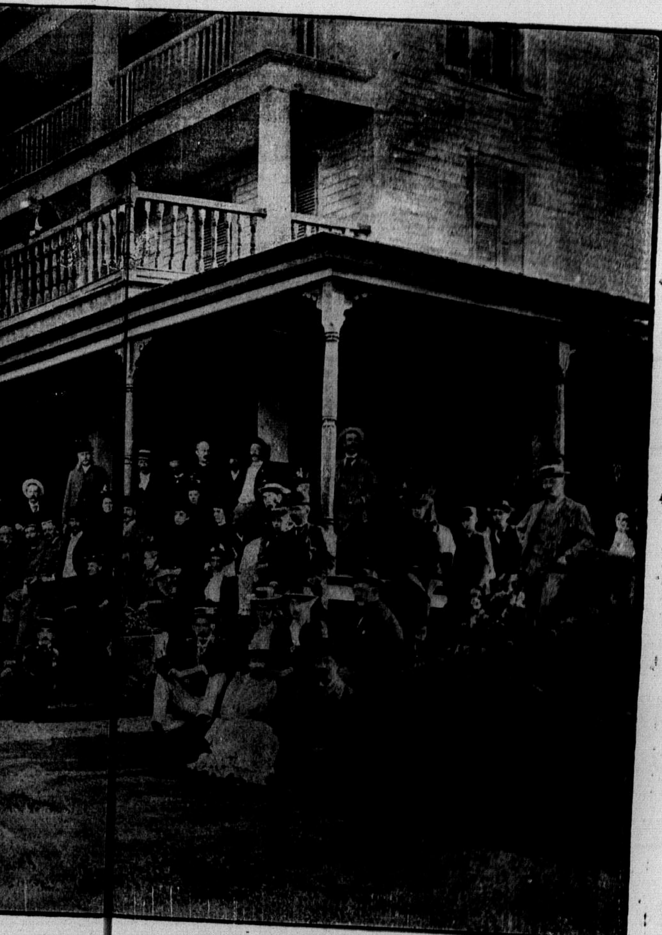
Prof. Harrington. Prof. Cox. W. H. Merritt. J. B. Smith. F. D. Tay . W. Stevenso
Prof. H. T. Bovey. B. T. Kirkhouse. S. P. Franchot. Bell.
A. M. Evans. J. L. Wills. L. A. H. J.
A. H. Murphy. J. J. Penhale. W. H. Irwin.

cGill College, Montreal, January, 1891.

F. D. Tay . W. Stevenson. H. A. Brown. F. Bacon O. M. Harris
ot. Bell. F. Cirkel. C. Koenig. W. Stewart.
L. A. H. J. Williams. W. S. Gardiner. W. T. Gibbs. G. Mullin.
J. Penhale. W. H. Irwin. W. H. Jeffrey. W. Boyd.



Excursion Party at the Owl's Head Lake



Owl's Head Lake Memphremagog, July, 1893.

APPENDIX.

CONTENTS.

OFFICERS AND COUNCIL

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YEARS 1894-5.

—

President:

John Blue, C. & M. E. (Eustis Mining Co.), Capelton, Que.

Vice-Presidents:

J. Burley Smith (British Phosphate Co.), Glen Almond, Que.
George E. Drummond (Canada Iron Furnace Co), Montreal.
F. P. Buck (Dominion Lime Co.), Sherbrooke.
Col. Lucke (Beaver Asbestos Co.), Sherbrooke

Council:

Hon. George Irvine, Q.C. (Johnson's Co.), Quebec, *Past President*
James King, M.L.A (King Bros.), Quebec.
F. A. Halsey (Canadian Rand Drill Co.), Sherbrooke.
S. P. Franchot (Emerald Phosphate Co.), Buckingham.
Hector McRae (Electric Mining Co.), Ottawa.
R. T. Hopper (Anglo-Canadian Asbestos Co.), Black Lake.
John J. Penhale (United Asbestos Co.), Montreal.
George R. Smith (Bell's Asbestos Co.), Thetford Mines.
Fritz Cirkel, M.E., Ottawa.

Treasurer:

A. W. Stevenson, C.A , Montreal.

Secretary:

B. T. A. Bell, Ottawa.

OFFICERS AND COUNCIL.

—

YEARS 1895-6.

—

President:

John Blue, C. & M. E. (Eustis Mining Co.), Capelton.

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Capt. R. C. Adams (Anglo-Canadian Phosphate Co.), Montreal.
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George R. Smith (Bell's Asbestos Co.), Thetford Mines, Que.
H. A. Budden (Intercolonial Coal Co.), Montreal.
J. S. Mitchell (Beaver Asbestos Co.), Sherbrooke.
J Burley Smith, M E. (British Phosphate Co.), Glen Almond.
C. H. Carrière (Carrière, Lainé & Co.), Levis.
R. T. Hopper (Anglo-Canadian Asbestos Co.), Montreal.

Treasurer:

A. W. Stevenson, C.A., Bank of Toronto Bdg , St. James St., Montreal.

Secretary:

B. T. A. Bell, Slater Bdg., Sparks St., Ottawa, Ont.

LIST OF MEMBERS.

*Those marked * are Original Members; × prefixed to a Name indicates the Contributor of a Paper published in Vols. I and II of the Journal.*

HONORARY MEMBERS.

Elected.		
1893	×	Adams, Dr. F. D., *McGill College, Montreal.*
1893	×	Bell, Dr. Robert, *Geological and Natural History Survey, Ottawa.*
1893	×	Blue, Archibald, *Director, Bureau of Mines, Toronto, Ont.*
1891	×	Dawson, Dr. Geo M., C. M. G., *Director, Geological and Natural History Survey, Ottawa.*
1891		Dawson, Sir J. Wm., *Principal, McGill University, Montreal.*
1893	×	Ells, Dr. Robt. W., *Geological and Natural History Survey, Ottawa, Ont.*
1894		Flynn, Hon. E J., M. L. A., *Commissioner of Crown Lands, Quebec, Que.*
1893		Gilpin, Dr. E., Jr., *Deputy Commissioner and Inspector of Mines, Halifax, N. S.*
1893	×	Gibson, T. W., *Bureau of Mines, Toronto, Ont.*
1893	×	Hardman, John E., S. B., M.E., *Jersey Mills, Beauce Co., Quebec.*
1891		Harrington, Prof. B. J., *McGill University, Montreal.*
1893		Ingall, Elfric, D., M.E., A. R. S M., *Chief of Division of Mineral Statistics and Mines, Ottawa.*
1894		Ives, Hon. W. B., Q.C., M.P., *Minister of Trade and Commerce, Sherbrooke, Que.,*
1891		Laflamme, Rev. Father, *Laval University, Quebec, Que.*
1893	×	Low, A. P., B. Ap. Sc., *Geological Survey, Ottawa,*

Elected.		
1893	×	McInnes, W., *Geological Survey, Ottawa.*
1893	×	Obalski, J. M. E., *Inspector of Mines, Quebec.*
1893	×	Poole, Henry S, M.A., A.R.S.M, F.G.S., *Acadia Coal Co., (Ltd.,) Stellarton, N.S.*
1893	×	Raymond, Dr. Rossiter W., *Secretary, American Institute of Mining Engineers, New York.*
1891		Selwyn, Dr. A. R. C., C.M.G., *Ottawa, Ont.*

ORDINARY MEMBERS.

Elected.		
1891	×	*Adams, Capt. Robt. C., (Anglo-Canadian Phosphate Co., Ltd.), *41 St. Francois Xavier St., Montreal.*
1891		*Allan, W. A, (Little Rapids Phosphate Mine), *Victoria Chambers, Ottawa.*
1803		Bacon, F., (Park Bros., Ltd.), *377 St. Paul St., Montreal.*
1893		Bacon, T. P., (New Rockland Slate Co.), *Montreal.*
1895		Belcourt, N. A., Q.C., (Wallingford Mica Co.), *Ottawa.*
1891	×	*Bell, B. T. A., Editor CANADIAN MINING REVIEW, *Ottawa.*
1891	×	Blue, John, (Eustis Mining Co.), *Capelton, Que.*
1895		Boas, Feodor, (Danville, Slate & Asbestos Co.), *Sherbrooke, Que.*
1895		Bonner, W. T. (Babcock & Wilcox Co.), *Board of Trade Building, Montreal.*
1894		Bowen, Cecil, *Sherbrooke, Que.*
1893		Brainerd, Dwight, (Hamilton Powder Co.), *Montreal.*
1891		Brown, D. A., (Bell's Asbestos Co., Ltd.), *Boston, Mass.*
1895		Brown, T. B. (Kingman, Brown & Co.), *Custom House Square, Montreal, Que.*
1895		Browning, J. M., (Cariboo Hydraulic Mining Co.), *Vancouver, B.C.*
1895		Budden, H. A., (Intercolonial Coal Co.), *Commissioner St., Montreal.*
1893		Buck, F. P., (Dominion Lime Co.), *Sherbrooke, Que.*

Elected.		
1895		Burnet, G. F., *Montreal, Que.*
1895		Burritt, G. L., (Ingersoll Rock Drill Co.), Montreal, Que.
1893	×	Carlyle, W. A., M.E., *McGill University, Montreal, Que.*
1893		Carrier, C. H., (Carrier Lainé & Co.), *Levis, Que.*
1895		Chouillou, L., *Montreal, Que.*
1891	×	Cirkel, F. M. E., (Templeton Asbestos Co.), *Ottawa.*
1891		*Cooper, James, (McGregor Lake Phosphate Co.), *Montreal.*
1893		Costigan, W. T., *196 St. James St., Montreal.*
1895	×	Dean, W. F., (Canadian General Electric Co.), *Montreal.*
1893	×	Donald, J. T., M.A., *156 St. James St., Montreal.*
1891		*Doucet, Theo., N.P., *St. James St., Montreal.*
1891		*Drummond, Hon. George A. (New Rockland Slate Co.), *St. Francois Xavier St., Montreal.*
1893	×	Drummond, George E. (Canada Iron Furnace Co., Ltd.), *New York Life Building, Montreal.*
1894		Drummond, T. J. (Canada Iron Furnace Co., Ltd.), *New York Life Building, Montreal.*
1895		Drummond, Huntley (Cumberland Ry. & Coal Co., Ltd.), *Imperial Building, Montreal.*
1895		Drummond, Thos., M.E. (Cariboo Hydraulic Mining Co.), *Montreal.*
1894	×	Drummond, John J. (Canada Iron Furnace Co., Ltd.), *Radnor Forges, Que.*
1893		Dugas, His Honor, Judge (Mica Mine Owner), *Montreal.*
1895		Dwyer, J. T. (Carrier, Lainé & Co.), *Montreal, Que.*
1894		Eustis, W. E. C. (Eustis Mining Co.), *Kilby Street, Boston, Mass.*
1895		Fleck, Alex., Jr. (Vulcan Iron Works), *Ottawa.*
1895		Fleming, Walter A., *St. Francois-Xavier St., Montreal.*
1895		Foley, Jas. (Petroleum Oil Trust, Ltd.), *New York Life Building, Montreal.*
1891		*Franchot, S. P. (Emerald Phosphate Co.), *Buckingham, Que.*
1892		Gardner, W. S. (Machinery Supply Co.), *Montreal, Que.*

Elected.		
1895		Gendreau, L. J., *Jersey Mills, Beauce County, Que.*
1893		Gilman, E. W. (Ingersoll Rock Drill Co.), *Montreal, Que.*
1893		Greenshields, J. N., Q.C. (Danville Slate Co.), *British Empire Building, Montreal.*
1893		Grundy, Frank (Quebec Central Railway), *Sherbrooke, Que.*
1891		*Halsey, F. A. (Canadian Rand Drill Co), *Park Place, New York.*
1891		*Hanson, E., (Glasgow & Montreal Asbestos Co.), *Temple Building, Montreal.*
1891	×	*Haycock, E. B. (Star Gold Mine), *46 Sparks St., Ottawa.*
1893		Higginson, J. S. (Owner Mineral Lands), *Buckingham, Que.*
1895	×	Hobson, J. B., M.E. (Horsefly Hydraulic Gold Mining Co.), *Quesnelle Forks, B.C.*
1891		*Hopper, R. T. (Anglo-Canadian Asbestos Co., Ltd.), *Board of Trade Building, Montreal.*
1895		Innes, F. C. (Montreal & British Columbia P. & P. Co.), *Vancouver, B.C.*
1891	×	*Irvine, Hon. Geo., Q.C. (Johnson's Co.), *Quebec.*
1891		*Jenckes, John M. (Jenckes Machine Co.), *Sherbrooke, Que.*
1893		Jenckes, S. W. (Jenckes Machine Co.), *Sherbrooke, Que.*
1892		Johnson, A. S. (Johnson's Co., Ltd.), *Thetford Mines, Que.*
1891		*King, James, M.L.A. (King Bros.), *Quebec, Que.*
1895		King, Col. Charles, *Sherbrooke, Que.*
1891	×	*Klein, L. A. (American Asbestos Co, Ltd.), *Black Lake, Que.*
1895		Lawrence, H. D., *Sherbrooke, Que.*
1895		Lynch, Lawrence (Johnson's Co.), *Quebec.*
1895		Loomis, D. G., *Sherbrooke, Que.*
1894		McCall, J. T. (Canada Iron Furnace Co., Ltd.), *Montreal.*
1891		McRae, Hector (Electric Mining Co.), *Ottawa.*
1895		Mann, D. D. (Victoria Hydraulic Mining Co.), *Windsor Hotel, Montreal.*
1893		Macdonald, A. (Owner Mineral Lands), *St. John, Que.*
1895		Marcuse, B. (Danville Asbestos & Slate Co), *Sherbrooke, Que.*

Elected.		
1895		Martin, R. H. (Beaver Asbestos Co.), *New York.*
1893		Mitchell, J. S. (Beaver Asbestos Co.), *Sherbrooke.*
1895		Mitchell, Wm., *Drummondville, Que.*
1892		Morgan, E. W. (Northey Mnfg. Co.), *Toronto, Ont.*
1893		Munroe, Robt. (Canada Paint Co.), *Montreal, Que.*
1895		Nellis, T. F. (Vavasour Mining Association), *Ottawa.*
1894		Nichols, W. H. (Nichols Chemical Co.), *41 Cedar St., New York.*
1895		Nichols, W. H., Jr., M.E., *New York.*
1892		Nolan, W. H., *Craig St., Montreal.*
1895		Parker, Moses, *Montreal.*
1891	×	*Penhale, John J. (United Asbestos Co.), *Black Lake, Que.*
1893		Powell, W. F. (Mica Mine Owner), *47 Cooper St., Ottawa.*
1895		Powell, C. Berkeley, *Ottawa.*
1891		*Prefontaine, R., Q.C., M.P. (Owner Mineral Lands), *Montreal.*
1895		Reed, Dr. James, (Asbestos Mine Owner), *Reedsdale, Que.*
1891		*Sclater, Wm., (Owner Mineral Lands), *44 Foundling St., Montreal.*
1894	×	Sangster, A., Jr., (Canadian Rand Drill Co.), *Sherbrooke, Que.*
1893		Smith, Daniel, (Hamilton Powder Co.) *Brownsburg, Que.*
1893		Smith, George R., (Bell's Asbestos Co.), *Thetford Mines, Que.*
1891	×	Smith, J. Burley, M.E., (British Phosphate Co.), *Glen Almond, Que.*
1893	×	Spafford, S. L., (Nichols Chemical Co.), *Capelton, Que.*
1891		*Stevenson, A. W., C.A., (Owner Mineral Lands), *Bank of Toronto Chambers, Montreal.*
1895		Taylor, C. H., M.E., *Montreal, Que.*
1895		Tuck, T. J., *Sherbrooke, Que.*
1893		Wadsworth, F.M.E., (American Gold Co.), *River Gilbert Gold Mines, Sherbrooke, Que.*
1893		Watters, Don. C., (Lake Girard Mica Mining System), *Ottawa, Ont.*

Elected.		
1893		Wiley, F. A., (Owner Mineral Lands), *Port Arthur, Ont.*
1893		Williams, Capt. John J., *Danville, Que.*
1891	×	Williams, H. J., (Danville Slate and Asbestos Co.), *Danville, Que.*
1891		*Williams, Capt. T. W., (North Star Mine), *Buckingham, Que.*
1893		Woodside, J. W., (Beaver Asbestos Co.), *Sherbrooke, Que.*

STUDENT MEMBERS.

Archibald, W. M., McGill College, (Science) Montreal, Que.
Askwith, W. R., 24 Alexander St., Ottawa, Ont.
Angel, F. W., 36 Cathcart St., Montreal, Que.
Bacon, F., 377 St. Paul St, Montreal.
Boyer, Amelieu, 58 Drummond St., Montreal, Que.
Bell, J. W., McGill College, (Science) Montreal, Que.
Baker, H. C., B.A. Sc., Blackburn Mine, Perkins Mills, P.O., Que
Dougal, R, McGill College, (Science) Montreal, Que.
Gwillum, J. C., Kaslo, B.C.
Green, R., McGill College, (Science) Montreal, Que.
Gunn, R. A., B.A. Sc., 1135 Dorchester St., Montreal, Que.
Hart, O. C., McGill College, (Science), Montreal, Que.
Hillary, G. M., McGill College, (Science) Montreal, Que.
Johnson, W. S, McGill College, (Science) Montreal, Que
Mussen, H. W., McGill College, (Science) Montreal, Que.
Rutherford, F., Clapham, Que.
Stewart, R. H., McGill College, (Science) Montreal, Que.
Thompson, H. N., McGill College, (Science) Montreal, Que.
Turnbull, J. M., P. O. Drawer 2412, Montreal, Que.
Van Barnwell, C.E., McGill College, (Science) Montreal, Que.
Webb, W. M., McGill College, (Science) Montreal, Que.

OBITUARY.

Since the organization of the Association, the following members have been removed by death :—

1892—Dr. T. Sterry Hunt, New York.

1892—J. D. Ducharme, C.E., Montreal.

1893—W. Hall Irwin, Montreal.

1894—Lt.-Col. Lucke, Sherbrooke.

1895—W. H. Jeffrey, Richmond.

GENERAL MINING ASSOCIATION

TREASURER'S STATEMENT FOR THE

RECEIPTS.

Balance from 1892-3	$ 216 42
Members' Subscription receipts	690 00
Grant by Dominion Government	1,000 00
Grant by Quebec Government	500 00
	$2,406 42

MONTREAL, 10th January, 1894. (Signed) A. W. STEVENSON, *Treasurer.*

OF THE PROVINCE OF QUEBEC.

YEAR ENDING 13TH JANUARY, 1894.

DISBURSEMENTS.

INTERNATIONAL MINING CONVENTION:			
Paid Canada Iron Furnace Co			
" Windsor Hotel	$270 23		
" Montreal Amateur Athletic Association	255 60		
" Victoria Skating Club	90 00		
" Rent, Windsor Hall	40 00		
" Victoria Rifles Band	57 00		
" Sharp & Curtin	50 00		
" J. Keith Reid, services	18 00		
" do Windsor Hotel	108 50		
" W. H. Irwin, disbursements	24 25		
" A. W. Stevenson, do	12 75		
" Shareholder Printing Co	20 00		
" C. Campbell, Florist	4 50		
" Henry Morgan & Co	5 00		
" L. Patton & Son	1 50		
" Ontario Bank, interest	1 75		
" C. G. Rogers, stenographing	10 82		
" Mortimer & Co., printing	69 25		
" Journal Printing Co., Ottawa	50 00		
" J. Hope & Co.	75 25		
" Bureau & Freres	5 00		
" Ottawa Engraving Co	8 25		
" Paynter & Abbott, printing	8 00		
" Freight	3 00		
" Secretary's travelling expenses and disbursements as	2 29		
per statement	352 42		
			$1,543 36
ORDINARY EXPENSES:			
Paid Secretary as per vote		$100 00	
" Dr. R. W. Ells, expenses		9 70	
" Mortimer & Co		26 80	
" Shareholder Printing Co		2 50	
" Morton, Phillips & Co		2 50	
" Commission collecting subscriptions		6 50	
" Mail Printing and Publishing Co		6 00	
" Bank collections on cheques and drafts		4 25	
" Treasurer's Clerk preparing statements and posting books, &c		25 00	
" Treasurer's postages		23 57	
" " telegrams, expressage, etc.		3 42	
" Vote for Sherbrooke meeting		71 50	
" Secretary's travelling expenses and disbursements for the year as per accounts		444 45	
Balance in hand			726 19
			136 87
			$2,406 42

STATEMENT

SHOWING

SUBSCRIPTIONS PAID TO TREASURER

DURING THE YEARS 1893-1894.

Geo. E. Drummond	$10 00	Col. Lucke	$10 00
C. H. Carrière	10 00	Charles Pearson	10 00
I. B. Futvoye	10 00	Don. C. Watters	10 00
B. T. A. Bell	10 00	W. F. Powell	10 00
Alex. McDonald	10 00	E. W. Morgan	10 00
A. W. Stevenson	10 00	J. M. Jenckes	10 00
S. P. Franchot	10 00	S. W. Jenckes	10 00
F. P. Buck	10 00	F. Cirkel	10 00
John Blue	10 00	James King, M.L.A.	10 00
Hon. Geo. Irvine	10 00	W. T. Gibbs	10 00
W. H. Nolan	10 00	W. A. Allan	10 00
F. A. Halsey	10 00	O. M. Harris	10 00
E. B. Haycock	10 00	S. L. Spafford	10 00
Wm. McIntosh	10 00	Wm. Sclater	10 00
Dwight Brainerd	10 00	D. L. Lockerby	10 00
Capt. R. C. Adams	10 00	E. W. Gilman	10 00
R. T. Hopper	10 00	E. Hanson	10 00
W. H. Irwin	10 00	A. S. Johnson	10 00
F. S. Wiley	10 00	J. S. Mitchell	10 00
J. B. Smith	10 00	F. Wadsworth	10 00
W. E. Bell	10 00	J. R. Woodward	10 00
Judge Dugas	10 00	W. A. Carlyle	10 00
G. R. Smith	10 00	Theo. Doucet	10 00
J. S. Higginson	10 00	R. Prefontaine, Q.C., M.P.	10 00
D. Smith	10 00	W. S. Gardner	10 00
T. P. Bacon	10 00	A. W. Elkins	10 00
F. Bacon	10 00	Capt. J. J. Williams	10 00
J. N. Greenshields, Q.C.	10 00	C. M. Martin	10 00
Robert Munroe	10 00	J. J. Penhale	10 00
W. H. Jeffrey	10 00	W. T. Costigan	10 00
D. A. Brown	10 00	B. Rising	10 00
Hon. G. A. Drummond	10 00	J. T. Donald	10 00
James Cooper	10 00	L. A. Klein	10 00
Hector McRae	10 00	Frank Grundy	10 00
S. H. Fleming	10 00		
			$690 00

STATEMENT

SHOWING

SUBSCRIPTIONS PAID TO TREASURER

DURING THE YEAR 1894-5.

H. J. Williams (1893)	$10 00
W. H. Nichols (1894)	10 00
J. J. Drummond	10 00
Jno. Blue	10 00
F. P. Buck	10 00
J. J. Penhale	10 00
D. Smith	10 00
E. B. Haycock	10 00
Capt. Adams	10 00
D. Brainerd	10 00
B. T. A. Bell	10 00
George E. Drummond	10 00
J. T. McCall	10 00
T. J. Drummond	10 00
A. Benson	10 00
Col. Lucke	10 00
J. B. Smith	10 00
C. H. Carrier	10 00
A. Macdonald	10 00
R. T. Hopper	10 00
W. E. C. Eustis	10 00
A. W. Stevenson	10 00
A. S. Johnson	10 00
Judge Dugas	10 00
J. S. Mitchell	10 00
D. L. Lockerby	10 00
James King	10 00
E. Hanson	10 00
Hon. George Irvine	10 00
W. A. Allen	10 00
F. A. Halsey	10 00
Hector McRae	10 00
S. L. Spafford	10 00
S. P. Franchot	10 00
E. W. Morgan	10 00
Robert Munro	10 00
Hon. G. A. Drummond	10 00
W. S. Gardner	10 00
F. Grundy	10 00
A. W. Elkins	10 00
J. M. Jenckes	10 00
S. W. Jenckes	10 00
G. R. Smith	10 00
D. A. Brown	10 00
R. Prefontaine	10 00
F. Hilton Green	10 00
E. W. Gilman	10 00
T. P. Bacon	10 00
F. Bacon	10 00
James Cooper	10 00
C. H. Bowen	10 00
A. W. Morris	10 00
A. Sangster	10 00
H. D. Lawrence	10 00
Wm. Mitchell	10 00
Dr. Jas. Reed	10 00
T. J. Tuck	10 00
B. Marcuse	10 00
L. A. Klein	10 00
Col. Chas King	10 00
R. H. Martin	10 00
F. Boas	10 00
H. J. Williams	10 00
J. W. Woodside	10 00
Theo. Doucet	10 00
	$650 00

GENERAL MINING ASSOCIATION

TREASURER'S STATEMENT

RECEIPTS.

Balance on hand from 1893-4		$ 136 87
Subscriptions		650 00
Sale of copies of Journal—		
To members	$136 00	
" Dominion Government	96 00	
" Quebec Government	250 00	
		482 00
Balance due Treasurer		22 35
		1,291 22

(Signed) A. W. STEVENSON,
Treasurer.

MONTREAL, 9th January, 1895.

OF THE PROVINCE OF QUEBEC.

FOR THE YEAR 1894-5.

DISBURSEMENTS.

PRINTING:		
Mortimer & Co., Vol. Reports	$607 38	
" " and General	58 50	
		$ 665 88
ENGRAVING:		
McLaughlin & Co.		41 00
SECRETARY:		
Grant as per vote	$150 00	
Travelling expenses attending meetings at Montreal, Sydney, Halifax and Sherbrooke, and outlays on telegrams, postages, stationery and other disbursements as per statement	197 56	
		347 56
TREASURER:		
Bank commissions and drafts	$ 8 50	
Collector's commission	5 60	
Postages	16 60	
Clerk posting books and preparing statements	25 00	
Circulars and receipt book	2 75	
		58 45
STENOGRAPHING PROCEEDINGS:		
C. G. Rogers, Sydney and Sherbrooke		71 90
DINNERS AND LUNCHEONS:		
Balance annual dinner	$ 32 40	
Vote to Sherbrooke meeting	74 03	
		106 43
		$1,291 22

CONSTITUTION AND BY-LAWS.

(AS AMENDED TO DATE.)

SECTION I.—NAME.

1. The organization shall be called The General Mining Association of the Province of Quebec.

SECTION II.—OBJECT.

2. The object of the Association will be to mutually benefit and protect its members by facilitating the interchange of knowledge and ideas, and by taking concerted action upon all matters affecting or relating to the mining industries of the Province of Quebec, and generally to promote the said industries by all lawful and honorable means.

SECTION III.—MEMBERSHIP.

3. The Association shall consist of Members, Associate Members, Honorary Members, and Student Members.

4. Members shall be persons engaged in the direction and operation of mines and quarries in the Province of Quebec, more particularly mine and mill owners, parties interested in the ownership of mines, mining engineers, mine managers, superintendents and metallurgists.

5. Associate Members shall be persons not eligible in the foregoing clause, but such persons whom the Association shall deem worthy of admission. All associates shall enjoy full privileges of membership.

6. Honorary members shall be persons eminent in the profession or history of the industry of the Province.

7. Student Members shall be persons who are qualifying themselves for the profession of mining, metallurgical or mechanical engineering, or other branch of engineering, and such persons may continue student members, until they attain the age of twenty-five years. They shall have notice of, and the privilege of attending all meetings and excursions, and shall have all the privileges of the Association, except voting.

Section IV.—ELECTION OF MEMBERS.

8. A recommendation for admision according to Form "A" in the Appendix, shall be forwarded to the Secretary and by him laid before the Council, who shall have power to elect or reject by a majority vote. The recommendation shall be in writing and signed by not fewer than two members of the Association in good standing.

9. When the proposed candidate is elected the Secretary shall give him notice thereof according to Form "B," but his name shall not be added to the list of members of the Association until he shall have signed the Form 'C' in the Appendix.

Section V.—FEES.

10. The membership fee shall be ten dollars, or such amount as may from time to time be determined by the Council, payable annually in advance at the Annual General Meeting of the Association, but any member or associate member being one year in arrear of his annual subscription shall cease to be a member.

11. Student members shall pay an annual fee of one dollar.

12. The office-bearers of the Association shall consist of: 1st, a President; 2nd, four Vice-Presidents; 3rd, a Secretary; 4th, a Treasurer; and nine members in good standing, who shall act with the other office-bearers as a General Council.

13. The President shall not hold office for more than two consecutive years, but shall be eligible to re-election to that office after an interval of a year.

14. All Past Presidents of the Association shall be elected Honorary Presidents and shall be members of the Council *ex-officio*.

15. All officers and members of Council shall retire annually, but shall be eligible for re-election.

Section VII.—DUTIES OF OFFICERS.

16. The President shall be Chairman at all meetings at which he shall be present, and in his absence one of the Vice-Presidents. In the absence of a Vice-President the members shall elect a Chairman for that meeting.

17. The Treasurer shall hold in trust the uninvested funds of the Association, which shall be deposited in the name of the Association at a bank approved by the Council; he shall receive all moneys and shall

pay all accounts that are properly certified as correct by the Council, and shall present from time to time a statement of the Association's accounts

18. The Secretary shall attend all meetings, shall take minutes of the proceedings, shall be responsible for the safe custody of all papers, books and other property of the Association, and, under the direction of the Council, shall conduct the general business of the Association.

19. The Council may communicate with the Governments, Provincial or Federal, in cases of contemplated or existing legislation of a character affecting or relating to the interests of mining, metallurgy, engineering or their allied interests.

20. The Council may appoint committees, consisting of members of the Association, for the purpose of transacting any particular business or of investigating any specific subject connected with the objects of the Association.

21. A committee shall not have power or control over the funds of the Association, beyond the amount voted for its use by the Council.

22. Committees shall report to the Council, who shall act thereon, and may make use thereof as they may direct.

23. At meetings of the Council five shall form a quorum.

Section VIII.—MEETINGS

24. The Annual General Meeting for the election of Office-bearers, the transaction of the business of the Association and the reading and discussion of papers shall be held in the City of Montreal on the second Wednesday of January in each year.

25. General Meetings for the reading and discussion of papers and for the transaction of business, shall be held once in every four months in each year, at such time and place as the Council may determine. Any special business or subject for discussion shall be specified in the notice convening such meetings, and the Secretary shall give not less than fourteen days' notice thereof to all members of the Association.

26. Extraordinary or urgent business may be transacted at any meeting, when considered absolutely necessary, by a three-quarter majority of those present.

27. Special meetings may be called by the President or a majority of the members of the Council at any time, notice of which, stating the

nature of the business, shall be mailed by the Secretary to each member of the Association.

Section IX.—CONSULTING OFFICERS.

28. The Council shall have power to appoint such consulting officers as may be thought desirable from time to time and may vote them suitable remuneration.

Section X.—PUBLICATIONS.

29. The publications of the Association may comprise:

(*a*) Papers upon the working of mines, metallurgy, engineering, railways, and the various allied industries.

(*b*) Papers upon the management of industrial operations.

(*c*) Notes on questions of law concerning mines.

(*d*) Such proceedings of the meetings of Council, or of the Association, as may be determined by Council.

30. The Association as a body is not responsible for the statements and opinions advanced in the papers which may be read, or in the discussions which may take place at any of its meetings, or which may be reproduced in any of its publications.

Section XI.—MEDALS AND OTHER REWARDS.

31. The Association may award annually the sum of fifty dollars, in the form of medals or other rewards, to student members for original papers contributed to the proceedings of the Association.

Section XII.—DISSOLUTION.

32. The Association shall not be broken up unless by the vote of two-thirds of the members present at any general meeting convened for the purpose of considering the dissolution, and after confirmation by a similar vote, at a subsequent meeting to be held not less than three or more than six months after the first—and notice of this last meeting shall be duly advertised as the Council or a General Meeting may advise.

Section XIII.—AMENDMENTS TO CONSTITUTION AND BY-LAWS.

33. The foregoing Constitution and By-Laws may be amended by a two-thirds vote of any meeting, but notice of motion for such amendment must be given at least four weeks previous to the discussion of the same, of which notice the Secretary shall duly inform every member.

APPENDIX TO CONSTITUTION AND BY-LAWS.

—

FORM A.

Mr.....................being desirous of becoming a member of the General Mining Association of the Province of Quebec, we the undersigned, from our personal knowledge, do hereby recommend him for election.

.... } *Names of two Members.*

Date.................... .... }

FORM B.

Sir,—I beg to inform you that on the..........................you were elected a member of the General Mining Association of the Province of Quebec, but in conformity with the Constitution your election cannot be confirmed until the accompanying form be returned with your signature.

I am, Sir,

Your obedient servant,

....

General Secretary.

FORM C.

I, the undersigned, being elected a member of the General Mining Association of the Province of Quebec, do hereby agree that I will be governed by the regulations of the said Association, as they are now formed, or as they may be hereafter altered; that I will advance the interests of the Association as far as may be in my power; provided that, whenever I shall signify in writing to the Secretary that I am desirous of withdrawing my name therefrom I shall (after the payment of any arrears which may be due by me at that period) be free from this obligation.

(Signed) ....

Date..................

....