CANADIAN MINING MECHANICAL REVIEW

CONDUCTED BY . . . . B. T. A. BELL.

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THE OFFICIAL ORGAN

—OF—

THE GOLD MINER'S ASSOCIATION OF NOVA SCOTIA,

THE UNITED MINING SOCIETY OF NOVA SCOTIA,

THE ASBESTOS CLUB, QUEBEC,

THE GENERL MINING SSOCIATION OF QUEB EC

THE following Resolutions of Council indicate beyond a peradventure the statu. o. THE REVIEW as the exponent of the Canadian Mineral Industries:—

The Gold Miners' Association of Nova Scotia.

"At the annual meeting of the Gold Miners' Association of Nova Scotia, held at Halifax on 6th March, 1889, THE CANADIAN MINING REVIEW was adopted the official organ of this Association.
(Signed), B. C. WILSON, *President.*
G. J. PARTINGTON, *Secretary.*

The Mining Society of Nova Scotia.

"Moved by Mr. R. G. Leckie, seconded by Mr. C. A. Dimock, That the thanks of the Society be tendered to Mr. B. T. A. Bell for his kind offer placing the columns of THE REVIEW at the disposal of the Society; and that THE CANADIAN MINING REVIEW is hereby appointed the official organ of the Society."
(Signed), H. S. POOLE, *President,*
H. M. WYLDE, *Secretary.*

The Asbestos Club, (Quebec.)

"Resolved: That THE CANADIAN MINING REVIEW is, by authority of the Members and Council, hereby appointed the official organ of the Asbestos Club."
(Signed), D. A. BROWN, *President.*
A. M. EVANS, *Secretary.*

The General Mining Association of the Province of Quebec.

At a meeting of Council held at Montreal on Friday, 6th May, 1891, it was moved by Captain Adams, seconded by Mr. R. T. Hopper, and resolved: That THE CANADIAN MINING REVIEW be the official organ of the Association.
(Signed), GEORGE IRVINE, *President.*
B. T. A. BELL, *Secret ry.*"

The Lake View Mining Syndicate, Ltd., of London, G.B.

From time to time it has been the policy of the REVIEW to advise caution on the part of both home and foreign investors when some mining scheme has been brought forward the record of which has not warranted the glowing statements of prospectuses issued.

It is fairly open to question whether to such category belongs "The Lake View Mining Syndicate, Limited," an English incorporation formed to work gold mines at Waverley, Nova Scotia, and the prospectus of which has lately been issued in London.

The British courts, in various cases of late, have held that the directors of such companies are personally responsible for the accuracy of the statements contained in the prospectuses, and the object of this article is to call the attention of the directors of this scheme to one or two matters into which it would be well to inquire before sending the documents out broadcast.

The object of the Syndicate, as set forth in print is to acquire "a lease (granted to Alonzo A. Hayward for the term of two years, from September 7th, 1892) of the entire plant, personal property, and gold mining areas, owned by the Lake View Mining Co., Ltd, a company organized under the laws of Nova Scotia, Canada; also the option to purchase the said property for the sum of one hundred thousand dollars, about £20,000, at any time during the term of the lease." The lease requires a payment of 10 per cent. of the gross output, 2 per cent. to the Nova Scotia Government for royalty, and 8 per cent. to the owning company for rental, or additional royalty.

The prospectus says: "Nova Scotia mines having been comparatively little worked, the public are (*sic*) scarcely aware that it is a gold bearing country." Are there many Londoners agreeing with the above? Some, at any rate, will remember the *New Albion Co., The British and Colonial Land and Mining Co.*, and other companies of both more recent and older dates, and well remember that Nova Scotia gold was the cause of their being.

Another statement to catch the eye is: "The mine has been thoroughly proved * * The Government returns show that 16,226 tons of quartz taken from this mine yielded 11,034 ozs. of gold, or an average of $16\frac{1}{2}$ dwts. per ton." The phraseology of these two sentences, following one close upon the other might lead an unsophisticated investor to suppose that the mine had been recently proved to contain quartz of an average value of $16\frac{1}{2}$ dwts. per ton. The sworn returns from this property since January 1st, 1888, published in the Government blue books, show an average of only $4\frac{7}{10}$ dwts. per ton, from nearly 5,000 tons crushed. The cost of extracting and milling the ore, *including dead work*, is put at about 6 dwts. Was there any margin for profit on these 5,000 tons?

The prospectus also says that the "excellent plant of modern machinery," now on the property was "erected at a cost of over £16,000;" that "over £30,000 has been already expended in opening up the property, and in erecting buildings, purchasing machinery, etc., etc." Also that "the directors have secured as manager, the present lessee, Mr. Alonzo A. Hayward, who has the advantage of knowing the property thoroughly, having as lessee carried on the work profitably for several years past," and that he has "agreed to devote his entire time to the management at the mine, receiving only the nominal amount of £15 per month," etc., etc.

One can imagine an inquisitive shareholder asking these questions: "How is it that this excellent plant of modern machinery cost £16,000 stg. when it is assessed on the tax books of the Province at only £1,600 or thereabouts? Why should it have cost £16,000 stg. if it is worth only £1,600 or 10 per cent.?

This inquisitive shareholder might also have a taste for calculations, and, fortified by the Government returns might say: "The total number of days labor returned upon this property since this American company began work under Mr. Hayward, is about 15,000; assuming the average price of labor per day to be $1.50 (which is above the average rate for Nova Scotia) $22,500 will be required for the labor bill; the ratio of fuel, power, explosives and supplies to labor in Nova Scotia appears to be under 50 per cent., but assuming it to be 50 per cent. we must add $11,250 to the above, making a total of $33,750, or say broadly £7,000 stg. This will leave the *cost price* of your plant *less labor on same*, some £23,000. Now your prospectus says £16,000, and the taxed value is £1,600. Is it wise to select for the future management of this syndicate a gentleman who has needed so much money to erect a plant assessed at so low a valuation? or are your figures wrong? If so what do you mean by publishing them in a document for which you are liable?"

The directors may also have this question asked them, "You state that Mr. Hayward 'as lessee carried on the work profitably with little or no capital for *several years past*.' Can you give to shareholders any statement of the margin of profit per ton obtained by Mr. Hayward on the 8 or 9 dwt. quartz mined by him during the 10 or 12 *months* of his lease in 1891 and 1892?"

The directors would be less liable if the word "*years*" was changed to "*months.*" The prospectus says "It is estimated that the ore won in the exploratory work will in any event more than pay expenses incurred" in such work. The Government returns show that the ore won in the exploratory work done by the former manager in the years 1888 to 1891 inclusive, was $3{,}041\frac{8}{10}$ tons, yielding $349\frac{1}{2}$ ozs. of gold, an average value per ton of $2\frac{1}{3}$ dwts. Does this syndicate really believe that $2\frac{1}{3}$ dwts. of gold per ton "will more than pay" the expenses of driving cross-cuts and levels through the hard country rock of Waverley district? If so they disagree with the estimate of their own engineers who have put it at at least $3.00.

The prospectus also says that the "statements and estimates are made upon the authority of information furnished by the vendor and Messrs. Bainbridge, Seymour & Co., who have favorably reported on the property." The inquisitive shareholder again comes to the front and says to these gentlemen, "Your report is dated 6th January, 1893, and as all work ceased on the property in April, 1892, it is presumable that you would have all data of production at hand before you made this report. Have you, or any of your subordinates, visited this mine since December, 1891? Because your report says that from January 1st, 1888, to January 1st, 1893, the production has been 2,197 tons, yielding 911 ounces. Now the sworn returns made to the Mines Office between the above dates show 4,927 tons yielding 1,166 (and a fraction) ounces. Up to the 1st of December, 1891, some 2,076 tons had been milled by the Lake View Co., but only 237 ounces were returned. You make 674 ozs. more than the sworn returns show. Will Messrs. Bainbridge, Seymour and Co. kindly explain from whence those 674 ozs. came; or what particular 2,197 tons gave 911 ozs?"

A pertinent question is, what evidence have the directors to show that the average yield of the past five years ($4\frac{7}{10}$ dwts.) is going to at once increase to the 15 dwts. upon which is based their calculation of dividends?

The gold mines of Nova Scotia are good investments when properties are selected with care and managed with ability and economy, and they need, as a rule, large working capital. But British investors are asked (not only with regard to this scheme but all others as well) to look carefully into the alleged merits of the enterprise and also into the character of the management proposed.

EN PASSANT.

In the compilation on the subject of the Industrial uses of mica presented by the editor of this paper before the General Mining Association of the Province of Quebec last month it was stated that the new insulator known to electricians as Micanite was made from pulverized or comminuted mica mixed with liquid cement. In a letter from the Mica Insulator Company of New York, the writer describes this new insulator as follows:—

"We take natural sheet mica, small pieces preferred, from which we manufacture Micanite. We have nothing to do with ground mica, nor do we use it in any form. We are able under our patented process to take small pieces of waste mica, and build it up into sheets 40 inches square, and larger if necessary; and we are also able to make it in any desired form. We are supplying the electrical trade very largely, in fact we have more orders than we can fill. We wish to compliment you, however, on your article, as it is certainly very interesting. We send you by mail a sample slot trough made for the W. P. 50 Armature Thomson-Houston motor. By examining this, you will see at a glance that we do not use ground mica as any one would suppose we do from reading your article." It gives us great pleasure to acknowledge and give space to this correction.

They who are ever looking for the American capitalist whose arrival will develop our iron mines, and who believe he is sure to come because President Cleveland will take the duty off iron ore, may be able to reconcile their hopes with the facts that hundreds of iron miners have been paid off in the Lake Superior districts, several mines have been shut down, and ore has been offered cheaper than ever before known in the history of American iron mines.

The market for Canadian Asbestos, at last advices, is reported more hopeful and several contracts at fair prices, have been made. An English correspondent states that stocks on hand are greatly reduced but that buyers are holding off in the hope of getting a further drop in prices.

With the closing down of the High Rock and Squaw Hill Mines active operations in the production of apatite in the Ottawa Valley ceases and the industry for the first time in its history is at a complete standstill. Our last quotation for 80 per cent. is 10½ d. Hamburg, a slight advance which we trust will be the precursor of better things.

Another new device for the prevention of cage accidents has been invented. This time the patentee is Mr. T Settle, manager of the New Mill Gas Works, Huddersfield, England. According to the description supplied by Mr. Settle, a chain or rope is attached to the cage in the ordinary way, but on the top of the cage, on either side of the chain, is a hinged vertical link, on the upper end of which is a horizontal lever, the opposite end being hinged to a block capable of sliding up and down vertical rods placed at each side of the cage for that purpose. The vertical links and horizontal levers are so arranged that when the cage is suspended by the chain the blocks move more freely up and down the vertical rods; but if the chain or rope break and cease to suspend the cage then the ends of the horizontal levers come into contact with a stud and bind against the vertical rods, whereby the descent of the cage is at once arrested. This takes place whether the rope or chain is lowering or lifting the cage. Guide rods of 1½ inches in diameter, it is stated, will bear a breaking strain of 78 tons considerably in excess of the weight and load of an ordinary cage, which usually ranges from five to fifteen tons.

Accounts come from Germany that Herr Krupp is now constructing a number of experimental engines to test a novel idea. A German inventor has taken out letters patent covering the utilization of the general principal that finely divided carbonaceous matter floating in the air readily explodes. He proposes to grind coal to an impalpable powder, and, after introducing the dust floating in the air into the cylinder of an engine, explode it, the idea being to follow very much the same lines which are being so thoroughly developed in the use of gas in engine practice. Naturally, the first question which has arisen has been how to get rid of the ash. Herr Krupp is reported to have stated that his experience in gun manufacture convinces him that this is not a serious obstacle. The advantages which would grow out of a direct utilization of mineral fuel as mined are very obvious. While modern practice converts only 10 to 15 per cent. of the heat energy stored in coal into power at the crank shaft of a steam engine, it is believed that no less than 75 to 80 per cent. could be made available by the direct combustion of the fuel through explosion of coal dust.

Professor A. B. W. Kennedy, F.R.S., delivered a lecture in the Royal Institution, London, Eng., recently on "Possible and Impossible Economies in Energy Utilization," a subject which he described as of national interest, as economy in energy might mean wealth and prosperity to a nation, while waste in energy might mean diminished commerce and general depression. As an engineer, he stood on the firm basis of the fact that nothing was impossible except perpetual motion and the transmutation of metals. In essence, all the imposibilities he would have to mention were perpetual motions—attempts to get more out of something than was in it. He gave as instances the attempts to utilize the steam in an engine over and over again, and to make out of coal a fuel which had twice the value of the coal itself. More than half the possibilities of economy were possibilities of improving up to the best work already done. If, for instance, the average working of steam boilers all over this country were brought up to the standard of the best working, about 30 per cent. of our coal would be saved. He analysed the working of electric light plant, compressed air plant, and electric tramway plant, as well as steam and gas engines, and said there was no very large possibility in saving in the generation of electricity, but there was an enormous possibility of economy in utilizing the current for light in the lamp itself. He also emphasised the importance of superheating steam. To sum up, there seemed to be no very startling possibilities before us, except in increasing the efficiency of electric lamps and bringing up gas engines to their theoretical maximum. In other respects matters would develope more or less rapidly, but always less and less rapidly as they approach the limit of efficiency.

The Council of the Mining Society of Nova Scotia is arranging an excellent programme for the Quarterly General Meeting to be held on *27th and 28th of June, at New Glasgow.* The works of the Pictou Charcoal Iron Co., the New Glasgow Coal, Iron and Rail Co., and the Nova Scotia Steel Works, together with an inspection of the collieries in the neighborhood are features which in themselves should stimulate a large attendance.

The General Mining Association of Quebec will hold its next meeting at Sherbrooke on Wednesday, 5th July. An excursion on Lake Memphremagog to the charming watering place at Newport, together with other items of unusual attractiveness are on the cards. Mr. F. P. Buck, a prominent citizen of Sherbrooke, and a member of Council, has the programme in hand which is a sufficient guarantee of the excellence of the bill of fare to be provided. At the sessions several papers on subjects of interest will be submitted.

In a discussion on the subject of mis-shots before the Manchester Geological Society a Mr. Dobbs said that at his colliery they had fired some 16,000 shots during the year, and 23 had missed. These detonators were recovered by boring a hole 9 in. to 12 in. from the old hole and charging it, then connecting the wires of the mis-shot to the cable, so that when the mis-shot was fired there was no difficulty in finding the mis-detonator. His instructions were strict on this point; the mis-detonator must be found. When recovered they were brought to his office and the cause of the mis-shot ascertained. In eight cases out of 23 he had found it to be the fault of the detonator wires being broken, and in the 15 he could not fire them with the battery. Another speaker claimed that the occurrence of missed shots can be largely prevented by the action of managers in insisting that the shot-lighters should test the exploders and cables at least once a week, the exploders to be tested on a volt-meter to see if the proper number of volts are registered (at least 65 volts.) and the cables tested to see that the wires are not damaged by being broken or short circuited in any way. It is advisable in choosing exploders that those having a large reserve of power should be selected. Instruments are now made registering .120 volts, and only weigh a few pounds.

It would seem that the miners of the Province of Quebec are not alone in their grievance on subject of explosives for we find on reading Lord Randolph Churchill's interesting book "Men Mines and Animals in South Africa," that at Johannesburg, dynamite, an article of prime necessity in a mining country has been made the subject of a monopoly, and granted by the Government of the Transvaal to an individual who, for considerations unknown, is entitled to exclude all other dynamite from the country but his own, and receives a royalty of 12s. 6d. a ton on all his own dynamite which is consumed.

Mr. Isaiah Johnson (Manchester Geological Society) claimed for the steel or iron girder as a substitute for timber in mines the following advantages:—First, That its life is at least six times that of timber. Second, That there is a proportionately less risk. Third, No stoppages through falls. Fourth, That when a roof is done with, the materials can be used again, or, even if they had to be sold, they would at least take scrap price, whereas timber when broken would be worthless. Therefore taking into consideration the use of labor, and the danger of taking out old timber and refixing new, which is very costly apart from risk, he was convinced that the use of steel and iron for the securing of main roads is preferable to timber.

The revenue derived by the Department of Interior from the sales of coal lands in the North-West Territory during the year ended 31st October, 1892, was $3,374.70, being an increase of $1,093.70 over the preceding year. The total area of coal lands sold up to date is 13,649 86 acres, and the total amount received therefor [illegible] 11,083.27.

In our issue of March we published an interesting contribution to the Transactions of the American Institute of Mining Engineers from the pen of Mr. E. E. Russell Tratman, New York on the subject of unfreezable dynamite. In a recent note to the Institute Mr. Tratman called attention to a new high explosive called Maximite, which has been brought out in the United States and is claimed to be both unfreezable and smokeless. It is a nitro-compound, with gun-cotton for its base, and is the invention of Mr. Hudson Maxim, who has had considerable success with the manufacture of smokeless rifle-powders from nitro-compounds. He is now erecting a plant for the manufacture of the new explosive on a commercial scale. Maximite is said to be equal in power (weight for weight) to pure nitro-glycerine and nitro-gelatine, while 10 ounces of it are equal to 1 pound of 90 per cent. dynamite. The cartridges are fired by ordinary exploders, and cannot be exploded by striking. The products of combustion are mainly carbonic acid gas and water.

As to Liebert's unfreezable dynamite, Mr. Tratman has not yet been able to obtain from the owner of the American patent any particulars of the extent of its manufacture and use abroad, but it is said that arrangements are being made for its manufacture on a large scale in England. A company was organized in London for this purpose in 1890, but apparently nothing practical has yet been done. Col. Majendie, R.E., Chief Inspector of Explosives for the British Government, writes that no explosive of that name, and none claiming to possess its non-freezing property, has been placed on the official list of authorized explosives. A dynamite (Von Dahmen's) which was claimed to possess this property was submitted to the Department of Explosives in 1889. Upon due examination it was approved, but no examinations were made as to its alleged non-freezing property. No license to manufacture or import this dynamite was ever secured, and it is therefore not on the official list.

In a recent number of the Transactions of the Manchester Geological Society, Mr. Jas. Grundy, one of H. M. Inspectors of Mines in Great Britain has something of interest to say on the subject of barometric observations in connection with colliery working. He suggests that one of the practical steps to find out the real value of the barometer as an indicator of dangers to be avoided would be for a number of persons intimately connected with collieries to keep records of a self-recording barometer of a good make, and at the same time arrange for the many and varied changes that take place in mines being as far as possible noted and compared with barometric readings. The observations and records would include falls of roof and sides, unusual appearance of fire-damp or black damp. They would also be of great service in the solution of the problem as to what extent the weighting and unexpected falls of roof, sides, or coal, as well as the issue of gas from them, and from the coal, are affected by the atmospheric pressure. Another matter worth investigation, is the changes, if any in the generality of air circulating in the mine; or the relative value of the air for ventilating, during the varying atmospheric pressures.

Notwithstanding the dullness that is prevalent in certain branches of our mining industries it is gratifying to find that our manufacturers of mining machinery have their hands more than full. The Ingersoll Rock Drill Co., is working night and day shifts, and the same activity is noticeable at the works of the Canadian Rand Drill Co. and the Jenckes Machine Co. at Sherbrooke. The Ingersoll people have orders in hand for two 20 x 24 piston inlet compressors, and 22 Sergeant coal mining machines, eight boilers and other plant for the new Dominion Coal Company, besides compressors and mining plant for the Lake Gerard Mica Mining System and other mines. The Jenckes Machine Co's large and well equipped establishment at Sherbrooke is also busy on plant for the Dominion Coal Co., among which we noticed the other day two large hoisting engines. Other manufacturers in Ontario and Nova Scotia, we are glad to see, are also doing good business with our mines and quarries.

At a meeting of sub-committee of the General Mining Association of the province of Quebec, held at Sherbrooke, Que., on 12th instant, it was resolved to recommend that the Association memorialise the Government to extend the working of the present law respecting the free admission of mining machinery to read "That all machinery and appliances for mining, quarrying, smelting, concentrating, refining and treating ores or minerals not manufactured in Canada be admitted free of duty." As our readers are aware the law at present is restricted to *mining* machinery only. Needless to say such a change in the application of the tariff is a consummation most devoutly to be wished by every mineral operator in the country. At the same meeting a statement of the various classes and kinds of mining machinery manufactured in Canada was drawn up. This has been forwarded to the Mining Society of Nova Scotia for extension and revision and will be finally submitted for adoption at the meeting of the Association at Sherbrooke on 5th July. It will then be fyled with the Department of Customs for reference.

Under date of 15th instant the North Sydney *Herald* contains the following:—

"Can you give an anxious public any information as to what has become of the threatened legal proceedings against the Ottawa Mining Journal by Mr. Kennelly? It will be remembered that this periodical over six months ago gave some enlightening information of certain management of the property of the Sydney & Louisburg Coal & Railway Company's property in Cape Breton. The uninitiated and unsuspecting stood aghast at the fearlessness, certainly begotten of an honesty of purpose, that characterized the utterances of the Mining Journal in its criticisms of the management of that unfortunate company's property. After the appearance of those articles Mr. Kennelly threatened the Mining Journal with legal annihilation unless it would withdraw its statements. The Journal refused to move one iota from its position or withdraw one word of its published statement and dared Mr. Kennelly to legal combat Has the ex-manager of the Sydney & Louisburg company considered discretion the better part of valor and withdrawn the libel suit against the Mining Journal? Possibly dreams of that famous "impact of running ice" has cooled down his wrath. It would be funny to hear his narrative, under cross-examination in a court of law, of the origin, growth, capital, disposition of profits, management and personnel of a mercantile firm in this town called 'J. Webb & Co.' The Journal, in its scathing review, referred to this concern. Does the ex-manager remember this? Although his career in Cape Breton is ended, and although everyone laughs at him and at the many, in a certain sense, amusing tales told of a management, the success of which I will allow sore-hearted stockholders to tell, yet I, like the rest of a curious and amused public, would like to know what has become of Kennelly's famous libel suit against the Ottawa Mining Journal?"

So would we!

MINING NOTES.

Nova Scotia.

Beaver Dam.

It is reported, on good authority, that this district will be worked again this summer, satisfactory arrangements having been made with the concern formerly operating here.

Darr's Hill.

Quartz from the Dufferin mine is reported to be rising in grade. The vein found in the north crosscut is being worked, and shows a higher grade of ore than in the old vein. Miners are reported scarce.

Killag.

From the manager of the Old Provincial Co., it is learned that the level driven this winter on the Stuart lode has shown up a large body of pay quartz. Rumor says some of the reserves are high grade rock. Cross-cuts from the first level are now driving north and south to cut other veins lying parallel with the Stuart lode. Only a small force employed.

Fifteen Mile Stream.

Arrangements for the operation of the properties recently consolidated here, are reported completed, and it is expected that the district will produce largely this summer. Mr. James A. Fraser is in charge of the work.

Gay's River.

The mammoth mill erected here two years ago, has been sold to the corporation owning (and about to operate) the Memramcook, N.B. conglomerate. Rumor says the price paid for 50 stamp mill complete (engines, boilers, etc.) with the store, dwelling houses, and other buildings was $5000.00. The Memramcook Co. got a bargain, but we advise them to go slow on their mine.

Country Harbor.

The Antigonish Co. are remodelling their mill and hoisting outfit. The Truro Foundry Co. has the job of supplying and erecting most of the machinery. This company, under the conservative management of Mr. J. C. MacDonald, has already won an enviable record, and when the changes contemplated are finished will have much enlarged their capacity and output. The yield from Stormont district this year, is likely to lead all other districts.

Stormont.

The Richardson mine continues its regular yield of about ½ oz. per ton, producing a monthly output of 150 to 180 ozs. Five additional stamps are being added to the fifteen head already in, and will be dropping in June. This mine and the Antigonish mine at Country Harbor, appear to have reserves ahead for a steadily prosperous year in 1893.

Negotiations are on foot looking to the re-opening of some of the old properties in the east side of Isaacs Harbor. This side has been idle for several years, but owing to causes other than lack of paying veins The whole east side should be consolidated and put under one management, in which case large and steady returns would follow.

Waverley.

The West Waverley Co's mill of ten stamps, crushed during March, 651 tons in 24½ full working days. This is believed to be the best record yet made in Canada for a ten stamp mill. The company are now adding ten more stamps making a total of twenty, and expect to have the new stamps dropping in June. The Truro Foundry Co. is suppling the iron work for the new plant.

Oldham.

This district, for the first few months of the present year, is beating previous record. Something over 1100 ozs. is reported to May 1st.

Quartz is now being mined by the Standard Co., (Taylor & Hardman) from a depth of 500 feet, yielding from 5 to 10 ozs. to the ton. A new straight line Rand Compressor has just replaced a smaller machine, and work this summer will be vigorously pushed.

The Napier Mining Co., will start to sink a new lift in the vertical shaft June 1st.

The Columbia Mining & Milling Co., returns 58 ozs. from 225 tons crushed, to April 1st. All work by this company is now on contract.

Montague.

The Nova Scotia Mines Ltd., under the able management of W. R. Thomas are opening up a large body of reserves, whilst steadily increasing their output. This mine has been seriously handicapped by the reckless operations carried on under previous managements, and the London Company is to be congratulated in having at last got the right man at the Nova Scotia end.

Quebec.

Eastern Townships.

The Eustis, Nicholas, and Howard pyrites mines are reported to be working full time.

With the opening of summer the asbestos mines at Black Lake and Thetford show increased activity, but the general demand for the product has been so limited that the operations are confined to a few companies.

At Thetford the Bell's Asbestos Co. has a large force at work, principally producing lower grades (No. 2 and 3), there being evidently enough of "firsts" on hand to supply all demands.

Messrs. King Bros. who have operated their mill during the winter on lower grades have resumed mining with about twenty men.

The Johnson's Company has not yet attempted any mining this year, but a few men are kept on mill work.

The Beaver Asbestos Co. is working a fair force, but of course, greatly reduced in comparison with former years.

The American Asbestos Co., after being closed down for two years, has resumed work with a large force under Superintendent Klein.

The only other property at Black Lake on which mining is being done is that of the Anglo-Canadian Asbestos Company, and here too, as at Thetford the number of men employed is comparatively small.

The other companies it is understood will raise but little if any asbestos this season, the general desire being to wait for an improved market and work off stock at present on hand.

The annual general meeting of the members of the Asbestos Club has been called for the 25th inst., but at date of writing we have not heard the result of the meeting. Dull times at the mines and unfortunate differences among the executive have of late rather demoralized this useful institution. The REVIEW in common with all visitors to the asbestos region, has a very lively recollection of many pleasant and instructive gatherings and of hospitality served with a generous hand in the comfortable club house. We sincerely hope matters may be so adjusted that the club will resume its sphere of usefulness. The club is altogether too important an institution to be allowed to drop.

Extensive improvements at the Lake Gerard mica mine are contemplated this summer. A larger compressor (Ingersoll) and other plant will be put in. The output continues about 20 tons weekly.

Work on the Hall white mica mine at Escoumains, below Quebec, has been resumed this month. The mine was opened up in November and shut down toward the end of January. Ten men were employed. During that time 3,700 lbs. of cut mica of an average value of $1.50 per lb., was taken out. This mica was taken from a shaft about 15 feet wide, 10 feet long and 25 feet deep. The vein of spar and quartz now being worked runs from 50 to 60 feet in width and about 1,700 feet long. The mica is of excellent quality and gives an average size of 4 x 4. It is beyond a doubt the richest deposit of white mica ever discovered in Canada. The property is owned by Messrs. G. B. Hall, Daniel McGir and John C. Eno, all of Quebec.

Ontario.

North Burgess.

The Lake Girard Mica System's mine at North Burgess has produced about 50 tons monthly since January last.

Mr. T. W. H. Leavitt, of Detroit, has opened up a fine amber mica property in North Burgess. Ten men are employed and some 1,500 tons taken out in a few weeks work.

Lake of the Woods.

The Sultana gold mine is now employing 32 men, about half in the mine and half in the mill. The mill has a 10-stamp battery with an amalgamating plant, and is crushing some 20 tons of ore per day. The concentrates are shipped. The new development recently has consisted in opening up a new lode which is said to be about 12 ft. in width, averaging from 1 to 3 oz.

At the Tremaine the shaft is down about 100 ft. and a considerable quantity of ore has been taken out, most of which is free milling gold ore. A reduction plant is soon to be put up, it is said.

British Columbia.

Mr. Geo. McCabe of Kaslo, was in Ottawa a few days ago and returned to the coast with a bond of Mr. John Askwith's gold property in the McMurdo district, the "Bobbie Burns." The property was bonded for some American investors at a figure in the vicinity of $25,000.

The Kootenay and Columbia Prospecting and Mining Co. of Ottawa shipped a car of mining machinery to the "Wellington" near Kaslo, B.C. last week. The outfit consisted of Kelly sectional boiler, Ingersoll drill, Blake pump, steam hoist, ore buckets, tools, steel, etc. Shipment was routed over the Canadian Pacific, via Revelstoke and the C. & K. Navigation Co. to Kaslo. The rate of freight averaged $2.75 for 100 lbs.

This company had a working bond on the "Wellington" and closed for purchase on May 1st. Development work will be pushed and arrangements made for freighting ore out in June. About 60 tons high grade ore varying from 240 to 1000 ozs. silver are now on the dump ready for packing.

Says the *Nelson Tribune*:—"The boys who make their headquarters at Ainsworth have lost more sleep locating claims after midnight than those of any other camp in Kootenay. A claim, believed to be of value, was relocatable at midnight of the 12th inst, and two parties started to relocate it. One party was made up of well known prospectors like Alex. McLeod, Henry Cody, and George Whitten; the other was headed by George W. Adrain. Both knew the ground well in daylight, but neither party knew the lay of the land after dark. For a while the hills around the Patah claim looked as if a hundred jack-o'-lanterns had suddenly sprung up. One party had no end of mishaps in the dark before they got the claim staked, and the other had no end of misfortunes in daylight before he left the inside of the recorder's office. The Adrian party knew nothing of the other party, and the other party knew all about what Mr. Adrian was sitting on the steps of the record office for so early on the morning of the 13th. Promptly at 10 o'clock the record office was opened, and while Mr. Adrian was placing a Winchester rifle, with which he was armed, in a place of safety, the other boys stepped in and handed the recorder their location notice for the mineral claim "Nightshift" When Mr. Adrian handed his location notice in he was informed that he was too late. Mr. Adrian is now in doubt whether to use the Winchester on the mining recorder or on the boys who got ahead of him, and the mining recorder wishes the "Nightshift" had never been located."

Says the *Golden Era*:—"We hear that there is every probability of the Golden smelter being in active and continuous operation this year. The information is based on the knowledge that arrangements for a supply of ore are complete."

Writing under date 5th instant, the Kaslo-Slocan correspondent of the *North-West Mining Review* says:

The snow is fast disappearing here and the indications are that before the month of June the prospectors and miners now lying idle here will all be busy in the hills. There has been no ore shipped from the mines for the last few days and it is doubtful if there will be any for some time to come as the road is almost impassible and threatens to become worse. However there still remains hundreds of tons stored away in Hughes' warehouse awaiting shipment.

All speculation regarding the merits of this district has been removed by last winter's showings and it must now be conceded that the Kaslo-Slocan is among the richest ore producing countries in the world. It was generally believed when first discovered that there might be a few mines in this locality, but as development work goes on it brings to light the fact that not one or two of the prospects, but all of them which have been worked are Simon pure mines whose average production will exceed $165 per ton in value and in quantity seems illimitable. The veins which have been worked all winter and prove themselves worthy of trust are the Bluebird, Washington, Freddy Lee, Mountain Chief, Chambers Group, Idaho, Wonderful, Slocan, Boy, Reco, Fremont, The Best, Queen Bess, Dardanelles, A. D., (formerly Big Bertha), Slocan Star, Grady group, Jackson, Noble 5, Alamo, Lucky Jim, Payne group and Northern Belle.

All of these have opened up in splendid fashion, some exceeding the most sanguine expectations of their owners or bonders. The Washington, Idaho, Freddy Lee and Grady group have been shipping ore all winter and have more ready for shipment. The A. D. people lost the ore chute recently but are now drifting and expect to tap it again shortly.

All the way between here and the Duncan river the shores are lined with the camps of prospectors who are working up that way.

Reports from the Duncan and Lardeau state that those rivers are rising rapidly and all desirous of reaching those sections had better start in now.

Rumour has it that they have struck a very rich body in the Chambers. This group is going to make John M. Burke, the fortunate bond holder, a very wealthy man.

Reports of new strikes are coming in every day but with few exceptions it is impossible to verify them; several have been made in the immediate vicinity of this city.

The Occurrence and Reduction of Gold.*

By Alfred Woodhouse, F.G.S., Mem. Inst. Mining and Metallurgy.

In this paper I propose to deal with points of interest that have struck me in the gold fields of India, Africa and Nova Scotia, and as my acquaintance with the latter is very short, I put forward my views with considerable diffidence, trusting that other members with far greater experience of this Province, will not hesitate to criticize and explain the errors I fall into, for in my opinion, it is the discussion and not the paper that educates.

The subject gold has a fascination for every one and though termed the "root of all evil," is decidedly a blessing to civilization when properly employed. Gold is, I believe, the only metal for which a market is always ready, and it is the standard by which all products are valued.

Although gold occurs usually in very small quantities compared with other metals, it is probably one of the most widely distributed, as traces of gold are found almost everywhere, but not often in paying quantities.

Experience in different countries has shown that the profitable working of gold *does not necessarily follow* the existence of the metal in payable quantities, and I propose to point out in this paper some of the causes of failure.

Gold occurs in three forms as follows:—

1. In veins of quartz or other hard substance embedded in the matrix.
2. Associated with sulphurets of iron, copper, lead, etc., either chemically combined or otherwise.
3. In alluvial; that is in the detritus formed by the erosion of auriferous rocks due to action of weather, sun and atmosphere, by which particles of gold have been liberated, the lighter grains of ground or powdered rock have been carried away, leaving the heavier mineral near the orignal source. I do not propose entertaining the disputed question of nuggets.

These three occurrences of gold are too extensive to be dealt with in one paper, and I will therefore confine myself to the first, or the occurrence in quartz and other hard silicious matrix.

Although one continually hears that gold occurs in some particular district, in quite a different way than in other countries, experience tends to show that, *practically the same laws of nature* govern all districts in different parts of the world, and I have found practical knowledge in any one country proves invaluable in new fields.

The miner however, must expect to find *local characteristics* and probably no two districts have the same, but if parallel veins of quartz occuring in identically the same formation and lying only a few feet apart, differ so entirely not only in yield of gold, but actually in the nature of matrix, one may reasonably expect very great differences in two districts thousands of miles apart. To sum up I wish to convey the probability that gold occurs in veins of quartz in all countries, following certain laws of nature, affected by certain local characteristics, and that the difference in yield of two parallel veins in similar formation tends to show that our knowledge of the origin of gold is very limited.

A visitor to Nova Scotia hears a great deal about the anticlinal (or anticline) angulars, etc., but does the anticline affect the richness of the ore or do the veins nearest this point prove richer than those farther away? I think we must look further for a cause of rich streaks or deposits.

"Angulars" is a good local name for the numerous veins, strings or droppers of quartz that fall into and in some cases cross the true or formation veins or leads. These small angulars are not confined to Nova Scotia but are generally found in all countries under the name of feeders, which have leeched the country rock of mineral matter and fed them to the mother or formation veins.

All angulars however do not bring in a deposit of gold, and therefore certain angulars must have special advantages, if these are *really* the only source for introduction of gold, which theory I cannot agree with. Owing to the entire absence of a system of cross cutting in settled ground below, little is known of parallel veins except from surface indications, which are usually most deceptive, but I think it probable that many of these angulars are merely strings of quartz connecting two parallel veins. Angulars do not always terminate on contact with formation veins but pass through and continue on the opposite side, or they continue parallel with the vein for several feet and then cross over; in these cases they should, I think, be called "cross courses," and these cross courses *do* in my opinion play a very considerable part in the occurrence of gold. I have found by experience the nearer the cross course approaches to a parallel with the true vein the richer the deposit of mineral matter.

In the Montagu district the gold "chutes or streaks" usually occur from 200 to 250 feet apart and dip to the west at an angle of 43° to 45° and the irregularity indicates that the the "chutes" owe their origin to something more than angulars or cross courses.

If it is acknowledged that the precipitation of gold and metals is caused by certain laws of nature, and not by chance, we have reason to expect that the same laws have placed the gold in Nova Scotia mines that have occasioned the deposits in other countries.

The following will illustrate one theory of how gold may have been deposited in "chutes" or "streaks":—

All will admit that originally the formation of slate and quartzite was in a horizontal position, as it was deposited under water probably containing mineral matter in solution, now it follows that this mineral matter would be precipitated provided certain foreign elements were introduced, say for instance, some vegetable matter.

No doubt everyone has seen the peculiar streaks or lines of seaweed on the ocean carried in comparatively parallel lines by currents, the water between these lines of seaweed being entirely clear of foreign substance. Precipitation of mineral matter will be far greater on the line of seaweed or foreign substance than in the clear water. This illustration merely shows the possible theory of gold deposits in streaks by vegetable or other matter carried in parallel lines by currents over the newly deposited muds since converted into slates and quartzites.

Interesting as any theory of formation may be, I propose confining myself to the practical and profitable side of gold mining, that is following and extracting to the greatest advantage this valuable metal.

In commencing mining operations the engineer's first work is to very thoroughly inspect his ground, locating as far as possible his different leads and learning where gold has been found by former owners, making careful notes of past results. From his notes he will be able to make a rough plan and form some idea where gold may be expected below. With this knowledge he locates the position of his first attack, by adit if possible, if not by main shaft, selecting a position as convenient as possible to the mill site, which should be chosen well above the flat ground, so that no trouble will occur in the future from tailings. As the main workings and mill site form the centre of all future operations, too much care cannot be given to the selection of a place which offers the greatest facilities for permanent works. Managers often forget to look ahead to the future, when the mine requirements may assume very great proportions and instead of adding to the original works, a *fresh start* has to be made on a more suitable site.

The works should be laid out *originally* with a view to future contingencies, and the plan of operations carried out by degrees as funds will permit. Above all things the reckless cutting up of the surface by what are termed trial shafts should be avoided, as these become reservoirs to catch water and flood the future workings, necessitating afterwards costly pumping machinery, for once the mischevious work is done, it can never be undone.

Having located the main shaft, the manager should decide to sink certain depth, say 120 feet for his first level, and steadily continue to this depth, no matter what rich rock is met, the gold will not run away, and can be far more cheapl yraised by overhand stoping from below, than from the system of burrowing or underhand stoping so common in the province.

I very strongly advise following the value of the rock passed through by saving "the drillings," the miners being supplied with marked tins for this purpose. It should be the foreman's business to see that these are delivered regularly to the manager who should pan them off and enter results in a book kept for that purpose. Many rich deposits have been found by this method when the gold was too finely distributed to be visible and and would possibly otherwise have been overlooked.

As a rule the gold, or rather the payable portion of the lead, will be found to occur principally in chutes or streaks, the quartz rock between two streaks proving unpayable, and yet too often this unprofitable rock is taken out and crushed not only with a loss on the work, but also on the wear and tear of the machinery.

It is true every mine cannot maintain an assay department, but the manager can always follow his ore with the pan, and I am surprised to see the pan so seldom used in Nova Scotia knowing from experience its great value as a guide.

The question of vertical or inclined shafts is one that is attracting attention; the inclined shaft, for prospecting work, has the advantage that the lead is tested as sunk upon, but any fault, slide, or change in dip of the vein at once causes trouble, and with the numerous quartz leads found in most districts of Nova Scotia which must be cross cut afterwards, I consider vertical shafts the most desirable for permanent works, as it is only the one vein and that at one point which can be tested by the incline following the lead. When the vertical shaft has been sunk to a level it is easy to raise up or sink a winze on the vein in order that stoping can be commenced.

Working capital is provided to carry out the dead work which opens a mine, that is, sinking shaft and drifting on the various leads and further, when the mine is proved, to provide for the purchase and erection of the necessary machinery. When this has been accomplished, the cost of developing fresh ground to replace that extracted, should be added to cost of breaking and crushing a ton of ore.

With the shaft down to first level, the pan should prove the value of rock passed through, and the result should be carefully noted on the large working plan of the mine so that the position of the gold streaks on the next level may be fairly located. My experience has shown, that once the rule of the occurrence of the gold is determined, nature is wonderfully true to herself, and unless from some fault or intrusion the gold will be found where looked for. If more careful attention was given to this matter much useless work need not be attempted.

In some mines of the Province, notably Montagu, "nuggets" so called are found within the line of the streak or chute, and often contain from two hundred to three hundred ounces of gold in a few hundredweight of quartz. These nuggets occur with some regularity 10 or 12 feet apart, and naturally greatly increase the yield, but as it has been the custom in the past to crush all ore throughout the mine, the average value of the rich chute has been much reduced by the addition of the unprofitable rock between the streaks, worth possibly only two or three dwts. per ton; and as there would be fully ten times as much of this poor rock crushed as of the streak ore, the rich ore has had to pay the loss on treating an increased tonnage, which must return a lower yield per ton throughout.

When the developments of Montagu enable the manager to attack only the streaks, leaving the poorer rock 'in situ' the returns should greatly exceed those made in the past, especially as by that time more of the occurrence of the gold will have been learned by experience under systematic workings.

The mines I have seen in the Province, appear unusually free of water, except such as is derived from surface, where the numerous pits and cuttings form attractive reservoirs, and I have reason to think that if the shafts were puddled with clay well tamped behind the lagging, very little water would be found below.

Considering the minute proportion of gold to the bulk of rock, too much care cannot be given to avoiding unnecessary handling of the ore, from which there must be loss in gold and increased expense. The rock as broken should fall into passes connecting with the level, whence a truck after being filled carries it to the shaft, and is hoisted to surface on the cage and delivered by tramway to the mill-house. When tipped, the ore is shot through a grizzly into the ore bins which supply the self-feeders, the large lumps which fail to pass through being put into the stonebreaker. By this method, handling of quartz is reduced to a minimum.

Too ofen the first object of a manager is to make a good show on the surface, and he starts erecting substantial works before he has learnt the value of the mine. This is surely putting the cart before the horse, for surface works do not pay dividends and it is far wiser to expend working capital first in development to prove what the mine contains, merely erecting such plant as is absolutely necessary for the requirements of development; before launching out into handsome buildings and expensive machinery, a system which has brought many a good mine into liquidation.

Ample working capital is most essential, and I do not consider Nova Scotian mines as a rule have had a fair chance in that respect. What would have been accomplished in other countries if they had had only the few hundred pounds that this Province has had? Failure would have been anticipated and I consider very great credit is due to the mining men here that they have done so much with the small means at their command.

Again, owing to the fact that many of the mines have been opened by men having small capital, the profits have been distributed without building up a reserve fund for developing new ground when the rich ore they worked yielded smaller returns, and in consequence many mines that have yielded handsome profits in the past, are now closed down from want of funds to open out rich ore lying below. With ample working capital mines can be worked not only on a larger scale, but by drawing ore from a dozen different points, the temporary falling off in yield at one or two places would not materially affect the return.

With the experience of the Indian Mines, having a working capital of at least $100,000, and those of the Transvaal where half a million dollars is far from an uncommon working capital for machinery and mine development, the small system of working in this Province, cannot be considered a fair comparison and yet I am convinced, from my own personal experience, that Nova Scotian mines will amply repay the outlay of large capital, provided it is judiciously expended, I mean in *bona fide* development, and not for show on surface.

The quartz occurs principally as bedded veins in a country formation of talcose or argillaceous slate, and dense quartzite tilted almost on edge, and the leads are likely to continue gold bearing to great depth, in fact, as deep as the slates. It is, however, probable that the sulphurets will increase as greater depth is reached. And as considerable gold is associated with these sulphurets of iron, copper, arsenic, lead and zinc, more attention should be given to their concentration and treatment, and generally they will be fonnd a welcome asset.

The ore having been delivered at the mill the next process is, to extract the gold as effectually as possible, and I would impress upon mining men that amalgamation is a science, and that it does not mean feeding so much rock under stampers with the addition of water to splash out the crushed particles, which are then conducted over some amalgamated copper plates. Any school boy or ignorant man can do that and catch a certain percentage of the gold.

The science of amalgamation is arresting and separating the last particle of gold that can profitably be extracted from the quartz rock, and I mean by this, that there is a point of gold saving, beyond which it costs more to extract the extra percentage than the value of the gold recovered

The two first objects are to get the particles of crushed rock out of the mortar box, when reduced sufficiently to pass the screens, without unnecessary pounding; and secondly to retain the gold in or as near the box as possible, and with this idea an amalgamated plate is generally placed inside the mortar box. On the crushed ore or pulp leaving the box, the great object is to check the forward flow of pulp as much as possible without causing it to silt, the tendency of a check being to precipitate any particles of gold either floating on the water or held in suspension, on to the amalgamated copper plate.

* Paper presented at the last meeting of the Mining Society of Nova Scotia.

The advantages and disadvantages of introducing quicksilver into the mortar boxes, are much disputed, but I have found that with most ores it answers well provided a copper plate is securely fixed at the back in a recess cast for the purpose, but in case of introduction, it should be used cautiously, otherwise it will be floured and splashed out on to the plates and a good deal will pass away into the tailings, as it is found floured quicksilver will not readily remain on the copper plate.

In case of grease and oil getting into the box with the quartz, it is advisable to introduce common caustic soda every few hours, as this dissolves the grease and keeps the inside sweet.

For ordinary quartz, I find a drop 8-9 inches 80 to 85 times a minute most effective, and with coarse gold a steel wire screen with 1,000 holes per square inch. In some ores however, the gold is so finely disseminated, that 2,000 holes is not too fine, but the capacity of the mill is naturally reduced with the smaller mesh.

In the Montagu mill the pulp as splashed through the screens falls on a plate 10 inches wide inclined towards the battery, with a pitch of 1 in 10 or 12, and is thus directed over a series of two ripples of quicksilver, with a third one below empty, so as to catch any quicksilver washed over, and thus protect the plate which should be 4 feet long with two ripples below, the upper one only being filled with quicksilver. From here the pulp passes over a second plate 4 feet long and then is conducted to the concentrator.

Although there are numerous patents for concentrators they are mostly very expensive, and often decidedly complicated, and I find the old fashioned straight throw Australian percussion table answers very well and has the great advantage of cheap construction by the mine carpenter.

This concentrator consists of a solidly built wooden table some eight feet long with two divisions. The first with a copper plate set at a low angle say 45 degrees eighteen inches long, from which with a rise of 1½ inches in 2 ft. 6 in. is built the floor up which the ore must ascend. The lower half of the table is similar. This table is hung by four strong iron arms and is held firmly against a bumping block by a powerful spring. With a treble cam the table is pushed forward about one inch to be pressed back by the spring when free of cam, from 180 to 240 times a minute.

The jar naturally settles the heavy pyrites, the lighter sand passing off with the water. Any straying particles of gold or amalgam are caught on the copper plate, while floured quicksilver is again united by the continuous action. The machine is capable of taking five to seven tons every 24 hours. The concentrates are removed with a small shovel by the amalgamator when necessary.

A frequent loss of gold occurs from using too much water over the tables, there should only be just enough to make the black sand and pyrites drag along without actually silting.

Plates should be dressed every four hours, and at that time the battery and water should be stopped, as a piece of amalgam once moved is liable to be swept away with a rush of water. In dressing the plates, a very weak solution of cyanide of potassium may be used to remove any oxide of copper, but on no account should a plate be touched by the naked hand, a piece of chamois leather should always be used.

The quicksilver in the ripples should be retorted once a month as retorted quicksilver has a greater affinity for the fine particles of gold than that which is charged and the gold produced from retorting well repays the cost and trouble.

The use of sodium amalgam and cyanide is not to be encouraged, as both are very dangerous to the plates, and quicksilver, unless thoroughly understood, but a very small piece of sodium amalgam, say the size of a pea, may be placed in each ripple once or twice a week to liven up the quicksilver.

Samples of tailings should be drawn every hour, water and all, and allowed to settle, and fire assays should determine the daily loss of gold per ton.

All details of mill work, such as stoppages, length and cause, time quicksilver introduced to mortars, speed of stamps, delivery of ore, etc., should be regularly entered in the mill book, which should be signed at end of shift by amalgamator. If these details are necessary, in an ordinary office, surely they should be attended to when a valuable mineral like gold is concerned.

It is not possible to enter into the question of the various chemical processes for treatment of concentrates in this paper, but I have found very effective results from simply grinding them to a fine slime, more especially if they have been spread out on floors, and exposed to the action of the sun and weather for several months. If a little salt is added, and the material kept constantly moist and turned over once a week, decomposition is rapidly effected and a very considerable proportion of the gold is liberated on treatment, and is rapidly amalgamated by quicksilver.

In grinding, I have found it advisable to add very little water for some time, so that the quicksilver may permeate the very thick mud in minute globules (which however are not in the form of floured mercury) and to assist the process, I usually add a little salt, caustic soda and cyanide, and after grinding for three or four hours a stream of water is turned on and carries off the slime to a percussion table, where pyrites not sufficiently ground are retained. The quicksilver remains in the grinding pan, which after the water is syphoned off, is ready for a fresh charge of concentrates say 5 or 10 cwt.

My object in dwelling on the concentrator and grinding process for treatment, lies in the fact that both can be carried out on most of the mines in the province at low cost and are fairly effective, but should practical bulk treatment prove the sulphurets to have the value I believe they have it will then be time for the manager to look about for a more effective and modern process.

The President then called for discussion on the paper, printed copies of which the members had received previously.

MR. HARDMAN—I am going to say a few words about Mr. Woodhouse's paper. The main thing I wish to say is that he does not give us a chance to attack him. He has dealt largely with generalities in which we all agree. But there is one point in connection with the illustration given of "How gold may have been deposited in chutes or streaks" to which I may draw attention. I do not think Mr. Woodhouse has elaborated this illustration so much as he might have done.

The existence of gold in the seawater of the present time in amounts equivalent (according to Sonstadt) to nearly 1 grain, or 4 cents per ton justifies the assumption that the ancient seawaters were equally auriferous and very possibly more so. From these mineral bearing waters the slates and quartzites in their deposition as muds or sands may have precipitated or taken down with them more or less gold. And I may say here that a rough calculation will show that the gold contained in the present oceans is sufficient to account for more than all the gold that has ever been extracted from the earth's crust so far as we have any records in history. If then we use Mr. Woodhouse's illustration of parallel lines of seaweed, or organic debris, we have *a* theory of the deposition of gold in streaks; assuming that organic matter has been a good and sufficient reagent for the deposition of metallic gold from dilute solutions, the deposition will have been greatest, as a matter of course, along the lines where this organic matter was accumulated.

Perhaps you are all familiar with the beautiful experiments of Mr. Chas. Wilkinson and Mr. Daintree of the Victorian Geological Survey, which have shown so conclusively the way in which gold can be precipitated in metallic form, even from very dilute solutions, by organic matter. In a paper written by Mr. Chas. Wilkinson in 1866 these experiments are given in detail, and he mentions an accidental experiment of Mr. Daintree's which led to the experiments undertaken later by himself. Mr. Daintree even in those early days, was an amateur photographer; on one occasion he had prepared for photographic use a solution of chloride of gold, the ordinary terchloride, leaving in it a small piece of metallic gold undissolved. Accidentally a piece of the cork, with which the bottle was stoppered fell into the solution, decomposing it, and causing ths gold to precipitate around the small piece of undissolved metal, increasing it to two or three times its original size. Previous to this however, Dr. Selwyn, who at that time was director of the Victoria Geological Survey, had in one of his reports suggested as a possible reason for larger nuggets being found in the drifts or gravels than in the quartz reefs, that gold might have existed in solution in the mineral waters permeating the Silurian drifts or gold gravels of Victoria, and that this mineral water in so percolating might have been in some way decomposed and have precipitated its gold contents around the most congenial nuclei presented to it, which, electro-chemically speaking, would be the particles of reef gold already existing in the gravels.

Mr. Wilkinson, having knowledge of Mr. Daintree's accidental experiment, and of Dr. Selwyn's suggestion, was led to make some experiments. Briefly stated, the results were confirmatory, and established that metallic gold was easily and rapidly (in from 3 days to 3 weeks time) precipitated from dilute solutions of the chloride salt by the agency of organic matter, which, in order to imitate nature's processes as closely as possible, usually consisted of a chip of wood. In these experiments Mr. Wilkinson used as neuclei particles of iron and copper pyrites, galena, zinc blende, antimony and other metallic minerals, and he found also that weak solutions gave better results than strong ones. But I am taking up too much time, and will say little more, except that to those interested in the matter the experiments of Newberry with mine timbers taken from Sandhurst, Ballarat and Scarsdale will prove instructive. In every case gold was found in the timber assayed. I might also refer to Dr. Holland's article in the "Geology of Vermont" and to the well known fact that sulphuretted hydrogen is evolved from the decomposition of marine vegetable matter. All I have said has been meant to follow out the idea in this paper of Mr. Woodhouse's, an idea which is well worth keeping in mind as bearing on the possible origin of "Streaks and Chutes."—I think his illustration of the precipitation of gold along the lines of seaweed, formed by wave action is very apposite. I would like however to ask Mr. Woodhouse to define what he means by "Formation Veins," and also to give us his reasons for the statement made on page 7 of the printed copy of his paper that "*It is, however, probable that the sulphurets will increase as greater depth is reached.*" We are seekers after information, and any knowledge as to *why* we may expect an increase of gold or of sulphurets with increased depths will, I am sure, be very acceptable and pleasing to all of us who are mining for metals.

MR. WOODHOUSE—I am very much obliged to Mr. Hardman for the criticisms and remarks he has made. Perhaps the paper is rather more general than it should be. By "formation veins" I mean veins running with the formation, what are called here "main" or "regular" lodes. In regard to the statement that gold may have been precipitated from sea water—while there is no doubt about one grain of gold being contained in every ton of sea water, yet it is a very vexed question how it may be thrown down from its solution. I have heard some professors on different occasions give their views, and very rarely have any two agreed. As regards the sulphurets being found in increased quantity at increased depths—the tendency would be to get them below the water level at greater depths, because below the water level the deposit of metallic sulphurets is going on at the present time. I do not mean to convey in this paper the idea that sulphurets will persistently increase the farther down you go. At a certain point you will find a considerable change, which point varies in different mines, and is usually the water level.

MR. HARDMAN—May I ask what you have found to be the permanent water level in this country?

MR. WOODHOUSE—Say you go down a couple of hundred feet.

MR. HARDMAN—I have been down 500 feet and have not struck subterranean water.

CAPT. GEO. MACDUFF—As far as my experience has gone we have no water level in the gold-fields here; it is all surface water that we contend with. I may mention that at our mines in Waverley we built dams in the 200 level which caught all our water, and it was surface water; below that level we only had two or three casks of water per day.

MR. HAYWARD—Leaving the question of water-level and returning to Mr. Woodhouse's statement as to sulphurets, if the veins when formed were in an approximately vertical position there might be something in Mr. Woodhouse's claim, but if in a horizontal position I fail to see it.

THE PRESIDENT—Some years ago I interested myself a little in the matter about the formation of our gold lodes, and the presence of gold in streaks and in so-called nuggets. I have got out of the business of late, and it comes to me like a very vague recollection. I have just turned up what I had written some years ago in reference to cross leads or cross-courses, and their apparent effect on certain of the many formations, and I may just quote:* "Mining operations are not confined to the bedded leads, for rich streaks of paying quartz have been followed in cross leads and in what are called "angling" leads. As a rule cross leads of later age than the true leads are barren, or contain but a few pennyweights of gold. Their influence, or that rather of some so-called cross leads, on the productiveness of a regular lead is often remarked on, but cross courses of later date are not always distinguished from contemporaneous connecting bands of quartz filling transverse fractures of the same age as the bedded leads. The effect of cross leads on the productiveness of regular leads is worthy of note. For instance, at the junction of a cross lead with the belt lead at Montagu, some rich spots gave as high as 40 ounces to the ton. Then in the discovery lead at Uniacke the quartz was found to be richer near the junction of what is there called a cross lead, but which in reality is an off-shoot from the lead into the hanging wall, the quartz of both being homogeneous. * * * Whether the yield of the bedded leads is in reality influenced by the position of the cross leads may be doubted, and so of off-shots, for in many leads the number is great and a rich streak has many chances of being near one. It does not appear, however, to be a rule that the dip of the streak and the off-shoot is in the same direction. No cross lead is known to shift a bedded lead, though faults and breaks are numerous."

These are some of the conclusions I came to:

Regarding the divisibility of gold and its universal dissemination, although we regard gold as one of the most stable of substances—it is interesting to note an incident at the Mint in Philadelphia. After pulling off the roof of the old Mint building it was sold for $4000, and it realized to the purchaser a greater value.

Regarding the formation of gold or nuggets in gravel deposits I have in my possession a small piece of gold about one-half an inch in diameter from the lower carboniferous conglomerate of Gays River, which has a perfectly smooth surface with rounded edges, and it is water worn. It must have been formed prior to the conglomerate for on its flat surfaces rest groups of sharp edged particles; evidently they are subsequent attachments, *i.e.* subsequent to the deposition of the conglomerate.

CAPT. MACDUFF—Speaking of "cross-courses," the term does not seem to be understood here in Nova Scotia. In Australia we always find the richest gold near the disturbances. I have not, in my experience in Nova Scotia, met with a true cross-course excepting the one at Waverley in the workings of the Lake View Company, but that has not seemed to have effect upon the veins. I have however met many times with breaks, slides, slips, &c., shifting the vein for a few feet. Where you have a cross-course it is usually filled up with broken foreign matter, and it heaves the vein many feet.

MR. REID—I would refer Capt. MacDuff to the lake lode at Caribou.

CAPT. MACDUFF—I have been there and examined the lode; that is not a cross-course but a shift or heave of the lode.

MR. WILLIS—I may mention two cross courses met with at Rawden, one, from two to fourteen feet in width filled with broken fragments of slate quartz and quartzite, which cuts the old Northup mine vein; and a second one 1,500 feet east and parallel with the first one. This second one is now being tested by the Central Rawden Co.

* Report of the Dept. of Mines, N.S., for the year 1878, pp. 22, 23.

Notes on some Special Features in Lode Formation and Deposition of Gold, as Presented in the Waverley Gold District, Halifax Co., Nova Scotia. *

By B. C. Wilson, Waverley, N.S.

I do not know that a knowledge of the origin of gold would be of any practical value or add anything to the sum of human happiness, but the method of its deposition and its geological associations are of economic importance as affording inferential authority as to the best means of extracting it from the place "where they find it," as Solomon expressed it.

This question when applied to Nova Scotia deposits is usually answered upon the generally accepted theory that most of our auriferous quartz veins, now found at all angles, from horizontal to vertical, were originally beds of silicious matter impregnated or charged with the constituents of the several minerals now found imbedded in them with intervening beds of slate or other rock, and built up in alternating layers much as the Coal Measures are, only differing in composition and presumably in age, and that apparently through the shrinking of the earth's mass and the forces of gravity calling on the outer crust to "close up" towards the centre, which crust, from its acquired rigidity, in consequence of exposure to external influences, could not follow in unbroken order it had to obey the inexorable mandate by reducing its surface area through a series of synclinal and anticlinal folds. Of the former, we, from obvious reasons, see fewer examples than of the more exposed anticlinal exhibits.

Every gold district has certain features in common with all the rest and each has other features distinctively individual, which, if thoroughly studied out, afford authority for local development, and I purpose to give you some account of these features generally and individually, as presented in the Waverley gold field.

This district is located twelve miles from the City of Halifax, and was among the very first half dozen discovered in the Province, and has the distinction of having had the very first licensed quartz mill in the country as appears on the records in the Mines Office at Halifax.

The auriferous veins of this district are on an anticlinal with an exposure of about two miles in a general east and west direction conforming in this respect with the general trend of upheavals over the Province. A very pronounced fault or break occurs near the middle of the district locally causing the distinctions East and West Waverley, and crosses the strata or line of upheaval at nearly right angles, that is, north and south, forming the depression occupied by the chain of lakes and stream utilized years ago by the "Shubenacadie canal." This fault is the most important one of the district, and so far it has not been possible to locate any vein found on one side as a continuation of any vein on the other. Another fault occurs on the west division which follows a surface depression along the line dividing areas 174 and 175, but the displacement is not important and the respective veins have been located on each side of it.

The anticlinal is most pronounced on the western division, the upheaval having been greatest there, and exposing more of the auriferous lodes, which stand nearly vertical in the middle of the district and assume gradually greater depression as they reach towards the western curvature. The extreme western exposure presents the continuation of the same veins round from the north dip to the southern dip, as notably exhibited in the workings on the Tudor vein between 1862 and 1869.

It is a noticeable feature of the district that while we have two western curvatures and dips of the veins, as yet we cannot place our hands on any indication of an eastern curvature or dip, nothing in fact to determine the termination of the lodes easterly.

The two western curvatures or depressions are represented: first, by the one on West Waverley including such veins as Dominion, Tudor, Taylor, No. 6, &c., some of which have been traced to and into the canal lakes before referred to and under which the main fault occurs. Beyond this commence the lodes of East Waverley (east of the fault) and they too present a west curvature and dip towards the same lakes, and extend away east indefinitely, their eastern curvature and dip not being yet demonstrated, a piece of swampy ground operating against surface exploration.

I do not consider it at all proven that the two formations are identical, or rendered only apparently independent through influences of the great fault nor that they represent separate or independent anticlinals. This must be left for future developments to determine.

The ores of the district are recognized as free milling, with limited quantities of sulphurets, the gold being present in fine grains through the quartz, with occasional quantities of considerable value as instanced in a lot of about 500 ounces taken from about 1,000 pounds of quartz from the Barrel lode on East Waverley in 1862.

The Taylor and Tudor lodes were early representative lodes on the west division of the district. The first gold found on the Taylor was a nugget of 6 to 8 ounces, the ore being quartz with but very little associated minerals. The Tudor was an exceptionally well defined vein from 10 to 30 inches thick with smooth walls, and though no large nuggets were found, small ones from 5 to 20 dwt. were frequent. This lode was for a long time the chief gold producer of the district, the monthly brick from it at times being from 1,000 to 1,200 ounces.

* Paper read before last meeting of the Mining Society of Nova Scotia.

Formerly no account was taken of the sulphurets in the ore nor of the gold they carried, but latterly more attention has been directed towards them. By far the greater proportion of sulphurets in the Waverley ores is arsenical iron, of which one distinctive feature is noticeable, (and I am not aware whether it prevails in other districts or not,) which is, that where the arsenical iron is imbedded in the body of the quartz it is usually rich in gold, but where it is situated as a slab or deposit on one side of a lode, that is mixed up with the slate and quartz on one side of the vein only, it rarely carries much gold, assaying but from 10 to 25 dollars per ton of concentrates.

Some thirty years ago a vein two or three inches thick was opened near the centre of the district on West Waverley which was practically solid arsenical iron but as it showed little or no visible gold it was ignored, for no one at that time thought of an assay test. Also about the same time a vein 4 to 6 inches thick was opened on the extreme western curvature which was probably 75 to 90 per cent. sulphurets, chiefly arsenical iron but associated with copper, and though presenting but very little free gold yielded under the stamps from 10 to 21 dwts. per ton, but the vein being narrow and the density of the ore making it objectionable for crushing, it was not worked beyond a few tons and no assay test of its value was ever made, but from my recollections of it I have every confidence it was a valuable ore, and if it maintains its size will yet pay to work.

The Barrel lode on East Waverley carries arsenical iron distributed in small quantities through the quartz and frequently in pockets from a pound to a hundred pounds, and occasionally in lots of a ton or thereabouts, quite crowding out the quartz or more properly taking the place of the quartz in the vein, and such deposits were invariably rich in gold, but at the time they were worked, twenty-five to thirty years ago, their value was not recognized, but I have knowledge of a lot of four or five tons collected by natural concentration as it ran from the mill and taken up after a year's exposure to the elements and put through the stamps again which yielded 63 dwts. of gold for the lot.

The workings on the western division have reached nearly 400 feet in depth, and have developed no special feature beyond a well defined formation, the veins on both the north and south dips maintaining their full strength and showing no signs of extinction.

One important feature demonstrated in this district is that comparatively no flow of water worth mentioning has been found in the deep workings. What has to be contended with is from surface sources largely increased in the old workings by the ill advised methods of mining twenty-five years ago where the drainage has been *into* instead of *from* the mines, but this can be avoided in the future by making new openings and operating under the old works which in general have no considerable depth.

During the first 14 years that the Waverley mines were operated some 51,000 ounces of gold were reported at the mines office, fully eight tenths of which were obtained from West Waverley, since which time until the last two or three years all mining there was relegated to the spasmodic and destructive operations of tributers.

The ore on the east division though discovered simultaneously with that on the west and at that time considered the richest in gold was supposed to be circumscribed in area and local conditions prevented any extensive operations. Yet it is on this east division where the most interesting geological problems are presented, and where glacial and pre-glacial forces have left their unmistakable imprint.

The ground to the west of the main fault before referred to extends away in low hillocks seldom reaching over 90 feet above the level of the lakes.

On the east side the exposed rock rises abruptly from the lake in a strong mountain range, backed by an extended table-land and attaining an altitude of about 200 feet in places, and this heavy deposit of metamorphic rock appears to have been an occupant in possession long anterior to the anticlinal upheaval, which brought the auriferous lodes of the Waverley district to the surface, and further, this back bone of table rock appears to have presented decided objections to being disturbed by the ambitious new comer, and if the two powers of the period exchanged any courtesies they were probably akin to those between the ant and the elephant "Who are you shoving," at any rate there are evidences of some very decided "shoving" on the part of the latest arrival and some equally obstinate resistance by the original "party in possession" and so vigorous was this conflict that the old mountain carries very conspicuous marks of it on his back, and had grudgingly to afford room for the obtrusive metaliferous series, but still held its own so well that there are no scars on its western brow, and it had such a firm foothold under the waters of the lake below that there are no signs of his having "budged an inch."

In 1862 some drift quartz carrying gold was found on the top of this hill, and further search revealed the outcrop of a sheet of quartz lying nearly horizontal, covered with two to four feet of soil and a corresponding amount of rock, and continued workings disclosed what might aptly be termed a blanket of quartz overlying the hill and gradually dipping south, west and north, but most decidedly to the west, or towards the lake at the foot of the hill, and several small owners soon made numerous openings on it, each apparently intent on forming open reservoirs for the local water-shed and in which they were exceptionally successful, and discounting the future for immediate results, soon got it in such condition that no one could work it, notwithstanding the ore at one time was very remunerative; and eventually all work ceased except an occasional effort of some tributor, who managed to find some spot of ore on high ground. But practically everything was under water and it became generally conceded that the only economic means of operating it would be through a tunnel driven from the lake level and intercepting the vein at about 200 to 250 feet below the surface openings and thus escape the overwhelming water of the surface. The scheme though a good one was confronted with the necessity of providing many thousand dollars to carry it out, also a further deterrent was the frequently expressed doubt of the vein existing at that depth and in such position as to be reached as proposed. But after a lapse of many years such a tunnel was eventually driven some 635 feet, and last December struck the vein on the back or crown of the anticlinal on its western dip toward and presumably under the lake where as before mentioned the old mountain has such a firm foothold.

The developments from both tunnel and surface workings are most interesting to the geologist as well as to the miner, a very interesting feature being the peculiar forms presented by the auriferous vein.

At the outcrop it was crimped or folded together upon itself and if smoothed out like a sheet of paper would have presented a vein not over 10 to 12 inches thick, but being folded together it filled a space of 20 to 30 inches, and with associated slate occupied a working belt of about 48 inches between the upper and lower enclosing walls of hard metamorphic rock, and when denuded of the overlying rock presented the appearance of rows of barrels and hence the name "Barrel Lode" was applied.

There was originally much speculation as to what would be the form of the vein at the tunnel level. Some thought it possible that it would be smoothed out, that is, divested of its crimpings which were presumed to be the result of surface shrinkage or compression. On the contrary the foldings as demonstrated in the tunnel workings are in no way changed beyond being apparently compacted by the increased weight of the superincumbent rock.

Whatever may have been the difference in age or time of deposition of the several strata and auriferous veins the condition in which we find the quartz may be accepted as presumptive evidence that at the time of upheaval, the material composing the several belts must have been in different states of rigidity as the quartzite under the Barrel Lode shows only occasional change of form, consequently must have been quite rigid while the overlying rock was most pliable and conformed in some measure to the forces exerted upon it, but the auriferous belt, particularly the quartz part of it (and now the most rigid of all) and which plainly shows the marks of laminated deposition must have been the most plastic of the lot, to admit of its carrying all its laminations unbroken through all its various bendings and curvatures, and there are instances where the quartz is found forced into wedged-shaped cracks or cavities in the rock ending in rounded edges and leaving an unfilled space at the extreme end of the split, much the form that soft putty would assume if pressed into a similar cavity and apparently demonstrating that the infilling material was not silicious waters eventually solidified as in the case of fissure veins.

So far as present workings demonstrate, at the lower or tunnel level, which I estimate will vary at different points from 250 to 500 feet below the surface openings (not in perpendicular height, but on the dip of the vein) there is nothing to warrant the belief that the character or value of the ore is in any degree changed or that it is richer or poorer than was the 6000 tons (or thereabouts) mined at the outcrop, nothing in fact to throw any light upon the probabilities of deep mining in the Province beyond what we already know.

The ore is identical in color, markings and associated minerals and the gold is deposited in the matrix with the same idiosyncracy which characterized it at the surface, and so far as can be predicted, short of milling test, in about the same relative proportions.

Reviewing the foregoing from an economic or miner's standpoint I may observe that the conformation of our Province affords but few places where this method of reaching the ore through a tunnel giving drainage and exit for ore without pumping or hoisting, will apply.

The rock throughout the gold series of Nova Scotia is generally compact and after the first fifty or seventy-five feet there is very little 'coming' or bottom water to contend with. The greatest trouble being from surface sources aggravated by the pernicious system of mining heretofore pursued and perpetuated in many cases to the present day of artificially carrying the natural drainage into instead of away from the mine and ensuring to the persevering miner a supply of water sufficient to keep him poor and busy all his lifetime in keeping it out. If however the surface accumulations from whatever cause or source can be gathered and carried off by gravity, then further and deeper workings, though below Atlantic or other drainage level, can be conducted with such an immunity from this indispensable element in the wrong place, that it becomes a consideration if it is not economy to incur the initial outlay for drainage large though it be, where conditions make it practicable.

Returning to geological considerations again. There was one interesting feature presented on the Barrel Lode which it has never been my privilege to witness elsewhere, viz.: glacial markings on quartz.

When in the surface workings, the soil was removed from the rock overlying the quartz at or near the outcrop, the striae or glacial footprints were such as to rejoice the heart of an enthusiastic geologist, and in fact many are yet visible on portions of the undisturbed rock. In one spot where the auriferous vein protruded through its metamorphic covering a strip of quartz probably 25 feet long by 8 or 10 feet wide had been exposed to glacial scouring, the inequalities worn down, and the quartz polished like a piece of ivory, and eroded creases half an inch deep, cut into the retaining rock on either side, were continued straight on across this polished quartz showing the continuous striae or track of nature's great planing mill.

The fact of the quartz being so doubled up with the slate within the walls of the working belt, and that the underlying quartzite shows hardly any evidence of lateral compression, and the overlying only to a limited extent and only in the vicinity of a contact with the quartz, we are led to enquire what was the relative consistency of the several masses and whence came the apparent excess of vein matter to admit of so much folding. It would seem as if the piston of some mighty cosmic engine had been exerting special pressure upon the auriferous belt from some unknown distance, utilizing the upper and lower walls as a cylinder, and if so one might expect to find evidence of a movement of the material composing the working belt (slate and quartz) wit in the limits of its 'foot' and 'hanging walls,' and this is just what we do find evidence of in the polished state of the relative surfaces as though there had been a sliding of the auriferous belt within the stationary retaining walls.

Now whether this was just what did occur I am unable to state, I am merely giving you the facts as we find them illustrated in the workings and if we accept the inference as stated it would seem to demand that the auriferous vein as originally deposited must have occupied less space than now, say about 12 inches of quartz and 12 inches of slate —laying out smooth—not crimped, and contemporaneously with the upheaval, lateral pressure was exerted on the vein matter which forced the upper and lower retaining walls apart, permitting the quartz and slate to fold up and occupy about four feet between foot and hanging walls, but just how the great natural engine applied its force or whence it got the extra supply of auriferous vein matter are questions to which I offer no solution.

THE PRESIDENT—The second paragraph of Mr. Wilson's paper attracts my attention. I will only take one point. The good that a man does is always accepted —it is only his weaknesses that we want to discuss, and therefore if I hold a view differing from Mr. Wilson it does not follow that I am objecting to the rest of the paper. The drawings which Mr. Wilson has prepared showing the actual position of these barrels is an interesting sketch. Mr. Wilson says:—

"This question when applied to Nova Scotia deposits is usually answered upon the generally accepted theory that most of our auriferous quartz veins, now found at all angles from horizontal to vertical, were originally beds of silicious matter impregnated or charged with the constituents of the several minerals now found imbedded in them with intervening beds of slate or other rock, and built up in alternating layers much as the Coal Measures are, only differing in composition and presumably in age."

I think I know something about coal measures. The auriferous quartz veins or lodes were not deposited in the same way. Mr. Wilson has a very good authority for the views which he takes. Dr. Hunt, whose chemical geology is a standard work even to-day, visited the Province about the year 1870 and wrote a report. I ventured in 1878 to take issue with him upon the conclusions which he drew—and then I wrote as follows:—*

"The distinctive features of the gold leads of Nova Scotia are their general conformability with the slate and quartzite beds and their regularity, suggesting that they are rather beds than veins. But there are characters that point to their being true veins in spite of these features, and they are the following The roughness of the planes of contact between quartz, slate and quartzite; the crushed state of the slate or gangue on some foot-walls; the irregularity of their mineral contents; the terminations of the leads; the effects of contemporary dislocations; and the influence of stringers and offshoots on the richness of the leads, characters that singly or collectively it would be difficult to account for, associated with a stratified deposit."

I venture to think that my opportunities of going underground which I had enjoyed some years before were greater than Dr. Hunt's, and having this statement in view I was continually looking at the face of the slopes to see if his conclusions were justified by the appearance of the quartzites, etc., and I came to the reverse conclusion. I saw nothing there that would lead me to believe that they were truly bedded deposits. The quartz in all cases appeared to me to be of subsequent deposition. That it contained fragments of slate lying in all conceivable positions in relation to the beds of quartzite—that fragments tailed off from the lead that appeared falling out and held partially away from the walls—just as you find them in drift veins which cross the regular leads contrary to the bedding. The only thing that made me at all doubtful was the invariable appearance of these leads lying between beds of slate and quartzite If you carefully observed you would see that the lode did vary in a bed of slate sometimes from one side to the other. Between two beds of quartzite which govern the character of the formation, you had always slate on one side and partially on the other I came to the conclusion that it was quartz which had been subsequently deposited. Of course these cracks occurred from the folding of the strata in the regular form which we now have it, and that is a point. Mr Faribault has been mapping these veins with a great deal of care showing the whole series from one end of the Province to the other His report will be to the effect that the folding is due to subsequent pressure and that the pressure that has been brought to bear by lateral pressure was caused by the continuous accumulation of depositions in deep seas which lie against or along the straight edge of older rocks—such as has since formed the range of the Appelachian chain which extended in this direction. I think this question is an interesting one and one open to great elaboration.

MR. HARDMAN.—I also wish to differ from Mr. Wilson in respect to his view that our gold veins were once horizontal beds, contemporaneous with the slate and quartzite. Mr. Wilson makes one or two statements rather in the line of questions, inviting comparison with other districts—one is in relation to the value of the sulphurets when found in different positions in the vein-stone. He says, "he is not aware whether it prevails in other districts or not, that where the arsenical iron is imbedded in the body of the quartz it is usually rich in gold, but that where it is situated as a slab or deposit one side of a lode (that is mixed up with the slate and quartz on one side of the vein only) it rarely carries much gold."

Our experience at Oldham, where the sulphurets occur on one side—the hanging wall side—is that they will average in value $75 to the ton; where they occur in the middle of the vein the assay yields $12 to the ton.

In the Dominion lode I am working at Waverley, I find a great divergence in the sulphurets, whether taken from the middle or side of the vein. One or two samples that have been taken from the foot wall side of the vein have shown values approaching $30 which is more than treble the value of those samples taken from the middle of the vein.

At Isaac's Harbor, on the Victoria lode, I noted also that the sulphurets nearest the slate wall were richer than those in the body of the vein. I may say that the slate in Oldham is on the hanging wall of the lode, and the sulphurets that are rich lie next the slate.

As to another point Mr. Wilson does not consider the two formations of Waverley identical—*i.e.* East Waverley and West Waverley. I would like to ask him whether he means to say that East and West Waverley were not contemporaneous—that they were not produced simultaneously by the same pressure which produced the anticlinal. If he does then he differs from Professor Hind. It seems to me also that he is going back of the record of the different lodes. I cannot avoid the conclusion that they were both contemporaneous. He also says that the fault on the western side is not important.

From a mercenary point of view I am extremely interested in this fault, and think it the most important of them all.

MR. WILSON—In reference to that fault Mr. Hardman refers I suppose to the fault between areas No. 174 and No. 175, which I believe is somewhere about 118 feet in extent. I look upon that as not a shifting of the material of the ground north and south, but I look upon it as a direct movement up and down of the material composing the rock on what is called the "American Hill," and you will understand if a vein or portion of ground lying at that angle is broken off, and lifted square up, that the other vein down here will be represented over here a number of feet to the north, on account of that dip being to the north. I have always considered that the fault referred to was not a lateral break of the ground, by which a portion of the ground was carried north or south, but rather a direct raising up of the material forming "American Hill."

MR. HARDMAN—In order to be a direct raising up the angle of that fault plane would have to be a ninety degree dip. The dip of that fault is to the eastward, therefore it could not have been a direct lifting up—there must have been a sliding action.

MR. WILSON—We must take a great deal of our our geology upon faith. I find a great many questions arising in the Waverley formation which are quite enigmas to me, and I cannot see that anybody else has been able to explain them. Our worthy president's father did undertake to explain to me the origin of the quartz at Laidlaw's Hill, but I do not know that his statements have been borne out by developments afterwards, nor that they have been very far astray either. There are certain points we have not got around yet, and I have been careful not to advance any of these as my own theory, nor would I back them up, still in the absence of anything better, I will have to adopt them.

I made the statements regarding sulphurets on my experience. I always considered where gold showed in the sulphurets, those sulphurets were richer than those which showed no gold. Sulphurets which are associated with gold in the quartz are invariably pretty rich.

MR. HARDMAN—I sent some nodules of arsenical pyrites to be assayed which were in the midst of white quartz, and which carried large gold particles, yet they gave only six pennyweights to the ton of arsenical iron.

MR. HAYWARD—Was that from the Dominion lode?

MR. HARDMAN—Yes.

MR. HAYWARD—As to East and West Waverley, and referring to the breaks, it has always been my opinion that American Hill has been shifted to the north 118 feet, and also that it has been raised up 80 feet, from its original position.

In forming these conclusions I found the formation of the rock east of the break, as it was broken, tailed to the south, and that the fault was traceable through the valley.

MR. STUART—I have nothing to say with regard to Waverley, Mr. President, but I agree with your own remarks and Mr. Hardman's in regard to this auriferous formation not carrying bedded leads. Every day I see evidence of that negative fact; and there is no stronger evidence that I have ever seen than the lake lead at Caribou, which is in a bed of talcose slate. This section I have made (and will hand around) represents 150 feet in length of the lode and if you will notice where the lode crosses the strata you will find it is much richer than where it runs parallel with the strata. I am now speaking of the lake lode vein proper. Where the rich quartz occurred in the lake lode mine, running back across the strata, there were no feeders.

Where we got the very rich quartz which I took out last December on the Truro Company's property, there were feeders, that is, the rich quartz was in or of those side leads which divide the vein. I cannot see how it is possible that our auriferous leads in Nova Scotia have ever been formed in any other position than that in which they are found to-day.

* Report of Dept. of Mines, N.S., for the year 1878, p. 27.

Mineral Wealth of British Columbia.*

By George Dawson, C.M.G., LL.D., F.R.S. Ottawa.

Had I known in time that it would be my privilege to address the Fellows of the Royal Colonial Institute on the subject of the "Mineral Wealth of British Columbia," I should have taken pains to provide myself with specimens of the ores, and with photographs and maps suitable for illustration. Without these means of enforcing and explaining my remarks, I feel that my endeavor is undertaken at some disadvantages, and this especially because I wish to speak of a country of which the mining importance lies chiefly in its future, and for which, though some substantial progress has already been made, it is not yet possible to refer to the statistics of great mining enterprises.

As it is, I am indebted to the Royal Geographical Society for the use of the map exhibited, upon which I must rely in order to convey some definite ideas on the subject in hand.

For fifteen years or more I have been engaged in the exploration and geological examination of British Columbia in connection with the Geological Survey of Canada, and have thus enjoyed the opportunity of traversing and inspecting a large part of this province of Canada. The information gained has been embodied in a series of official reports, published from year to year, and it is only because it may be assumed that such reports are seldom read that I can venture to hope that what I have to say may possess some interest or novelty at the present time.

British Columbia is the western province of the Dominion of Canada, with a coast-line of over 500 miles in length, from south to north, on the Pacific. It is the largest of the Canadian provinces which has yet been defined, and may be described as possessing truly imperial dimensions. Its length of coast (without counting its extraordinary sinuosities) is nearly equal to the combined length of England and Scotland; while its area of 383,300 square miles is over three time that of the United Kingdom, and greater than that of any country in Europe except Russia.

It is in the main a land of mountains, including nearly 1,000 miles in length of that broken western margin of the American Continent, which, in lieu of any better name, is known as the Rocky Mountain region or Cordilleran Belt. Although it possesses valuable fisheries and remarkable resources in its forests, besides important tracts of arable and pasture land, much of its prosperity must depend on the development of its mineral wealth, which is the compensation afforded by nature for the generally rugged character of a large part of its surface

Less than one hundred years ago, the region now named British Columbia was wholly unknown. At about that time its coast began to be explored in some detail by Cook, Vancouver, and other navigators, and soon after, this coast became the resort of a certain number of trading vessels in search of furs; but none of these adventurers acquired any knowledge of the interior of the country Almost simultaneously, however, the explorers and traders of the North-West and Hudson's Bay Companies, pushing on and extending their operations from point to point in the interior of the North American Continent, began to enter the hitherto mysterious region of the Rocky Mountain from its inland side. Mackenzie was the first to reach the Pacific, and following him came Fraser, Thompson, Campbell and others, all Scotchmen in the service of these trading companies, till by degrees several trading posts were established, and "New Caledonia," as the whole region was then named, came to be recognized as an important "fur country."

This era of discovery, with its results, constitutes the first chapter in the known history of British Columbia. It is replete with the achievements and adventures of these pioneers of commerce, who with their limited resources, and without knowing that they had achieved fame—often without even placing their journeys on record—extended the operations of their Companies across a continent. But this chapter, though full of interest, is not that with which we are at present concerned. It must suffice to say that what is now British Columbia remained a "fur country," and that alone, for many years. The existence of coal upon its coast was recognized by Dr. Tolmie, an officer of the Hudson's Bay Company, as early as 1835; but though small quantities of coal were actually obtained from natural outcrops from time to time, for the use of blacksmiths at the Company's posts, no importance appears to have been attached to the discovery. The world was at that time very spacious, and the Pacific Ocean was still regarded rather as a field for the exploration of navigators than as a highway of commerce between America and Asia.

* Paper read before the Royal Colonial Institute.

In 1849 gold was discovered in California, and with the resulting influx of miners, the seizure of that Mexican province by the United States, justified, if justifiable at all by its subsequent development, all are familiar. Two years later, a discovery of gold occurred on the Queen Charlotte Islands, now forming part of British Columbia. This constitutes an interesting episode by itself, but though some attention was drawn to it for a time, no substantial results followed, and no alteration in the condition of the country as a whole was brought about. The meaning and the worth of this particular discovery yet remained to be determined.

In 1857, however, four or five French-Canadians and half-breeds, employes of the ubiquitous Hudson's Bay Company, found gold on the banks of the Thompson, a tributary of the Fraser River, and their discovery becoming known, changed the whole fortunes of the country. California was at this time filled with gold miners, and it required only the rumour of a new discovery of gold to create a new "excitement." In the following year, it is estimated that within three months over 20,000 people arrived at the remote trading post which then stood upon the present site of the city of Victoria, while many more made their way overland to the New El Dorado.

The difficulties in the way of these fortune hunters were great. The country was without roads or other means of communication, save such rough trails and tracks as had served the purpose of the natives and those of the fur traders. The Indians, if not openly hostile, were treacherous, and not a few of the men who actually reached the Fraser Canons were never again heard of.

The Fraser and Thompson were at this time the objective points, and much of the lengths of these rivers were impracticable torrents. It is not therefore surprising that by far the larger part of those engaged in this sudden migration returned disappointed, many without ever reaching their destination. Some, however, persevered, several thousand miners actually got to work on the auriferous bars of the Fraser, and a new state of affairs was thus fairly inaugurated.

To follow the rapid progress of these miners along the Fraser and Thompson with their tributaries would be full of interest, though the records of their work now existing are scanty, but this again would lead us too far afield. The gold found on the lower reaches of the Fraser was what is known to miners as "fine" gold, or gold in very small scales or dust, minutely divided. Further up "coarser" gold was obtained, and the miners very naturally jumped to the conclusion that somewhere still further up the great stream the source of all the gold should be found. Thus, with restless energy, they pushed on till before long the Cariboo country, some 400 miles from the sea, was reached; and here the richest deposits of alluvial or "placer" gold were found, and for a number of years continued to be worked, with results which, considering the comparatively small number of men engaged, were most remarkable.

Later and more thorough investigations show that the theory so readily adopted by the miners was incorrect; that there is no regular gradation in amount or "coarseness" of gold from the lower part of the Fraser to the head waters in Cariboo, but that the gold found on the bars of the river, is of more local origin. Still the theory referred to, as a matter of fact, led the miners to Cariboo, which proved not only to be the richest district so far discovered in British Columbia, but for its area one of the richest placer mining districts ever found.

In this district the valleys of two streams, Lightning and Williams Creeks, have been most remunerative, and these and their tributaries have actually yielded the greater part of the gold obtained. The work was begun by the washing of the gravels of the streams themselves, but with the experience already gained in California and in Australia, the miners soon began to search deeper. The valleys through which these streams flowed were found to be filled to a considerable depth by loose material, gravel, and boulder-clay due to the glacial period or to inwash from the sides of the bordering mountain ranges; and in sinking beneath all this material the channels of older streams, the predecessors of the present, were found, with their rocky beds smoothed and worn and filled with rounded boulders and gravel. These contained vastly richer deposits of gold, because they represented the concentrated accumulations of great periods of continued work by natural forces of denudation and river action.

This discovery, once made, led to the initiation of more extended mining operations, which often necessitated large expense in labor and the construction of heavy pumping machinery; but the results as a rule repaid the enterprising miners. Thus the old deeply buried channel of Lightning Creek was found to average something like $200 in gold to each running foot of its length, while considerable lengths of Williams Creek yielded as much as $1,000 to the same unit of measurement.

Williams Creek affords some notable instances of the extraordinary concentration of "coarse" gold in limited areas:—Thus, from Steele's claim, 80 x 25 feet, over $100,000 worth of gold was obtained. From the Diller Company's claim, it is stated that in one day 200 lb. weight of gold, valued at $38,400, was raised; and in 1863, twenty claims were producing from 70 to 400 ounces of gold each per diem. Four hundred miners were at work on Williams Creek in this year, which is still admiringly spoken of as the "golden year."

Though, like Williams Creek, discovered in 1861, the deep channel of Lightning Creek was not successfully reached till 1870, but great developments followed. The Butcher claim at one time yielded 350 ounces of gold a day; the Aurora, 300 to 600 ounces; and the Caledonia, 300 ounces.

It must be remembered that the Cariboo mining district is situated in a high and densely forested mountainous region, which, because of its inaccessible character, had remained almost unknown even to the wandering native hunters. At the time in which these great discoveries in it occurred, it was reached only with extreme difficulty by trails or imperfect tracks, over mountains and across unbridged rivers. Every article required by the miner was obtained at an excessive cost; but all these drawbacks did not prevent the rapid growth of typical mining camps in the centre of this remote wilderness, with their accompanying lavish expenditure and costly if rude pleasures. So long as the golden stream continued to flow in undiminished volume, everything that gold alone could buy was to be obtained in Cariboo.

Perhaps more worthy of note is the fact that the development of these mines was carried out entirely by the miners themselves. No outside capital or backing was asked for or obtained. Money made in one venture was freely and at once embarked in another, and the investors were to be found working with pick and shovel in the shaft or drift.

But the lengths of the rich old channels on both these famous creeks which could be worked in this way proved to be limited to a few miles. Below a certain point in each case, the "bed rock" was found to be at so great a depth that it was not possible to reach it through the loose and water-saturated materials filling the old valley. Thus the great yield of gold became gradually reduced to comparatively modest proportions, and, at the present time, mining in the Cariboo district is mainly confined to hydraulic workings, by which poorer ground is utilized and a much larger quantity of material requires to be removed to obtain a given amount of gold. But the old valleys of Cariboo have never ceased to produce gold, and in 1892 their product still amounted in value to about $200,000.

It has been impossible to follow the fortunes of the Cariboo mining district in any detail, and time can only be afforded to name the other placer mining districts of the province. The Omenica district was discovered soon after Cariboo, but little was done there till 1867. This district is situated in latitude 56°, in the drainage basin of the Peace River, and, though so remote, has produced a considerable quantity of gold. Still further to the north, in latitude 58°, is the Cassiar district, first found to be auriferous in 1872, for some years thereafter resorted to by many miners, and still a mining centre not without importance. This is the northernmost mining region of British Columbia proper, but beyond the 60th parallel (forming the northern boundary of the province) alluvial gold mining has of late years been developed in the Yukon district, embracing the numerous upper tributaries of that great river, and extending to the borders of the United States territory of Alaska.

Neither must it be forgotten to note, that the working of alluvial gold deposits of greater or less importance has occurred at many places in the southern part of the province, to the East of the Fraser River, including Big Bend, Similkameen, and Kootanie districts, from all of which some gold still continues to be produced by the old methods.

The story of the discovery and development, the palmy days and the gradual decline in importance of any one of these mining regions, rightly told and in sufficient detail, would constitute in itself a subject of interest. But without attempting to do more than name the districts here, it is of importance to note how general, throughout the whole extent of the great area of British Columbia, the occurrence of deposits of alluvial gold has been proved to be. The gold thus found in the gravels and river-beds is merely that collected in those places by natural processes of waste, acting on the rocks, and the concentration of their heavy materials during the long course of time. The gold has been collected in these places by the untiring action of the streams and rivers, and it must in all cases be accepted as an indication of the gold-bearing veins which traverse the rocky substructure of the country, and which await merely the necessary skill and capital to yield to the miner still more abundantly.

Nevertheless, the results of alluvial or placer gold mining alone in British Columbia have not been insignificant, for, since the early years of the discovery, the province has contributed gold to the value of some $50,000,000 to the world.

One feature in particular requires special mention, and this is a deduction which depends not alone on experience in British Columbia, but which is based as well on that resulting from the study and examination of other regions. The "heavy," or "coarse" gold, meaning by these miners'terms the gold which occurs in pellets or nuggets of some size, never travels far from its place of origin. It is from this point of view that it becomes important to note and record the localities in which rich alluvial deposits have been found, even when the working of these has been abandoned by the placer miner. Their existence points to that of neighboring deposits in the rock itself, which may confidently be looked for, and which are likely to constitute a greater and more permanent source of wealth than that afforded by their derived gold.

Reverting for a moment to the Cariboo district, where such notably rich deposits of alluvial gold have been found within a limited area, and where, very often, the gold obtained has been actually mingled with the quartz of the parent veins, it cannot be doubted that these veins will before long be drawn upon to produce a second golden harvest. This district has suffered and still suffers from its great distance from efficient means of communication; but, notwithstanding this, praiseworthy efforts have already been made towards the development of "quartz mining," while much also remains to be done in utilizing by operations on a larger scale, and with better appliances, the less accessible placer deposits which have so far baffled the efforts of the local miner.

It is necessary to bear in mind that alluvial gold mining or placer mining requires but a minimum amount of knowledge on the part of the miner, though it may call for much individual enterprise and effort when a new and difficult region is to be entered. Any man of ordinary intelligence may soon become an expert placer miner. It is after all, in the main, a poor man's method of mining; and, as a rule, the placer miner lacks the knowledge as well as the capital necessary to enable him to undertake regular mining operations on veins and lodes. However promising the indications may be for such mining, he either does not appreciate them, or passes them over as being beyond his experience or means. He would rather travel hundreds of miles to test a new reported discovery, than spend a summer in endeavoring to trace out a quartz reef, with the uncertain prospect of being able to dispose of it at some later date.

Thus, though the development of placer mining in British Columbia began a new history for that great region, raising it from the status of a "fur country" to that of an independent colony, and subsequently to that of a province of Canada, there remained a gap to be bridged in order that the province should begin to realize its proper place among the mining regions of the world. It was necessary that railways should be constructed to convey machinery and carry ores, as well as to bring to the metalliferous districts men who would not face the hardships of pioneer travel in the mountains, but who are in a position to embark the necessary capital in promising enterprises.

For a portion of the province, the construction of the Canadian Pacific Railway has afforded these facilities, but by far the larger part still awaits railway communication. Had the Canadian Pacific Railway, in accordance with some of the surveys made for it, traversed, for instance, the Cariboo district, there can be no doubt that we should have already been able to note great developments there. This railway has, however, been constructed across the southern portion of the province, and in its vicinity, and concurrently with its progress, new mining interests have begun to grow up, of which something must now be said.

Before turning to these, however, I must ask to be allowed to say a few words respecting the development of the coal mines of British Columbia, which was meanwhile in progress.

The discovery of coal upon the coast, at an early date in the brief history of British Columbia, has already been alluded to. Following this discovery, the Hudson's Bay Company brought out a few coal miners from Scotland, and proceeded to test and open up some of the deposits. Thus, as early as 1853, about 2,000 tons of coal were actually raised at Nanaimo. San Francisco already began to afford a market for this coal, and the amount produced increased from year to year. The principal coal-mining district remained, and still remains, at Nanaimo, on Vancouver Island. At the close of the year 1888, about four and a half million tons in all had been produced, and the output has grown annually, till in 1891 over a million tons were raised in one year. California is still the principal place of sale for the coal, which, by reason of its superior quality, practically controls this market, and is held in greater estimation than any other fuel produced on the Pacific slope of North America. The local consumption in the province itself grows annually, and smaller quantities are also exported to the Hawaiian Islands, and to China, Japan, and other places. In the various ports of the Pacific Ocean, the coal from British Columbia comes into competition with coal from Puget Sound, in the State of Washington, which, because of the high protective duty established by the United States, is enabled to achieve a large sale in California notwithstanding its inferior quality. It also has to compete with shipments from Great Britain, brought out practically as ballast, with the coals of Newcastle in New South Wales, with coal from Japan, and in regard to the Pacific ports of the Russian Empire, with coal raised by convict labor at Duai, on Saghalien Island, in the Okotsk Sea.

It is sufficient guarantee for the quality of the coal of British Columbia that it is able to hold its own as against all these competitors.

Though Nanaimo has been from the first the chief point of production of coal, work has been extended within the last few years to the Comox district, also situated on Vancouver Island; while other promising coal-bearing tracts have been in part explored and examined on this island, and on the Queen Charlotte Islands.

These particular coal regions, bordering upon the Pacific Ocean, have naturally been the first to be employed, but they by no means exhaust the resources of the province in respect to coal. Deposits of good bituminous coal are known also in the inland region, and some of these in the vicinity of the line of railway are now being opened up, while others, still far from any practicable means of transport or convenient market, have been discovered, and lie in reserve. One of the most remarkable of these undeveloped fields is that of the Crow's Nest Pass, in the Rocky Mountains, where a large number of superposed beds of exceptional thickness and quality have been defined.

Besides the bituminous coals, there are also in the interior of the province widely extended deposits of lignite coals, of later geological age, which, though inferior as fuels, possess considerable value for local use.

In the Queen Charlotte Islands anthracite coal is found, but has not yet been successfully worked; and in the Rocky Mountains, on the line of the Canadian Pacific

Railway coal of the same kind again occurs, near Banff and Canmore stations. The places last named lie just beyond the eastern border of British Columbia in the adjacent district of Alberta, but require mention in connection with the mineral resources of the province.

The coals of British Columbia may, in fact, be said to represent, in regard to quality and composition, every stage from hard and smokeless fuels, such as anthracite, to lignites and brown coals like those of Saxony and Bohemia. Many features of interest to the geologist might be mentioned in relation to these coal deposits did time permit, but it must not be forgotten to note one principal fact of this kind—the very recent geological age to which all the coals belong. None of the coals of British Columbia are so old as those worked in Great Britain; they are, in fact, all contained in cretaceous and tertiary rock.

The general distribution of coals of various kinds in different parts of the province is of peculiar importance when considered in connection with the building of railways and the mining and smelting of the metalliferous ores. It insures the most favorable conditions for the development of these ores, to some further examination of which we must now return.

It is especially worthy of note, that wherever in the United States, the Rocky Mountain or Cordilleran region has been traversed by railways, mining, and particularly that of the precious metals, has immediately followed. It appears to require only facilities of transport and travel to initiate important mining enterprises in any part of this region. The building of the Canadian Pacific Railway across the southern part of British Columbia, with the construction of other railway lines in the neighboring States, near the frontier of the province, have already begun to bring about the same result in this new region; which, till these railways were completed, had remained almost inaccessible. It had long before been resorted to by a few placer miners in search of alluvial gold, and their efforts were attended with some success. Silver-bearing lead ores were also found to occur there, but under the circumstances existing at the time these actually possessed *no economic* value. It was impossible to utilize them.

In 1886, some prospectors, still in search of placer gold only, happened to camp in a high mountainous region which has since become familiarly known as Toad Mountain, and one of them, in seeking for lost horses, stumbled on an outcrop of ore, of which he brought back a specimen. This specimen was afterwards submitted to assay, and the results were such that the *prospectors returned* and staked out claims on their discovery. The ore, in fact, proved to contain something like $300 to the ton in silver, with a large percentage of copper and a little gold.

In this manner what is now known as the "Silver King" mine was discovered, and, as a consequence of its discovery the entire Kootanie district, in which it is *situated, began to be overrun with prospectors*. Hundreds of these men, with experience gained in the neighboring states of Montana and Idaho, as well as others from different parts of the world, turned their attention to Kootanie. The result has been that within about five years a very great number of metalliferous deposits, chiefly silver ores, have been discovered, and claims taken out upon them. Severa growing mining centres and little towns have been established; *roads, trails*, and bridges have been made, steamers have been placed on the Kootanie Lake and on the Upper Columbia River, and a short line of railway has been built between the lake and river to connect their navigable waters. The immediate centre of interest in regard to mining development in British Columbia has, in fact, for the time being, been *almost entirely changed* from the principal old placer mining districts to the new discoveries of silver-bearing veins.

So far as they have yet been examined or opened up, the metalliferous deposits of the Kootanie district give every evidence of exceptional value. They consist chiefly of argentiferous galena, holding silver to the value of from $40 or $50 to several hundred dollars to the ton. Nelson, Hot Springs, Kaslo, Slocan, Illecillewaet and Golden are at present the principal recognized centres in the new district, but it would be rash as yet to attempt to indicate its ultimate limits.

Though much has already been done in this Kootanie district, two principal causes have tended to prevent the more rapid growth of substantial mining up to the present time. *The first* of these is the difficulty still existing in respect to the local transport of large quantities of ores; the second, the exaggerated values placed by discoverers upon their claims. While it is evidently just that the prospector should receive an ample remuneration for his find, it is to be noted that the laws of British Columbia are so liberal that he (whatever his nationality) may, at a cost scarcely more than nominal, hold and establish his claim, even though he may be practically without means of developing it. Such development in all cases requires the expenditure of considerable sums, and this must always be of a more or less speculative character, while, even if thus fully proved, it becomes further necessary to incur an additional large expenditure in plant and machinery before any property reaches the status of a going concern. Scarcely an instance can be quoted anywhere of a mine which has paid its own way from the "grass down, but almost every prospector is fully convinced that his claim is precisely of this kind.

Such circumstances, which have unfortunately for the last few years retarded the development of the Kootanie country, are now happily passing away; and there can be no reasonable doubt that in the next year or two this country will establish its place as one of the most important, not only in British Columbia but in North America as a whole.

So far as England is concerned, the actual investment of capital in this district has been small. The investor *here would rather pay half a million for some property* which, as demonstrated in a prospectus, will produce a good annual rate of interest, than embark a comparatively small sum in a promising venture. But to a man with some knowledge of mines and mining and the command of even a limited amount of capital, who will visit and live in the district himself for a time, the opportunities for profitable investment are, I believe to-day, excellent.

I have been unable to say anything in detail in regard to the actual modes of occurrence of the ores now being brought to light in the Kootanie district and their geological relations. Neither is it practicable, on the present occasion, to pursue in further detail the history or description of other districts of the province in which more or less good work of a preliminary kind has been done in the development of metalliferous deposits of various kinds. Okanagan, Rock Creek, Nicola, Similkameen, the North Thompson and Cayoosh Creek can only be named. It has been possible merely to endeavor to indicate in broad lines what has already been done and what must soon follow. Within a few years this province of Canada will undoubtedly hold an important place in the list of quotations of mining stocks in London and elsewhere, and then the further development of its mines will become a subject of common interest from day to day.

In conclusion, I wish to draw attention to one or two ruling features of the actual situation which are too important to be left without mention:—

The Cordilleran belt, or Rocky Mountain region of North America, forming the wide western rim of the continent, has, whenever it has been *adequately examined, proved* to be rich in the precious metals as well as in other ores. This has been the case in Mexico and in the western States of the American union. Though some parts of this ore-bearing region are undoubtedly richer than others, generally speaking it is throughout a metalliferous country. The mining of placer or alluvial gold deposits has in most cases occurred in advance of railway construction; but this industry has always proved to be more or less transitory in its character, and has almost invariably been an indication of future and more permanent developments of a different kind. Placer gold-mining has, in fact, often been continued for years and then abandoned, long before the gold and silver-bearing veins in the same tract of country have been discovered and opened up. This latter *and more permanent phase of mining has followed* the construction of railways and roads, and the series of conditions thus outlined are repeating themselves in British Columbia to-day.

There is no reason whatever to believe that the particular portions of British Columbia now for the first time opened to mining by means of the Canadian Pacific Railway, are richer in ores than other parts of the province. On the contrary, what has already been said of the Cariboo district affords *prima facie* evidence of an opposite character. The province of British Columbia alone, from south-east to north-west, includes a length of over 800 miles of the Cordilleran region; and, adding to this the further extension of the same region comprised within the boundaries of the Dominion of Canada as a whole, its *entire length in Canada* is between 1,200 and 1,300 miles. This is almost identical with the whole length of the same region contained within the United States, from the southern boundary with Mexico to the northern with Canada.

Circumstances have favored the development of the mines of the Western States of the Union, but it is, as *nearly as may be, certain, that the northern half of the* similar region will eventually prove equal in richness to the southern, and that when the mines of these Western States may have passed their zenith of productiveness, those of the north will be still increasing in this respect. The explorations of the Geological Survey of Canada have already resulted in placing on record the occurrence of rich ores of gold and silver in various places scattered *along the entire length of the Cordilleran region* in Canada, and though so far we have to chronicle only an awakening of interest in the southern part of British Columbia, these discoveries stand as indications and incentives to further enterprise to the north.

While the remote and impracticable character of much of this northern country places certain obstacles in the way *of its development, on the other hand the* local abundance of timber and water power in it afford facilities unknown in the south, which will be of importance whenever mining operations have actually been set on foot.

No attempt has been made in this brief sketch of the mineral wealth of British Columbia to enumerate the various ores and minerals which have so far been found within the limits of the province in any systematic manner. Nothing has been said of the large deposits of iron, from some of which a certain amount of ore has already been produced, and which wait to realize their true importance, merely the circumstances which would render their working on a large scale remunerative. Copper ores have also been discovered in many places. Mercury, in the form of cinnibar, promises to be of value in the near future, and *iron pyrites, plumbago, mica*, asbestos, and other useful minerals are also known to occur. In late years platinum has been obtained in alluvial mines in British Columbia in such considerable quantity as to exceed the product of this metal from any other part of North America.

While, therefore, the more important products of this western mountain region of Canada are, and seem likely to be, gold, silver and coal; its known minerals are already so varied, that, as it becomes more fully explored, it seems probable that few minerals or ores of value will be found to be altogeter wanting.

Respecting the immediate future of mining, which is the point to which attention is particularly called at the present time, it may be stated that coal mining rests already on a substantial basis of continued and increasing prosperity; while the work now actually in progress, particularly in the southern part of the province, appears to indicate that, following the large output of placer gold, and exceeding this in amount and in permanence, will be the development of silver mines, with lead and copper as accessory products. The *development of these mining* industries will undoubtedly be followed by that of auriferous quartz reefs, in various parts of the province, while all these mining enterprises must react upon and stimulate agriculture and trade in their various branches.

Because a mountainous country, and till of late a very remote one, the development of the resources of British Columbia has heretofore been slow, but the preliminary difficulties having been overcome, it is now, there is every reason to believe, on the verge of an era of prosperity and expansion of which it is yet difficult to foresee the amount or the end.

Discussion.

THE CHAIRMAN—I will first call upon Sir Joseph W. Trutch, a former Governor of British Columbia, than whom I know no greater authority on that province of Canada.

SIR JOSEPH W. TRUTCH, K.C.M.G.—I have listened, in common, I am sure, with all present, with the greatest pleasure to Dr. Dawson's address. The subject is of great general interest to all—but of special *importance to those who, like myself, are* connected with British Columbia by bonds of sentiment and material interest. Like everything else of a similar character that has emanated from Dr. Dawson, that address bears the stamp of careful consideration and of the great practical ability of its author. British Columbians well understand and very gratefully acknowledge the obligations they are already under to him for many similar reports of his explorations and opinions in reference to their country, and I am sure I express their sentiments in anticipation in thanking him as I do for his further very valuable paper to-night. In it he has shown how we might confidently have anticipated from the geological point of view that British Columbia would be found a rich mineral country; and he has told us, from the results of his own *explorations and experiences, to what extent those antici*pations have been realized by him, and has given us a carefully drawn opinion as to the ultimate value of that mineral district. I do not think that any remarks of mine, detailing the observations and experiences and conclusions of a cursory character of inexpert like myself, would be useful or acceptable after this able and exhaustive address; I will only say that certainly all my experience in that country, extending now over thirty-five years, and the experience of all those more immediately engaged in mining pursuits, fully confirm all that he has told you of the particular features of that country; and, further, that the opinions and expectations entertained in that country with reference to the future development of that mineral district are of the most hopeful—I might, *perhaps, almost say, in some cases, of a sanguine char*acter. They have been so indeed for years past, and since I have been away from the province now some twelve months, I continue to receive from my correspondents there reports of discoveries and developments in that country, particularly in the Kootanie district, which fully maintain and strengthen all previous anticipations. I should like to say also, in confirmation of Dr. Dawson's address upon the more general topics of the country, that the conditions under which its mineral wealth, whatever it may be found to be, are to be developed, are surely of a most favorable character favorable from considerations of climatic conditions, of conditions of location, and of conditions of a more general character. As regards climatic conditions, you will allow me to say, in a word or two only, *as this is one of the subjects on which* British Columbians are apt to "enthuse" a great deal, that whether in the more equable temperature prevailing along the sea coast and in the valleys leading up into the mountains, or in the interior districts, with greater cold in winter and greater heat in summer, everywhere free from those malarial influences so common in most new countries, you have a climate under which, more truly, I believe, than of any part of the world, it may be said that labor itself is pleasure. Then as regards conditions of location, the times are past, not so long ago, however, when British Columbia was isolated by intervening tracts of mountain and uninhabited prairie, which cut her off from Canada, and rendered the sea the only means, practically speaking, of approach to that country; when, as Dr. Dawson has told us, access *into the interior* districts could only be had at the price of great endurance and at the peril of life. In those days, so difficult were the means of transport into the interior and the mining districts, such as Cariboo, that it was commonly said that a pound of salt was worth as much there as a pound of tea, or of any other commodity the intrinsic value of which was *infinitely greater*. Those days have happily passed away. Since the construction of that great transcontinental railway—thanks to the enterprise and courage of the gentlemen who form the Canadian Pacific Railway Company, thanks to their enterprise in initaiting and constructing that line under the auspices of the patriotic Government of Canada, and under your immediate able direction, Mr. Chairman, we now have railway communication through our country, and from our country through Canada to the Atlan

Ocean: a railway second to none on the continent, nor indeed, under all the circumstances, to any railway in any part of the world. That railway has already afforded the means of introducing machinery into some of our mining districts. The same enterprise—the enterprise of the same company and of other kindred railway corporations—has extended, or is extending, branch railways into the Kootanie country; and, as Dr. Dawson has said, nowadays you have no longer the same great difficulties to contend with. Machinery can now be introduced, and food obtained, at reasonable prices. And then, as to conditions of a more general character, bear in mind that nowhere else is British law more effectively maintained and administered, and consequently life more secure, and the rights of property more fully assured, and in particular, that the Mining Laws and Regulations, based on years of experience, have been framed with the special aim to encourage and promote the development of the minerals in the country, and to protect mining rights and property. I only desire, in conclusion, to express the hope and wish that, however many may be induced to embark their capital, and time, and energy in British Columbia in the pursuit of fortune from its mineral wealth or its many other resources, I trust they may all realize this result, at least: a result which, happily for me, I stand here prepared to profess and maintain, that British Columbia, if not the richest, is, at all events, the happiest country in the world.

MR. H. C. BEETON (Agent-General for British Columbia). In the first place, I beg to congratulate the Fellows of the Royal Colonial Institute on securing the valuable services of Dr. Dawson on this occasion, notwithstanding the very important duties which brought him to this country, in connection with the Foreign Office; and on behalf of the province, I wish to express my hearty thanks for his very able and interesting paper. It is quite certain we could not have had a higher authority on this subject. He knows the province most intimately, having travelled over the greater part of it, and from his knowledge as an expert he has given to the world in his works an exhaustive geological account of it. He has traversed familiar ground this evening, and he has reassured my mind—if indeed I ever had a doubt, about the brilliant future of the province. Dr. Dawson pointed out that, having passed through the placer period of mining, we have entered the deep-sinking and the quartz-mining period, which will naturally require a great deal of capital, machinery, and, of course, skill. The difficulty is to attract foreign capital to distant enterprises of a speculative character, which mining must always be. Consequently, the Americans have an advantage over the English, being nearer the spot, and they have also the advantage of experience in their own country, and, as we see, they are now working their way north and developing this rich Kootanie district. At the same time we are indebted to the Canadian Pacific Railway for the present development very much. British Columbia has been kept back mainly owing to the want of such communication, but I have no hesitation in saying that we are now on the eve, in this Kootanie district of the South-East province, of very important and most valuable mineral developments; and though one speaks with 'bated breath about paying mines after what I have listened to this evening, I have no hesitation in saying that this summer will demonstrate to the world that the Kootanie district will not only prove valuable but be a good paying district. Dr. Dawson has referred to the Cordilleran belt, which, as geologists know, exists not only in British Columbia and Montana and California, but further south; and so confident are our American cousins of the mineral wealth of this formation, of which we have over a thousand miles in our province, that I have myself seen a project on paper, which I should not be astonished to see one day carried out, for a railway running north and developing this rich mineral belt. The railway will extend to Alaska, and then, crossing the Behring Straits, will connect with the railway which I believe is about to be commenced in Russia, connecting finally with the European system; so that it is on the cards that our posterity will be able to go overland from British Columbia to the city of London. This will give you some idea of the opinion of our American cousins as regards this belt. Although I should be the very last to depreciate the importance of mineral wealth, there is no doubt it plays a very important part in the development of our Colonies, as witness Australia and the Cape; but experience tells us that for permanent sources of wealth we must look further than minerals. So British Columbia must look to the permanent sources of wealth she possesses in her fisheries, forests, and coal mines; and I think that in the near future we shall, like our neighbors to the south, have another industry—a most important one—the fruit industry. For years, California has sent to our markets enormous quantities of preserved fruits. There is no reason in the world why British Columbia should not add fruit to her export list; we are on the eve of that business, and I hope to have the good fortune of exhibiting what we can do in that respect in our court at the Imperial Institute. I beg to thank Dr. Dawson for the valuable assistance he has rendered me at the Imperial Institute in the arrangement of the mineral cases, and I hope, and am sure, that I shall in the future have his continued assistance in carrying out what we have so much at heart—viz., that the public may know what we are doing and have done in regard to minerals, and that those mineral cases will contain a permanent representation of our mineral resources.

DR. JOHN RAE, F.R.S.—I have gone over part of the country in British Columbia described by Dr. Dawson, namely, the Cariboo district, when the gold mining was in full swing; my object in going there was not to look after gold, but to search out the safest and easiest route by which to take a telegraph line across the continent, which the Hudson's Bay Company were desirous of carrying out—as there was a very promising-looking valley leading from Cariboo to the head waters of the Fraser River. My hopes in that direction were disappointed, nor could I examine the place closely, the ground at the time being covered with snow. It was altogether a rather rough journey, as we had to run down the dangerous Fraser River in very small "dug-outs," a thing never previously done by strangers, I was told, without guides, the Shushwapp Indians being unable to accompany us. I did a little gold-washing in the streams we passed by both east and west of the Rocky Mountains, and found color of gold more or less developed almost everywhere. At one small stream east of the Rocky Mountains I stumbled upon what appeared to be a fine outcrop of coal at least eleven feet thick, which was found to burn well, and boiled our kettle very nicely, but a sample I brought home and took to Jermyn Street Geological Museum was pronounced by Sir Andrew Ramsay to be only lignite. I have no doubt I showed my ignorance in expressing an opinion that *possibly*, as this outcrop had been exposed for hundreds of years to the changes of the weather, perhaps when mined deeper it would be different. It looked so very pretty and clean to handle. If I may wander away a little northward and eastward from British Columbia, I would say a word or two about the abundant indications of copper at and near the Coppermine River on the Arctic Coast, where we picked up some lumps of six or eight pounds' weight that appeared perfectly pure; in fact so pure that all the weapons and tools of the Eskimos are manufactured of this metal. The Indians, also, when they run short of lead, hammer lumps of copper into a substitute for balls for their guns. From my description of the rock formation, Dr. Dawson is of opinion that it is similar to or part of the copper-bearing rock stratum of Lake Superior. My object in getting on my legs was most surely not to say anything about myself, but on a more agreeable subject: to say a word about my friend, the reader of to-night's paper; whom I knew and saw a good deal of at home, when as a lad he was a student of geology in London, and how we were delighted with his intelligence and capacity—an opinion fully confirmed by a very high authority, Sir Andrew Ramsay, at that time at the head of the Geological Survey of Great Britain, who said he never had a student who showed more application and quickness in acquiring knowledge of his subject than Dr. Dawson—and thus the boy was father to the man. Dr. Dawson has done me the favor to send me from time to time many of the interesting papers he has published, not always geological, and I can testify to the immense amount of work they display, sometimes performed in very difficult and trying circumstances. They are full of important facts, and one can rely upon every word in them. He has shown what he can do, and I venture to express a belief that there is a great future before him.

MR. W. S. SEBRIGHT GREEN—As an old British Columbian, I have listened with great pleasure to Dr. Dawson's able address. The only fault I have to find is with the map on the wall, which makes the country look so rocky, lifeless, and inhospitable. Now, it is a glorious country. For climate and a happy life there is no country equal to it. The future of British Columbia no doubt is a great future. Its gold and other mineral resources must be developed. I have washed a pan or two out there in the days Dr. Dawson speaks about—the golden year 1863. It was a hard country, the Cariboo country, in those days, for there was no railway and travelling was very rough work. I walked through the snow from Lightning Creek to Williams Creek, and when I got to my journey's end I had to lie on the bare boards and was glad to get a sheepskin to cover me. But the Canadian Pacific Railway has changed all that. British Columbia is not so far off as it was. It can be reached now from London in little over a fortnight. In the sixties it took you about six weeks. Irrespective of gold, there is a future before British Columbia, for, notwithstanding that there are so many mountains, there is a great deal of really good land. I have ridden over miles of rolling prairie among those mountains, and beyond that there is no doubt a vast quantity of mineral wealth yet undiscovered. Speaking of the Kootanie district, I myself, in 1864 or 1865, had several specimens of the richest silver ore I ever saw in my life. The prospector who gave them to me told me he would divulge the secret of its whereabouts to me some day, but he wanted to see a little more it; and the secret, I believe, died with him. As to the gold, I have been told of a prospector who goes regularly every year to Victoria with gold dug by himself. He has kept the secret, but it is to be hoped it won't die with him. I should have been glad if Dr. Dawson had told us what he thought of the gold of Vancouver Island itself. There was a quantity of gold taken out of Leach River in 1865, but mining was not continued there beyond a few months, although there must be still gold there. I may say, in conclusion, that those who have any idea of investing money in gold or coal mines, in my opinion could not do better than go to British Columbia.

MAJOR WILLIAM CLARK—I have not had Dr. Dawson's experience of British Columbia, neither have I his scientific knowledge; I have not lived so long in that province as my friend Sir Joseph Trutch, and have not at any time held the position of Agent-General which Mr. Beeton so worthily occupies; but I do not yield to any of these gentlemen in the faith I have in the future of British Columbia. I have to thank Dr. Dawson for the paper which he has just read: it strengthens my faith in what I myself believe, and one is always ready to take hold of evidence in support of his own conclusions. We must remember that Dr. Dawson occupies an official position, and must, therefore, be extremely guarded in his statements. Were he free to "boom" British Columbia he would, no doubt, have let his tongue loose, and have said things which would have been more suitable for the promotion of mining companies; but it is right, and all the more valuable, that so high an authority should keep well within the mark. We have read somewhere that the Queen of Sheba, when she came to see the glory of Solomon, exclaimed that "the half had not been told" her; and I dare say, if any of this audience not personally acquainted with British Columbia were to go out and examine into matters as carefully as Dr. Dawson has done, the Queen of Sheba's certificate would be most applicable. We have been recently informed that Her Majesty belonged to a highly mineralized country, and it may have been that the Assistant Director of the Geological Survey of her dominions was her cautious informant. Joking apart, I feel sure that this contribution to our knowledge of British Columbia comes at an opportune time. We have lately heard a great deal about South Africa and of the sums invested in the development of that portion of the Empire, but firmly believe that it will well repay those who are pinning their faith on South Africa to follow up the lead which Dr. Dawson has given us to-night. I have nothing to say against South Africa, but investors will be quite safe to go on the information Dr. Dawson supplies; and considering the nearness of British Columbia, I would strongly recommend it as another basket into which part of the investors' eggs could with safety be deposited. Dr. Dawson has only had time to-night to indicate what possibilities lie in that province, and to touch on some of its leading features as a mineral country. He has passed over the question of placer mining with a few remarks regarding the early days of the placers, but it would be a mistake to infer that he considers these as by any means exhausted. I think Sir Matthew Begbie is authority for the statement regarding the "flour" or "scale" gold, that there is not a spadeful of soil on the benches of the Fraser and Thompson Rivers that isn't auriferous; and I believe that when proper appliances are brought to bear upon these benches and on the channels of the upper country, the results will outweigh those realized by the crude methods of the past. Working with shovel and cradle for the most part, and with no capital but the result of their daily toil, the miners had to be content with the products of the upper gravels. In many cases, where they were able to break through and reach the older deposits, as in Lightning Creek, the miners were "drowned out" when the pay was at its best. These claims remain to this day, and there are hundreds of miles of gravels within the province capable of returning large dividends on capital judiciously applied to working by more modern and scientific methods. It must be gratifying to everyone present—remembering that British Columbia is an integral part of the British Empire—to be made aware of Dr. Dawson's estimate of the country from the forty-ninth parallel to the Alaskan frontier. His words are in the highest degree encouraging, and indicate that when mining results have passed their zenith, in that equal stretch on the American side of the boundary line, British Columbia will be mounting upwards to greater prosperity, enriching the province and the Empire. The province, as has been remarked, is Imperial in its dimensions. It is about one-third larger than the German Empire. It stands on four pillars as regards its future, for besides its wealth of minerals, it has its forests, its fisheries, and its agriculture to support its population. This province, with its enormous extent and its equally enormous resources, contains only about 100,000 people, and the value of its resources can best be realized from the fact that this handful of people—less than half the population of an ordinary English town—were able to export last year surplus products to the value of over six and a-half millions of dollars. Results so remarkable surely serve to indicate that there is room for the application of capital, and especially of British capital, for the development of these varied resources. Ever alive to what will pay, our American friends are steadily gaining a foothold. They cannot be blamed, but we will be liable to blame if we do not step in and do the work which it is peculiarly England's duty and England's privilege to accomplish; and for my own part I would rejoice to see some really practical outcome in that direction as the result of to-night's meeting. There are unique opportunities for the investment of capital in the mines and forests, and in the industries to which their products lead. These will eventually give employment to a large population, which will be the best guarantee for a home market for those engaged in agricultural pursuits. The wants of the present population are inadequately supplied, and each year large quantities of every kind of farm, orchard, and garden product have to be imported. It will readily be understood that the prospect of a permanent home market will attract agriculturists, as against other districts which have to rely on export prices for their returns. The range of land suitable for the farmer of small means is limited, but large areas exist which would form the basis for profitable returns on capital employed in converting these into manageable holdings, to the benefit alike of the capitalist and the country. I will not venture to say anything of the fishery wealth of British Columbia, or the bearing which this resource has on the future importance of the province. I am afraid I would get too enthusiastic, but it is without doubt that these fisheries will constitute one of its most permanent sources of revenue. In the departments of fishing and agriculture there are opportunities for colonization which, if prudently carried out, will be productive of the happiest results; and I am sure that patriotism, philanthropy, and cold capital, with an eye to dividends, can safely join hands in furthering these truly Imperial interests. It has been my good fortune, under the guidance of our Chairman, the High Commissioner for Canada, to follow closely in recent years matters relating to the colonization and development of the Dominion, and in working out these interesting and important problems, and I am proud to recall the fact that it has been my privilege to serve under such a master.

DR. RANKINE DAWSON—I fear that I am not qualified to add anything of value to what has been already so well said, as regards the mineral wealth of British Columbia. As, however, the discussion has not been confined to this point, I may perhaps be allowed to say something of another characteristics of this great province for which, I venture to think, it will in future be as famous as it will undoubtedly be for its mineral wealth—I refer to its scenery. We have been told, as regards its mineral wealth, that much of it is at present inaccessible. The same is true of its scenery. Two sections of the country are, however, easily reached at the present time by the ordinary traveller, and of those only I shall speak. One is the line of the Canadian Pacific Railroad, which crosses at right angles three distinct mountain ranges on its way to the coast; the other is the coast itself, which extends over 500 miles from the international boundary on the south of Alaska. The mountain scenery is as fine as any to be found on the continent of America, and, so far as I know, is excelled only in grandeur and impressiveness by that of the Himalayas as seen from the neighborhood of Darjeeling. The Canadian Pacific with the foresight and enterprise for which that company is justly famous, has provided hotels at different points of exceptional beauty or interest, where artists, tourists, or sportsmen can obtain comfortable accommodation. Such are to be found at Banff and at Field in the Rocky Mountains, at Glacier, at the summit of the Selkirks, and at North Bend in the Coast Range. The scenery along the coast is of a different kind; there, long fjords and inlets cut up the coast line in the most fantastic way, whilst innumerable islands extend along its length, and form in many places natural channels, through which the traveller can pass for many miles without catching any glimpse of the open sea, whilst on either hand pine-covered mountains rise, almost precipitously, to a great height. In two other parts of the world only, so far as I know will similar scenery be found—viz. in Norway, and on the Western Coast of New Zealand. This voyage along the coast is already becoming a very popular one with tourists, and comfortable steamers ply at regular intervals throughout the summer season. Few things, perhaps, are more difficult to describe adequately than mountain scenery. It is not difficult to heap up adjectives, or to gradually advance from positive to comparative and superlative; but it is difficult indeed to convey real or definite conceptions to the mind of the listener. I shall make no such attempt to-night. This whole region well deserves the name which, in writing to the *Times* some two years ago, I ventured to give it: that of the Canadian Alps. In conclusion, I can confidently advise anyone who appreciates nature in its grandest and most impressive moods to take the earliest opportunity of visiting this great province for himself, and can promise him that he will not come away disappointed.

MR. JOSEPH NELSON—I made my first visit to British Columbia in the autumn of 1856. I worked the cradle on the Fraser River for the purpose of discovering gold, and I made the acquaintance of Sir James Douglas and Captain Cooper. The evidence I obtained I laid before Lord Taunton, then Secretary of State for the Colonies; a committee of the House of Commons having at that time been formed for the purpose of inquiring into the possibility and feasibility of colonizing the great North-West and British Columbia and Vancouver. I never formed a more favorable opinion of any country than I did of Vancouver and British Columbia during my short visit, and when I came back I wrote a handbook on the subject. At that time the discovery of gold was only beginning, and the result of the information which I had personally collected or received from various correspondents, and which I published, was that there was a considerable emigration to these parts. But the time came when the alluvial deposits were exhausted, and then they had to resort to more expensive methods. Gold was discovered up in Cariboo, but it was far removed from any means of communication, and the consequence was, the miners suffered great hardships. But that there was enormous mineral wealth there cannot be denied. I am speaking on the authority of one of the most successful miners of the present day—Mr. Mylchrest, who afterwards went to California and Australia, and then to South Africa, and who is now known as the great Diamond King. He was one of the pioneers, and had to undergo all these privations in consequence of the difficulties of getting provisions and the like. I was talking to him a few days ago on his visit to London—he is now one of the principal land owners in the Isle of Man—and he said: "I shall never forget the days I spent there; they were days of great privation; but there is a great future for that country when communication by rail is really opened up, and I have no doubt it will become one of the great gold producing countries of the north-west coast of America." On my return after my visit in 1856 I wrote a handbook, as I have already stated, and I said, "What is this distant country? The first thing to be done is to have steam communication with San Francisco," and I got up a company and spent a considerable sum of money, but did not succeed. The next thing I said was, "We will start a bank," and I obtained a Royal Charter. That is the Bank of British Columbia. I also proposed the construction of a railway, and that now forms part of the Canadian Pacific. Being a modest man, I will say no more on these matters, but this I must say—that I have read Dr. Dawson's contributions to geological knowledge with infinite pleasure. I may add that the present Lieutenant-Governor of British Columbia is practically experienced in mining matters, and when I heard of his appointment I felt that the right man had been put in the right place. Under him, I believe there is a great future before British Columbia. At the same time, we must always remember that mining is ephemeral, while the fisheries are perennial; still, as I have said, I believe th. the mining indu try will be developed, and that in th. as in other respects the country will go on and prosper.

THE CHAIRMAN—A very agreeable duty now devolves upon me. It is to move a vote of thanks to Dr. Dawson for the very able and interesting paper he has presented to us this evening. I may mention that more than twenty years ago the Government of which I had the honor to be a memb r appointed Dr. Dawson a member of the Commission for the survey of the international boundary, and we were not disappointed in the result. On the completion of that important work, he presented the world with a most valuable volume on the scientific points which had presented themselves in connection with the flora and natural history and other important matters connected with the survey. From that time he has steadily ascended, step by step, until he has attained very nearly if not the same rank as his distinguished father, Sir William Dawson. I have no hesitation in saying that he has done most valuable work for Canada and for British Columbia, and for every person interested in that important part of Her Majesty's dominions on which the paper has treated. As a man of science he has been cautious, and has not over colored his picture; but although I am not a prophet, I venture to say that the mineral resources of British Columbia will continue to attract more and more attention until the world is astounded at the developments in that direction. I have great pleasure in moving a vote of thanks to Dr. Dawson.

The motion was cordially passed.

DR. DAWSON—I have to thank you for the attention with which my paper has been received this evening, and to express also to gentlemen who have joined in the discussion my appreciation of the terms in which they have spoken of such work as I have been able to do in British Columbia. It has been particularly gratifying to find how many friends of British Columbia are present. Had we a longer time to discuss the prospects and resources of that province, many additional points of interest upon which it has been impossible to touch would occur. My difficulty has been, in endeavoring to speak on so large and important a subject as that of the mineral wealth of British Columbia, to know where to stop, for in a general sketch such as that attempted to-night it is not possible to include details which must always be more interesting than the mere skeleton of the subject. It is now my pleasing duty to ask you to join in a vote of thanks to the Chairman. Sir Charles Tupper's work in connection with Canada is so well known, his interest in this Institute, as well as in all other matters connected with the welfare of the Empire at large, is so fully recognized, that it would be presumption on my part to say more in submiting this motion.

The chairman thanked the meeting, and the proceedings terminated.

Mining in the North-West Territory.

In his report to the Minister of the Interior for the year ending 31st October last, Mr. Wm. Pierce, Superintendent of Mines writes as follows:—

Canmore Coal Mines—Development work in these mines has been actively prosecuted since my last annual report, and the output is now, or shortly will be, in the neighborhood of 300 tons a day.

Canada North-West Coal and Lumber Syndicate, (Limited.)—Since my last report, development work has been carried on continuously, though not very extensively.

H. W. McNeill Co., Ltd., Anthracite.—During last summer work on this mine was shut down, as the demand for anthracite fell off during the summer months, and, besides, the proprietor wished to concentrate all his available strength in development work at Canmore. He opened up, however, about the first of September, and the output is now about 125 tons per day. He is putting his coal through a breaker this year and sorting it. This, owing to the friable nature of the coal, causes a large percentage of waste. He thinks he obtains a better sale and a higher price by so doing. If a cheap way could be obtained for making the dust into bricqettes, a great saving could be effected both at this point and at Canmore. Like many coals whose percentage of fixed carbon is very high, they are very friable, so that there is much loss in handling.

Alberta Railway and Coal Company's Lethbridge Colliery.—Owing to the causes referred to in my last report, the output at this point has not been nearly so great as was hoped for. However, the market for this coal south of the International Boundary has greatly improved, with a fair prospect of some further improvement in price and permanency of demand. The output is now some 800 tons per day.

Petroleum.—There was a slight excitement this year about 25 miles north of Edmonton, at Egg Lake, owing to the discovery of supposed indications of petroleum there. The substance found is of a pitchy nature, almost of the consistency of tar, and is supposed to be an indication of petroleum. It is said to resemble very much the exudations along the Athabasca and Peace Rivers, which have been thought by many who have given the subject considerable attention to indicate the existence of a large petroleum field. This discovery would seem to indicate that this petroleum field extends much farther south than has been heretofore supposed.

Natural Gas.—An attempt was made during the year to obtain natural gas at Calgary, an expenditure of $7,000 being incurred and a depth of 1,468 feet reached. The joint stock company which made this attempt was unfortunate in several ways and had to abandon operations, their drill having stuck fast and their capital being exhausted. From the experience gained, however, whoever makes the next attempt will probably be able to accomplish as much as much as has been done in this instance at about forty per cent. of the cost. It was not anticipated that gas would be obtained at a depth of less than 2,400 feet, and the company considered it would have been justified in going to a depth of at least 3,000 feet if gas were not found sooner.

Asbestos in Newfoundland.*

This peculiar and important mineral substance, which has only recently begun to attract attention in this country, has been known to exist amongst the magnesian group of rocks for a long time. It is, however, only within a year or so that the attention of capitalists from outside has been directed to Newfoundland, as likely to become a source of future supply. The province of Quebec, is at present the chief centre from whence American manufacturers of asbestos goods derive their raw material. But the comparative scarcity of the mineral, together with the increasing demand, seems to point to a possible failure of this source in the near future. It was known through the operations of Geological Survey, that extensive areas in this Island the were occupied by the magnesian group of rocks, similar in all respects to those of Canada, from whence the asbestos was obtained. This led to prospecting for the mineral with the result, that specimens showing an excellent quality of fibre, were found at several points amongst the serpentines on the west coast, chiefly in the vicinity of Port-au-Port Bay. The first attempts at actual mining, however, were only made during the past summer. A company of American capitalists having leased a mining property in the vicinity of St. George's Lake, situated between St. George's Bay and Bay of Islands, were the first to commence active operations, and it was this property which was visited during the latter part of last season. It is situated so far from the sea-board, and the difficulty and delay in getting materials wherewith to begin work on the spot caused so much delay at the outset, that little more could be accomplished last season, than a mere surface exploration over a limited area. At the time of my visit in October, all that had been accomplished consisted in an open cut of some fifty or sixty yards into the side of a low bare ridge of serpentine, and a few surface openings here and there to ascertain the strike of the serpentine belt. The open cut, however, afforded the only satisfactory exhibition of the rock and contained mineral. It consisted, at the base, of a thick mass of very loose, shaly, dark green serpentine with scaly layers and strings of very pure, amber-yellow and oil green steatite. Caught up in this shaly mass, and apparently surrounded by it a great horse or boss of hard, dark, bottle-green serpentine, presenting highly polished and fluted surfaces is seen and the whole is capped by large disconnected blocks of hard, dark-grey diorite. The mineral appeared to follow closely the outline of the harder serpentine, frequently penetrating it, but almost invariably splitting up into innumerable ribbon-like strings, which finally become mere threads. The best fibre and most persistent veins followed the outline of the harder serpentine or occupied the position between it and the overlying diorite. Where the two approached each other nearest so as to squeeze up the intervening rock appeared to be the point exhibiting the greatest amount of asbestos. One vein at such a point measured nine inches wide, consisting of several rudely parallel layers of fibre divided by thin layers of serpentine. The fibre varied in length from one half to two inches and was of fairly good quality. Specimens of beautiful fibre of about an inch long, and still others of from 2 to 3½ inches were shown me as having come from a lower part of the cut, at a place not then visible, being covered with the debris from the mine, etc. The character of the deposit, judging from what little could be seen was, as is usually the case, exceedingly irregular and confusedly jumbled up. According to the experience in Canada, where asbestos mines have now been in active operation for ten or twelve years, there is apparently nothing to act as a guide in determining the value of a deposit except actual mining. No two properties present exactly the same features, and what may be found to hold good in one locality, proved entirely at fault in others, hence the difficulty in arriving at any conclusion as regards an undeveloped property, such as that descibed above. The indications are certainly good, the quality of the fibre excellent, and should the sepentine deposit in which the mineral occurs be found to occupy any considerable area, there is a reasonable prospect that asbestos will accompany it. At present the situation of the mine and character of the surface deposits, renders prospecting a tedious and expensive operation. The absence of some more feasible means of getting material on the spot, was sorely felt by those in charge last year, every pound of food consumed and every item of mining tools, etc., had to be carried on men's backs from the seashore through the woods, a two days desperate drag. Few men could be had to perform such labor, and these only at a high rate of wages. In order to facilitate the development of this and neighboring properties, I would suggest the advisability of speedily opening up communication with the sea shore by roads or other means. The Hon. P. Cleary had men at work all the summer prospecting a property of his near Bluff Head, Port-au-Port Bay, the result of which I am informed is of a very favorable character. The serpentine here is apparently more massive and forms extensive cliffs, exhibiting several small rudely parallel veins of asbestos. The fibre ranges from one quarter to about one and a half inches in length, and some of the specimens shown me from the locality were of excellent quality. Further up the coast at Lewis Brook and about two miles inland Mr. Hayes of Bay St. George holds a claim, from which a very fine sample of silky fibre about two inches long has been exhibited, but no prospecting of any consequence has taken place here as yet.

In view of the foregoing facts and the knowledge that the mineral is chiefly derived from the magnesian group of rocks, so familiarly known in Canada as Sir Wm. Logan's Quebec Group, which have been shown to occupy extensive areas in this island, both along the coast and in the interior, it is not unlikely that the next few years will witness a great amount of activity in prospecting for this substance. Newfoundland is already regarded in Canada as likely to prove "Quebec's greatest rival ere long." Should this valuable material be found in available quantity in this country, as there is every reason to expect, its development is likely to prove one of our most important and remunerative mining industries in the near future.

* From the Report of the Newfoundland Geological Survey.

The Manufacture of Peat Fuel.

In view of the papers that have from time to time appeared in the REVIEW urging the importance of the development of our great beds of peat in Ontario and Quebec for fuel, the following extracts from a report from the British Foreign Office, embodying the results of enquiries as to the manufacture of fuel, moss litter and other products from peat in Europe will be of interest:—

Denmark.—Sir H. MacDonell, Copenhagen, states that in the province of Jutland, where the peat moors extend over an area of some 90 English square miles, or one twenty-fifth of the area of the province, efforts have been made to turn this produce to profitable account. All the different modes invented during the past forty years for the treatment of peat have been tried in Denmark, and have been given up as impracticable, unprofitable, or both. Expensive experiments have been carried out at Silkeborg and Moseland within recent years, but with no appreciable results. In fact, peat may be said to be used merely for fuel, the people cutting sufficient for their own consumption. In some of the inland towns in close proximity to larger moors there still exists a certain demand for peat, but at seaports it seems never to have been able to compete with coal, the specific heating power being too low as compared with that of coal to enable the peat to pay the expenses connected with transport to any distance. Peat for fuel is either simply cut and dried, undergoing no further treatment ("Skoretorv"), or it is kneaded together and subsequently cut into regular shapes for fuel, called "Oltetorv" In this latter shape, as in the former, it does not pay the cost of transport to any distance. To the north of the Limfjord at Lundergaard Mose, the Aalborg Mosstroelsefabrik formerly employed some fifty to seventy men in cutting peat, which was used by the railway authorities for heating their carriages. This method of heating having now given place to steam, the occupation has ceased, and a moss litter factory has taken its place.

France.—From the reports received from Her Majesty's consuls, it appears that the peat industry does not exist to any appreciable extent in the consular districts of Brest and Cherbourg; a small quantity of peat is cut for the purposes of fuel, and in that of Marseilles turf is also used for burning in the neighborhood of Lyons, but there appears to be no appreciable commerce. As regards south-western France, Mr. Consul Ward reports that there are peat bogs of more or less limited extent in all the departments forming the consular district of Bordeaux, from which peat is extracted for fuel, but the production is confined to local consumption. In the district of the Charente some 7,000 tons are cut annually, but the amount is far less than in former times. But the only use to which the peat is applied on the spot is for fuel. In Paris there are four or five firms which supply peat for fuel. Under the name of "La Béraudine," a company founded by M. Leraud for working his patents and improvements in the manufacture of articles derived from peat fibre, is established at 8, Rue Saint-Martin, Paris. The company does not manufacture at present, but is about to set up a factory for utilizing the refuse for producing peat fuel or charcoal, which, it is stated, can be produced at about 50 per cent. cheaper than the "briquettes" now in use made from coaldust, &c.

Germany.—The use of peat as fuel is universal in the neighborhood of the moors, but is generally local. It cannot compete with coal for cheapness in any districts near the seaports, or near towns which have railway communication. Peat for fuel cannot pay railway freight for more than twenty miles from the place where it is cut, and very little is ever conveyed by rail. The rate charged is about 9s. per load of 9,600 sods of peat for ten miles. There are no available statistics either in Prussia or the other peat producing states as to the amount consumed, but considering the wide distribution of peat bogs throughout the country, it is probably very great. It is estimated, for instance, that in the Grand Duchy of Oldenburg alone about 150,000 tons of peat are burnt per annum, chiefly for household purposes, but also in baking-ovens, brick-kilns, &c. The following is the method of obtaining peat for fuel followed at Carolinenhorst, which may be taken as a fair example of the system generally employed. The turf is cut by gangs of four, one man cutting from the top with a sharp-cutting spade, square ended. The second cuts from the side following the first man, and at the same time dividing the turf into lengths as he goes on. This is usually done with a round-ended spade, in the shape of a turf cutter, or whale-spade, but sometimes, though rarely, a three-sided square-ended spade is used, somewhat in the shape of a brick mould without the fourth side. The third man follows the second, and takes the sods out with a four-pronged fork, the angle of which is bent upwards to an angle of 45 degs., and lays them in rows on the moor behind the cutting. The peat is cut to a depth of 3 to 5 yards. The whole of this stratum is good with the exception of 2 or 3 in. of the upper soil, which is thrown into the cuttings already made, and yields good agricultural soil when the moor has been exhausted of peat. No machines are used on the Government moors in Pomerania for cutting fuel peat, but they have been employed on private moors where labor is scarce. The cost of production is not sensibly reduced by machine cutting. The best peat for burning is generally that which lies undermost, the upper layer, to a depth of 4 ft. 6 in., being used (where it is of suitable quality) for moss litter; all beneath that depth for burning. At Carolinenhorst the peat is always dried in the open air, all other methods having proved too expensive. An attempt was made at Gifhorn to dry the peat artificially in an apparatus invented by Herr Rottbarth, but as the system was abandoned after a very short trial, it appears not to have been a success. The peat dries best in the spring and early summer, and when once dry it is not much injured by rain, which runs off. The drying takes on an average four months, but much of course depends upon the weather. The cutting is commenced at the end of March and continues until the middle of May—six to eight weeks. The drying lasts from the middle of May to the beginning of August—ten to twelve weeks. The stacking is carried out in the following manner:—One cubic metre of turf yields 400 sods of peat, which, as they are cut, are laid in rows as before described. Then the women employed for stacking take the wet sods from the rows and stack them in pyramids 6 ft. long by 3 ft. broad and 6 ft. high, each pyramid representing 3 cubic metres of peat, or 1,200 sods. The sods in these stacks are not laid close together, but with a space between each of the first layer, which space is covered by the succeeding layer, and so on. The peat is sold in these stacks or pyramids when dry, from the beginning of August to the middle of September, according to the weather. The pyramids are called "Klafter," and are classed for sale in the following manner:—The first class is the dark peat, approaching to coal, which is usually cut from the lowest stratum, and is heaviest. It shrinks most in the process of drying, a fresh sod when cut measuring 13 in. in length by 10 high and broad. This class of peat burns slowly, and when fifteen sods are burned in a closed stove they will leave about a large wineglassful of white ash. The second class is lighter in color and weight, and is a newer formation. The third class is the top stratum, and is of least value except in those cases where it is suitable for the manufacture of moss litter These lower classes of peat leave more ash in burning. In some places these differences in the quality of peat taken from the top or the bottom of the stratum do not occur, the moss being uniform throughout.

According to the general statistics of the German Empire, fuel peat was exported from Germany as follows:—

	Tons.	
1886	121,424	(includes exports to German free ports).
1887	116,713	" " " "
1888	82,300	(including 71,116 tons to free ports, and 11,184 tons to forign countries.)
1889	12,056	to foregn countries.
1890	11,819	" "
1891	11,457	" "

The greater part of this exportation goes to Switzerland from moors situated near the frontier. During the year 1891, 13,073 tons of fuel peat were imported into Germany.

Netherlands.—Black turf is almost exclusively used in the brick-kilns along the rivers Maas, Waal, Linge, Lek and Yssel. The period for digging the black turf lasts only from the 15th March to 15th June. If black turf gets frozen before having dried, it loses its heating power, and consequently its value as a merchantable article, and then it is sold at a very low price for domestic purposes. The factory turf is conveyed in barges to the brick-kilns, and here again the same difference in the cost of transport is observable in respect of the northern and southern moors, as was remarked in the case of moss litter. For instance, the freight from the north to the kilns on the Waal below Nymegen is double that from the southern provinces, but, at the same time, the competition is less keen than in the peat-moss trade, for many kilns, such as those on the Rhine and Yssel, are much nearer Groningen, Drenthe and Overyssel than North Brabant and Limburg. It is on this account that the producers of black turf in the northern and southern provinces have each their own outlets, and hence do not interfere with each other. The importance of the trade in this article may be gathered from the fact, that in the Netherlands about 7,000,000 tons (280,000 tons weight) are annually consumed in the manufacture of bricks, of a value of £133,000, of which £100,000 represent labourage and freight. The value of 1 hectare (upwards of 2 acres), good and favourably situated black peat, may safely be taken at £170.

Holland.—As regards turf for fuel, this article is produced by various means, and in very great variety of quality. The simplest form of this product is the natural turf, which has undergone no preparation, but has been cut with a spade or knife directly out of the peat, after the removal of the top layer of the so-called grey turf, in the form of a brick, dried in the air, and sold in blocks of various sizes, say, from 12 to 20 in. long, from 2 to 3 in. thick, and from 4 to 6 in. broad. This article has, in consequence of the original formation of the peat in layers, which shows itself at once when the turf is dried, all the inconvenience and undesirability of a spongy fuel, so that this natural cut turf is by no means a practical manner of preparing the peat, and is not popular as a fuel. Turf is also converted into charcoal in the same manner as wood, both in heaps and in specially constructed ovens. Turf charcoal is nearly equal to wood charcoal in heating effect, but is not so useful as the latter, as, on account of its porous nature, and proportionately large residuum of ash, the fire is less intense.

Russia.—Peat fit for fuel is found in Russia in forty-five of its provinces, on an area which, it is calculated, extends over 100,000 square versts (67,000 square miles), and is capable of yielding 875 milliards of poods (14 milliards of tons). No exact information as to the extent of the quantity of peat cut in Russia is in existence. It can only generally be said that it is found in the provinces of Moscow, Vladimir, Nijni-Novgorod, Tamboff, Orel, Kharkoff, Kieff, Esthonia, and St. Petersburg, where it is prepared as fuel for manufactories, sugar works, and other industrial establishments, as also for locomotives. Among the peat bogs which belong to the Crown, those lying in the provinces of St. Petersburg, Moscow, Orel, Riazan, Vladimir, Tamboff, and along the Kursk-Kieff line have been surveyed. The result of this survey proves that the peat bogs of the Crown in the above localities contain no less than 100 millions of cubic feet of peat of excellent quality. Some of these peat bogs are leased under the Crown by private individuals.

Sweden and Norway.—In the west, south, and south-east parts of this district, peat, as fuel for domestic purposes, has been extensively in use for the last century, and even earlier, as by degrees the forests have diminished, or become of too great value for like purposes. It is a bulky kind of fuel, but an excellent substitute where wood is scare or unobtainable. For industrial purposes peat is not yet used on any extensive scale; some glass-works, however, having large tracts of peat in their immediate neighborhood, have found it to their advantage to work the peat, and usually employ machinery of German construction for raising and shaping the material into a form of less bulk. Mixed with small coal, it makes an excellent fuel. Also some ironworks use peat, but not largely; it is, of course, unmixed, and only used for certain purposes, owing to its purity. A scheme of condensing peat into the shape of a coal is being tried, but as yet the undertaking is not sufficiently developed to judge whether it will prove a success or not. The peat bogs of Sweden cover an immense surface, amounting to many millions of acres, nor are they confined to any one part of the Kingdom, though the largest of them are either in the extreme northern provinces, or in the provinces of Dalecarlia, Vermland, Smaland, Halland, and North Scania. In Upper Noorland and in Lapland there are peat bogs hundreds of square miles in size, and consisting of turf of excellent quality; in other provinces the bogs have turf of different qualities, and occasionally different qualities of turf are met with in one and the same bog. The depth of the turf varies from 3 ft. to 37 ft., and even more. It is an old custom in the southern provinces to burn turf as fuel in private dwellings; especially is this the case in the provinces along the coast, where there is no wood to spare for burning. There are numerous ways of treating the turf (when cut) by machinery. There are different machines for disintegrating, rolling, and pressing it, and making it hard after drying. The actual drying generally takes place on a flattened-out piece of the bog itself, either by spreading it out or putting it up on frames. Besides the above air-drying of the turf, several ironworks have of late years established ovens of various sorts for the further dissection of the turf. These ovens have in general given very good results. They are heated by the surplus heat of the furnaces, which thus costs nothing, and yet the turf gains from 25 to 30 per cent. in value from the process. The ordinary turf for burning in dwelling-houses in the southern provinces, where wood is scarce, is chiefly cut brick-shape, by spades made for the purpose, and then dried at the place where it is cut, by simply spreading it out in small heaps. It costs very little to cut, but is rather loose, owing to its being treated in so primitive a fashion. Such turf as is intended for industrial purposes is always worked up or disintegrated in one way or another, so as to be hard and solid when dried, and thus give more heat when burnt. At ironworks, turf is used in the furnaces either by itself or else mixed with coal and fir cones. At wood-pulp factories it is used for drying the pulp. Turf is also burnt in glassworks, brickworks, and as fuel for steam engines, &c. It is only in the south of Sweden, and even there in but few cases, that there are factories for the preparation of turf for sale as fuel. It is impossible to give any exact figures as to the amount of prepared turf yearly produced in Sweden for burning, as no figures are recorded. Its use is increasing year by year, owing to its being a cheaper fuel than coal. About 25,000 to 30,000 tons a year may be said to be employed in metallurgic works of different kinds. The cost of producing well-made turf for fuel may be given as from 4s. 4d. to 5s. 5d. per ton, according to the price of labor in different places. Good turf for fuel is expected to contain from 30 to 40 per cent. of heating material, and not above 7 to 10 per cent. of ash, and there is an enormous quantity of such turf in Sweden.

Natural Gas.*

The various theories concerning the origin of oil and gas may be divided into two classes—one assisting the chemical reactions of minerals or inorganic matter, and those claiming an organic origin through the decomposition of vegetable or animal matter. According to the theory of the former, petroleum and marsh gas are formed by the action of water, carrying carbonic acid in solution, upon alkali metals existing in a free state and at a high temperature in the centre of the earth; and they point the reactions that would take place, resulting in the formation of hydrocarbon compounds.

This theory considers the production of the liquid and gaseous hydrocarbons as continuous, the vapours rising as they are formed, the condensible portion forming petroleum and both the condensible and incondensible being retained in the porous strata in which they are now found. This theory would make the supply of these products inexhaustible as long as the necessary minerals and water exist, but the theory, though chemically perfect, is not generally accepted by geologists, since it does not accord with geological facts, which point more to the organic origin of gas and oil—that is, to their derivation from the decomposition of vegetable or animal matter originally contained in the rocks in which they are found, or in closely associated strata. Peat bogs yield inflammable gases, and sometimes also members of the bitumen series closely allied to petroleum, proving the decomposition of vegetable matter to be competent to produce natural gas and petroleum. While geologists are pretty well agreed as to the source from which gas and oil are derived, they differ somewhat as to the process of production. There is the distillation theory and the theory of primary decomposition. I shall cite Mr. S. F. Peckham as the exponent of the distillation theory. In his report on petroleum contained in 10th volume of the Special Reports of the United States Census of 1880, he states he considers petroleum was formed by distillation principally from beds of shale, fucoid plants, and animal remains, with limestone as a minor source, basing this view upon the variations in composition of petroleum found in different portions of the same field, which, he thinks, can only be accounted for on the theory of fractional distillation. In Pennsylvania, he says, gas and oil are derived from vegetable remains in rocks far below the present level of the strata in which they are found, the heat for their distillation being supplied by the causes that resulted in the upheaval of the Appalachian mountain syst andem, the evidences of this heat are to be found deep down beneath the unaltered rocks in which gas and oil are now stored.

As an argument against the theory of distillation, Prof. Orton cites the fact that the study of the rocks underlying the Ohio gas and oil fields, as shown by means of boring, carried 1,800 ft. below the oil-bearing strata, shows no signs of metamorphism, which at this depth is below the only known sources of oil supply of the Pennsylvania type, and would seem to condemn the idea of distillation. In favor of the theory of primary distillation he notes the fact that at the present day in Trinidad, beds of slate formed in comparatively recent times beneath the sea, but now raised above its level and containing abundant vegetable remains, are yielding petroleum in large quantities by direct decomposition of vegetable tissues, this petroleum passing into asphalt as a result of exposure to the atmosphere. If the action took place when the petroleum could be stored out of contact with the air, it would remain as petroleum. This he considers is what has happened in the oil fields. Professor Orton's theory is that these oil fields were the site of a tropical sea, upon the floor of which the shales constituting the chief source of the oil were accumulated. The rivers emptying into the sea laid down sedimentary deposits of clay and sand with occasional gravel bars. In the sea itself was a vast development of marine vegetation. Some of the especially abundant plants had very resinous spores and spore cases, which were set free in enormous quantities, and in connection with other portions of these and similar plants were carried to the bottom in a macerated condition, there to pass through the coaly transformations resulting in the structureless carbonaceous matter that constantly characterises black shales. The shales, thus slowly accumulated at the bottom of the gulf, must have behaved as similar shales do now, petroleum, marsh gas and bitumen being formed. This process continued until the materials were exhausted, producing a shale much richer in petroleum than any portion of it is at the present day. On this shale formation was laid a bed of porous sandstone saturated with sea water and roofed in by a very fine grained shale. Then by a gradual exchange between sandstone and shale the gas and oil reached their final reservoirs. I have thus given somewhat in detail the two most prominent theories in regard to the production of petroleum and natural gas. Both theories assume that a shale containing the remains of plants and animals is the source from which they are derived. It seems to me the term "A slow system of exchange" simply means a slow system of decomposition or distillation, and therefore differs from the other only in degree. Probably both causes have been at work to produce the different results found in different fields. After further discussing geological features at some length, Mr. Young proceeded to speak of the chemical constituents of gas, and then passed on to the more practical phase of the question, the consumption of gas, dealing particularly with domestic uses. Natural gas is generally rated at 1,000 heat units per foot. The combustion of 1 cubic foot will raise the temperature of 1,000 lbs. of water 1 deg. provided all the heat the gas generates is absorbed by the water. This, however, can only be accomplished by carefully constructed appliances. In ordinary use not more than from 50 to 70 per cent. of the heat generated is utilized. One cubic foot of gas will also raise the temperature of 48,000 cubic feet of air 1 deg. if the heat generated is all absorbed by the air; therefore to raise the temperature of 48,000 cubic feet of air from zero to 70 degs. requires the consumption of 70 cubic feet of gas, and to raise it from 35 degs. to 70 degs. requires 35 feet of gas, consequently it will require double the quantity of gas to raise the temperature in a building to 70 degs. when the outside temperature is zero that it does to raise it to 70 degs. when the outside temperature is 35 degs. In actual practice it takes more than double quantity between these two points, as the greater the difference there is between the inside and outside temperatures the greater the inrush of cold air into the house and the greater the cooling effect of windows, &c. People often seem to forget this fact, but it is never overlooked by the silent recorder in the cellar, and when the bill comes in they open their eyes in amazement and immediately conclude the meter is a fraud and gas companies robbers of the worst description.

If we could only manage to utilize all the heat generated by the gas a comparatively small quantity would be required to heat our houses, but unfortunately, in the majority of appliances used for burning gas a large percentage of the heat is carried up the chimney, and it is more difficult to overcome this loss than might be supposed. For instance, in a furnace we have, which contains 95 square feet of absorbing and radiating surface, I find that with the volume of cold air passing into the furnace supplying three registers, and at a temperature of 30 degs., I cannot burn more than 30 ft. of gas per hour and keep the products of combustion down to a temperature of 150 degs. You can easily see what a large percentage of the heat would be lost if the products of combustion from the 30 ft. of gas went directly into the chimney instead of being drawn off by the radiators and passed on to the registers. In very few appliances for fire-places are there any radiators, and the products of combustion pass directly from the burner to the chimney. A large amount of water is formed in the combustion of natural gas, and if the products of combustion are too much cooled down the water vapor condenses and causes trouble. The products of combustion must be carried off at a temperature high enough to prevent condensation or else an excess of air must be admitted in order to absorb and carry off the moisture; in either case considerable loss of heat ensues. Of course it is possible to utilize all the heat generated if the products of combustion are allowed to pass into the room, but this is not only injurious to health, but under certain circumstances may prove fatal. Natural gas contains about 75 per cent. by weight of carbon, and the product of its combustion is always carbonic acid gas, at least 1 ft. of CO_2 for every foot of gas used. I have stated that water is always produced in the combustion of natural gas. It is produced by the union of the hydrogen of the gas with the oxygen of the atmosphere.

According to the last census report the average daily consumption of natural gas in the United States in 1889 was over 1,500,000,000 cubic feet. Taking 25 per cent. as the average proportion of hydrogen in the gas, the quantity of water produced daily would be 15,344,235 gallons.

The quantity of carbon carried daily through the pipes equals 24,454 tons. It is estimated that in 1889 natural gas displaced an amount of coal valued at $21,097,099. From this will be seen the immense proportions the use of natural gas has assumed within the past ten years. Before restrictive measures were fairly in operation the gas fields from which the gas was drawn had become so much exhausted that it was found necessary to largely cut down the use of gas for manufacturing purposes, and about two years ago it looked as if the supply would soon be at an end. However, new fields have been discovered and the gas companies have the drill constantly at work with the object of maintaining the supply. While it is not probable that in the future, in this vicinity gas will be found in sufficient quantity to justify its use to any great extent for manufacturing purposes, I think that with the economy now practised in its use we may have sufficient gas for domestic use for some years yet; however, the day may come when the supply of the natural article will be completely exhausted.

* Abstract of an introductory lecture delivered before the Western University of Pennsylvania by John Young, Superintendent Allegheny Heating Company.

From Mine to Furnace.*

By John Birkinbine, President of the American Institute of Mining Engineers.

The mining or quarrying of iron ores, coal and limestone, from the earth; their preparation, handling transportation, and the smelting of the ores into pig iron, offer the theme for what could be made an instructive story, increasing in interest as we take into consideration the earlier history of coal and ore mining and iron production, and as we note the improvement made in processes, and the advances in quantity and quality produced.

The story of iron production and manufacture is old. You have been told of Tubal Cain in the seventh generation from Adam, being "an instructor of every artificer in iron," and of the use of this metal in the pyramids of Egypt, and in the gates of the city of Babylon, of the ancient book of Job mentioning "bars of iron," "barbed irons," etc. This iron was probably made in the simplest possible manner, the ore being taken from the ground, and converted into wrought iron, with the aid of wood or charcoal in heaps in pits, or in crude furnaces. But we need not go far back to trace developments, for the past half century, or even the last twenty years, show more advancement in this specialty than all the preceding years since iron was first mentioned as a metal. I shall say little concerning iron as a metal, preferring to make this a connecting link between two lectures which I presented in this room, viz: "The Iron Ores of the United States" (delivered five years ago), and "The Development of the Pig Iron Manufacture in the United States," delivered in February, 1891. The substance of neither of these will be repeated, except to call attention to subsequent developments, and to mention facts necessary to bring these two lectures into a connected story.

I shall not, therefore, consider the mining of ores other than those of iron, nor the production of any metal except the necessary incidental reference to pig iron.

To smelt iron ores a fuel and flux are necessary, and in this country four fuels are employed, namely, anthracite coal, bituminous coal, coke made from bituminous coal, and charcoal. Coke is by far the most in demand for this purpose, and raw bituminous coal is used to but a limited extent, no record being now kept of the comparatively small portion of pig iron made with it exclusively. Including the output of furnaces using raw bituminous coal, alone, or mixed with coke, with those employing coke alone for this purpose, we find that of all the pig iron produced in the United States, 70·6 per cent. is smelted with coke and bituminous coal.

Coke is also liberally used with anthracite coal in varied proportions in the eastern part of the United States, 18·8 per cent. of the pig iron being made with these mixed fuels, and but 3·7 per cent. of our pig iron output being smelted with anthracite coal alone; the remainder, 6·9 per cent., is produced by the use of charcoal. At present the relative employment of the different fuels rank in the following order:

Coke, sometimes mixed with raw bituminous coal.
Anthracite and coke mixed.
Charcoal.
Anthracite alone.
Raw bituminous coal.

Limestone is the universal flux used, although different conditions require stone of varying composition, from nearly pure carbonate of lime to a mixture of the carbonates of lime and magnesia, known as dolomite.

The iron ores fed to blast furnaces are also of varying composition; the convenience of these to furnaces, the yield of iron, the proportion of other ingredients which they carry, such as silica, lime, alumina, magnesia, phosphorus, sulphur, titanium, manganese, etc., and the expense of mining the ores influencing their use.

It is not within the province of this lecture to discuss the chemical composition of ores, but as the methods of producing different varieties, and the yield of these in iron will necessarily demand attention, a brief summary of the classification adopted is offered.

The iron ores produced in the United States may be divided into four general classes, without particular reference to their geological occurrence, but approaching within narrow limits the practice generally followed in the sale and purchase of iron ores.

(1) *Red Hematite*, all the anhydrous oxides of iron known by various names, such as red hematite, blue hematite, specular, micaceous, fossil, slate iron, martite, flax-seed ore, etc.

(2) *Brown Hematite*, including the varieties of hydrated sesquioxide of iron, variously known as limonite, gœthite, turgite, bog ore, pipe ore, pond ore, grape ore, and also some manganiferous iron ore, and most of the iron ores mined in the Rocky Mountain region for the smelting of argentiferous ores.

(3) *Magnetite*, those ores in which the iron is found chiefly as magnetic oxide; this class also includes some martite mined with the magnetite.

(4) *Carbonates*, those ores which contain a considerable amount of carbonic acid, such as spathic ore, siderite, black band, clay ironstone, etc.

Coal.—The universal use of coal makes the quantity employed for producing pig iron, though aggregating millions of tons, represent but a small percentage of the total output, hence a few facts only need be given of the production, preparation, handling, or utilization of coal. A review of the methods employed in various parts of the country would make a lecture of itself.

Great Britain and the United States are the two principal coal producing countries in the world, followed by Germany, France, Austria, Belgium, Russia, Australasia, Canada, Japan, India and Spain, in the order named; these being the only countries which up to date have records of a yearly output of over 1,000,000 tons each.

The United States, occupying second position, produced in the year 1891, 150,500,000 tons of coal, or

* A lecture delivered before the Franklin Institute, November 14th, 1892.

thirty per cent. of the total coal production of the world, variously estimated as from 500,000,000 to 550,000,000 tons in 1891.

In 1891, Great Britain produced 185,500,000 tons or 30,000,000 tons more than the United States. If, however, a retrospective view of the increase in the coal production in these two countries be taken, it will show that Great Britain's output since 1880 has augmented 38,500,000 tons, while that of the United States, in the same period, shows an increase of 87,000,000 tons, and if this rate be maintained, it is probable that in the near future, the output of the United States will surpass that of Great Britain.

Of the other countries, Germany produced in 1891 94,000,000 tons (of which, approximately, one-fifth was lignite); France and Austria 26,000,000 each—two-thirds of Austria's product being lignite; and Belgium 20,000,000 tons. None of the other countries have yet reached a yearly output of 10,000,000 tons.

In coal mining, Pennsylvania occupies first place among the thirty-one States and Territories (including Alaska), which produced this fuel. According to the census of 1889, it contributed fifty-eight per cent. of the nation's coal output, and more than one-half of what was credited to this State came from the anthracite coal fields of Eastern Pennsylvania.

As coal is used for so many other purposes, the consumption of this fuel in the production of pig iron can be only approximated. An estimate carefully prepared places the consumption in our blast furnaces in 1891 at 2,000,000 tons of anthracite coal, 12,000,000 tons of bituminous coal, principally converted into coke, and 66,000,000 bushels of charcoal.

It should be borne in mind that when referring later to iron ores, the amounts mentioned are of prepared ore ready for shipment, for the actual exploitation of the various mines demands a removal of quantities much in excess of those given. The brown hematites, as a rule, are washed to remove clay and foreign matter, and to enrich the ore, and often the amount of such foreign matter removed is four or more times as great as that retained. The carbonate ores must be roasted to remove their carbonic acid, and the roasted ores represent only about half the weight of the raw ores. Roasting is also applied to sulphurous ores, and hand sorting is applied liberally employed in the Lake Superior region. In addition to this the separation of comminuted ore, either by jigs or by magnetism, produces a ton of concentrated ore from one and one-half to five tons of crude material. It is therefore probable that for the production of over 14,500,000 tons of merchantable ore in 1891, fully 25,000,000 tons of material were removed from the ground.

The quantity of limestone used as a flux for blast furnaces in 1890, as reported to the United States Geological Survey, was approximately 5,500,000 tons, and in 1891 the amount thus used would be about 5,000,000 tons. We therefore have in round numbers 35,500,000 tons of raw material, mined or quarried, and prepared for market, to produce 8,250,000 tons of pig iron, nearly all of which has to be carried a considerable distance to points of consumption. If we allow for unmerchantable material mined and handled, it is probable that we would reach a total exceeding 50,000,000 gross tons annually. No attempt will be made to discuss the amount of labor required to produce, prepare, handle and transport this raw material. A statement of the quantity required is sufficient for present purposes, but some of the features connected with the handling and transportation of these materials will be offered.

Iron Ores—The United States is at present the largest iron ore producing country in the world, her 1891 output of 14,500,000 gross tons being 1,750,000 tons more than her nearest rival, Great Britain, supplied in that year. Great Britain has in a former year, 1880, produced 18,000,000 tons, while the largest output of the United States was in 1890, when 16,000,000 tons were produced. Great Britain has, however, shown a great falling off in the output of her domestic iron ore mines, while her imports of foreign ores have been growing larger.

Of the other large iron ore producing countries, Germany contributed in 1891 over 10,500,000 tons, Spain approximated 5,000,000 tons, France 3,500,000 tons, Austria and Hungary over 2,000,000 tons, Russia 1,750,000 tons, and Sweden not quite 1,000,000 tons. Iron ores are also largely mined in Algeria, Italy (principally in the island of Elba), Greece, Cuba, China, and in smaller amounts in various other foreign countries.

Great Britain and the United States combined produce fully one-half of the iron ore mined in the world.

In the year 1887, when the lecture on iron ore was presented, this country was estimated as producing nearly 12,000,000 tons of iron ore; in 1890, the output of our domestic mines, as above stated, was over 16,000,000 tons: and although there was a marked decline in iron production and allied industries last year, the mining of over 14,500,000 tons of iron ore in 1891 shows an increase in five years of over twenty per cent.

There are no authentic records of the output of the different kinds of iron ores in the various States in 1887, or, in fact, for any years except 1880, 1889, 1890 and 1891, the first two being Census figures, while the last two were prepared for the division of mineral statistics and technology of the United States Geological Survey.

(The lecturer here exhibited a diagram, showing the amounts of the different kinds of iron ore produced in the various States in the four years above-mentioned. Only those States which mined over 100,000 tons of iron ore were shown, the smaller producers being grouped together under the head of "other States." Solid cross-section lines, indicated red hematite ores; dotted cross-section lines, brown hematite ores; black blocks, magnetite, and dotted blocks, carbonate ores. The States were placed in the order of their precedence as total producers in the different years, *i.e.*, the State holding first rank was placed at the bottom of the column, and the second immediately above it, etc. The same scale was used in each of the columns, and the same tonnage in one year occupied equal spaces in any of the other years.)

The diagram shows a decided advance in the use of hematites, a slight decline in the proportionate amount of magnetites, and a very great falling off in the quantity of carbonates used in the decade.

In the year 1880, thirty-one and one-half per cent. of the total iron ore product of the country was red hematite; in 1889, it had risen to sixty-two and one-third; in 1890, to sixty-five and two-thirds per cent., falling off slightly in 1891, when the percentage of the total was but sixty-four.

The brown hematites constituted twenty-seven per cent. of the total iron ore mined in the United States in 1880, the proportion declining in 1889 to seventeen and one-third per cent., and in 1890 to only sixteen per cent., but advancing in 1891 to nineteen per cent. of the total.

Thirty per cent. of the country's iron ore output in 1880 was of the magnetite variety; but in 1889, less than seventeen and one-third per cent.; in 1890, sixteen per cent., and in 1891, less than sixteen per cent. of the total was of this character of iron ore.

The percentages of carbonate ore used shows a constant decline from eleven and one-half per cent. in 1880 to three per cent. in 1889, two and one-third per cent. in 1890, and one and one-third per cent. of the total product for the country in 1891.

While the above indicates a decline in the proportion of all the ores used except red hematite, a comparison of the outputs for 1880 and 1891 shows a material decrease in quantity in carbonates only; the magnetites and hematites having an augmented production.

The amounts of the different kinds of iron ore produced in 1891 were as follows: 9,327,398 tons of red hematite, 2,757,564 gross tons of brown hematite, 2,317,108 gross tons of magnetite, and 189,108 tons of carbonate ore, making a total iron ore product for the year of 14,591,178 gross tons. Of this total, Michigan contributed over 6,000,000 tons; Alabama nearly 2,000,000; Pennsylvania over 1,250,000; New York, 1,000,000, and Minnesota nearly 1,000,000 tons; the total of these five States aggregating nearly 11,500,000 tons, or nearly seventy-eight per cent. of the country's output of domestic ores for 1891. This total will exceed 11,500,000 tons by adding scattered operations from which no returns were received. In addition to the American ores mined, nearly 1,000,000 tons of foreign iron ores were imported into the country. There was also considerable amounts of mill cinder, blue billy, franklinite slag, etc., used; but in tracing the ore from mine to furnace, these may be considered as being offset by the amount of iron ore which is used as flux in puddling and heating furnaces, as flux in silver smelting, and in the manufacture of paint, etc.

The relative rank of States as producers in the various years offers interesting suggestions as to the changes in their percentages of the iron ore output, and in the table below is given the total output of iron ores in 1880, 1889, 1890 and 1891, with the percentages of this total which each State produced:

	1880 Per Ct.	1889 Per Ct.	1890 Per Ct.	1891 Per Ct.
Pennsylvania.	27.41	10.75	8.50	8.72
New Jersey..	9.50	2.86	3.09	3.60
New York.	15.83	8.59	7.82	6.97
Michigan .	23.04	40.34	44.54	41.99
Wisconsin. .	0.52	5.77	5.92	4.04
Minnesota. .	—	5.95	5.56	6.48
Alabama... .	2.40	10.82	11.83	13.62
Virginia.....	2.29	3.43	3.39	4.52
Tennessee.	1.31	3.26	2.90	3.73
Georgia...	1.15	1.71	1.52	1.72
Missouri. ...	4.84	1.83	1.13	0.73
Colorado. .	—	0.75	0.71	0.76
Total output in gross tons,	7,120,362	14,518,041	16,036,043	14,591,178

All of the iron ore obtained from Minnesota in 1891, over seven-eighths of that from Michigan, nine-tenths of that from Wisconsin, three-fourths of that from Alabama and Tennessee, and nearly all of that from Missouri, was of the red hematite variety. Virginia is the largest producer of brown hematites (nearly all of its product being of that character of ore), followed in order by Alabama, Michigan, Pennsylvania, Georgia and Tennessee, as important contributors, and this is the only class of ore mined in the New England States, Texas, Oregon and some other States. Three-fourths of the total output of New York, over one-half the Pennsylvania product, and practically all of that obtained from New Jersey was magnetite, these three States producing seven-eighths of the total of this character of ore mined. Michigan follows New Jersey, then follow New Mexico and North Carolina as producers of magnetite. The State of Ohio was the only large producer of carbonate ore in 1891, although smaller amounts were obtained in New York, Pennsylvania, Kentucky and Maryland.

The product according to States does not properly represent the development of the iron ore industry, as well as that of certain prominent districts, and a diagram is presented to show the authentic record of such of the more prominent districts as could be obtained for twenty years past, or less. The rapid advance of the Lake Superior districts illustrates the growing favor of the blast furnace managers to the use of the rich red hematite ores. The combined lake and all rail shipments of the four districts will, in 1892, slightly exceed those of 1890. In this representation the importations of foreign ores (ninety-five per cent. of which were received at the ports of Philadelphia and Baltimore) were inserted for the purpose of comparison.

Even the products by districts does not truly show the remarkable extent which the development has reached in certain localities for nine mines in the Marquette Range, three in the Menominee, four in the Gogebic Range, and two in the Vermilion Range, have since their opening contributed from 1,000,000 to 6,000,000 tons each. The mines at Port Henry, N.Y., have yielded to date about 10,500,000 tons of iron ore, but no single deposit has equalled the record of the Cornwall ore hills in Pennsylvania, exceeding 12,000,000 tons, which have been obtained from this deposit, which has for a number of years averaged a greater output per annum than any other single mining enterprise, reaching its maximum of 769,000 tons in 1889. On three occasions, however, this maximum has been exceeded by the annual output of one of the Lake Superior mining companies.*

In the year 1891 there were but four mining enterprises in the country, the product of which exceeded 500,000 tons, although an equal number closely approximated this output. Two of these four great producers were located in Michigan, one in Minnesota and one in Pennsylvania. In addition there were in the Marquette Range three, in the Gogebic Range two, in the Menominee Range one, in Minnesota one, in New York two, and in Alabama three mining operations whose output in 1891 was between 200,000 and 500,000 tons.

Although iron ore in this country was first fonnd in North Carolina, and iron was first produced in Virginia, the successful pioneer enterprise was in Massachusetts, in the year 1645. Most of the ore used was bog or pond ore, and one plant in Canada, is still operated chiefly on this class of brown hematite ore. The following illustrates the way in which pond ores were obtained in Massachusetts in the year 1794:† "Vast quantities of iron, both cast and wrought, have been made in this part of the country for more than a hundred years past; but it was chiefly out of bog ore, until that kind was much exhausted in these parts. About the year 1747 it was discovered that there was an iron mine in the bottom of our great pond at Assowamset; and after some years it became the main ore that was used in the town, both at furnaces and forges, and much of it has been carried into the neighboring places for the same purpose. Men go out with boats, and make use of instruments much like those with which oysters are taken, to get up the ore from the bottom of the pond. I am told that for a number of years a man would take up and bring to shore two tons of it in a day, but now it is so much exhausted that half a ton is reckoned a good day's work for one man. But in an adjacent pond it is now plenty, where the water is twenty feet deep, and much is taken from that depth, as well as from shoaler water. It has also been plenty in a pond in the town of Carver, where they have a furnace upon the stream which runs from it. The quantity of this treasure, which hath been taken out of the bottom of clear ponds, is said to have been sometimes as much as 500 tons in a year." The average price of these pond ores was about $6 per ton, delivered at the furnace.

Nearly all of the iron ore mined in the earlier history of the iron industry was of the bog or pond varieties, and it was not until the commencement of the eighteenth century that any of the magnetic ores of New Jersey were utilized. The Dickerson mine, which lately closed down, was one of the first mines of this character of ore opened, being located in 1716. The ore was often carried to the iron works in leather bags on pack horses.

Blast furnaces increasing in number and size required larger supplies of iron ore, flux and fuel, and to meet this it was necessary to employ other methods than those of dragging for iron. At first most of the mines were worked "open cut," but as the demands increased it became necessary to work underground so as to avoid heavy stripping, and danger from slides. There are, however, numerous open cut mines wrought at present and some large underground operations are being transformed into open cuts. The pick and the shovel, while still used, are largely supplemented by the steam, air or electric drills, and in some cases by steam shovels. High explosives have displaced much of the ordinary powder. and the wagons or carts drawn to the surface by horses or mules are to a great extent superseded by hoisting appliances operated by steam power or by compressed air, and in place of ore carried in wagons or on pack saddles, we have the rapid and cheap transportation by the various steam railroads to supplement that by water. The harder red specular ores, which were first mined in Michigan in 1847, owing to low water transportation rates and the high percentage of iron they contain, came rapidly into favor and it may be of interest to draw a comparison between the pond ore exploitation described above and one of the modern iron ore mines of the Lake Superior district.

At the Chapin mine at Iron Mountain, Mich., the ore is taken from four shafts, ranging from 300 to over 600 feet in depth, and from an open pit of over an acre in area. The fourth shaft was sunk through a stratum of quicksand, and in order to pass this, a circle of iron pipes was driven and connected with a refrigerating machine. This reduced the temperature of the contents

* In 1892 three mining operations exceeded the output of the Cornwall ore hills.

† Vide Volume of Manufactures; Tenth Census, p. 798.

of the pipe to about zero, freezing the quicksand, and, keeping it frozen, this was then drilled and blasted like rock. The machinery of the mine is run chiefly by means of compressed air, although there is ample boiler capacity to operate the entire plant in case of accident to the compressor plant. This compressed air is carried a distance of three miles in wrought-iron pipe 24 inches in diameter. The Quinnesec Falls furnish, under a head of about 52 feet, the water to three 48 inch and one 54-inch turbines. There are three pairs of 32-inch diameter and 60-inch stroke, and one pair of 36-inch diameter and 60-inch stroke compressors. This compressed air is the motive power for the hoisting plant and also for more than 100 power drills. The number of employes varies from 1,800 to nearly 2,000. The ore is found in four large lenses, and is broken down by means of power drills and high explosives, loaded on mine cars, taken to the shafts, hoisted to the surface, where a cable conveys it to the trestle, on which the cars are automatically dumped into railroad cars or taken to the stock pile, from which the ore is afterward loaded on railroad cars by means of a steam shovel. By this means a twenty-ton car has been loaded in four minutes. As much as 2,700 tons of ore have been hoisted from one shaft in twenty-four hours, and in one year over 700,000 tons were mined.

While it would be interesting to follow the details of some of the special features of the great producers, it is not practicable in the limited time to do more than call attention to some typical illustrations of mines of different character, or the means employed for their exploitation, and the instances have been selected more with the object of exhibiting prominent features, than as an attempt to cover various details of operation. They are offered to illustrate the peculiarities of mining the different characters of iron ore in various sections of the country.*

During the present year considerable interest has been attracted to the apparently large deposits of iron ore of a satisfactory character, which can be easily mined from what is known as the Mesabi range, in Minnesota, and this locality is now passing through the developing stages which have characterized the earlier history of other sections in the Lake Superior regions, which have become producers of iron ore.

The pioneers penetrate the forest, generally "packing" their provisions and tools with them, erect a log cabin, and start the preliminary operations with pick, shovel and hand drill, supplemented by hand winch, bucket and pump. If an apparently satisfactory deposit is found, machinery soon takes the place of manual labor, and compressed air is early applied to these enterprises. The necessity of labor saving appliances demands the prompt application of such economies, and not only are power drills introduced in the early history of most of the mines, but diamond drills are among the implements which may be found at work in the heart of a forest or in the midst of swamps seeking to discover the subterranean secrets. In fact, one who has never visited a newly developing iron region, would be surprised to note how quickly the economies of exploring or exploiting mines, and for transporting the material from them are introduced.

Interesting lessons can be learned by visits to mines in different sections of the country, which are operated to produce the various classes of iron ores. The red hematite mines of the Minnesota Iron Company in Minnesota, the Norrie mine, the Ashland, the Colby, of the Gogebic range; the Lake Superior, the Cleveland, the Champion, the Ludington, the Florence and the Penn Iron Mining Company, in the Menominee range, each possess some quality of interest to the investigator, either by the depth to which the deposit is wrought, sometimes to 1,300 feet; the extent of the underground drifts, the occurrence of ore in the lenses, and in some cases the admixture of magnetite and hematite, all offering interesting themes for study. The Nevada system of timbering, which is liberally employed in the Lake Superior mines, is also in strong contrast with the solid ore columns, 300 feet high, supporting the roof at the magnetite mines at Port Henry, N.Y., and similar though shorter columns at Lyon Mountain, N.Y., and other magnetic mines.

More contrasts are found in the open cut and underground work in different localities; the Tilly Foster mine of magnetite in New York State has become renowned for the efforts there made to secure its dangerous walls, commencing with great arches of brick, sustaining massive braces of concrete, which were placed in rooms which had been worked out, so as to permit removal of pillars, and ending with the blasting away of 500,000 tons of hanging-wall rock, so as to make the work an open cut. On the other hand, the Iron Mountain, Mo., originally wrought as an open cut, is principally exploited by underground workings to remove a mass of detrital ore from the original deposits which had been subsequently covered by rock of later deposition. The Cornwall ore hills have been wrought open cut until over 12,000,000 tons have been removed from them, an amount nearly four times as great as that won from Iron Mountain, Mo., and there are to-day magnificent faces of this soft magnetite exposed in the hills and railroad cuts passing through the Cornwall property. The mining of the carbonate ore deposits near the Hudson River, N.Y., the winning of the fossil ores in Nothern New York, the stripping of sand from the bog deposits of Texas, the handling of the brown hematites of Alabama, Tennessee and other States by steam shovels, all add to the variety of methods and appliances used.

Transportation of Iron Ores and Coal.—Much of the iron ore from the Lake Superior region, from New York, and some from other States, also large quantities of coal, have to be transported long distances to reach points of consumption, and reshipment is necessary where the transportations are made by both rail and water. An essential of such rehandling and transporting is that it should be done in the least possible time and at small expense, in order to enable the ores to compete with others, which, although not so rich, are found nearer the blast furnaces. As the principal cost of rehandling is for labor, large amounts of money have been expended by different iron and railroad companies for docks and cars built specially for the purpose, so as to bring this item to the lowest point practicable, and also make it possible to handle greater quantities of material than by manual labor. It is now no unusual thing for ore to be taken from the mine in "skips," automatically dumped into specially constructed railroad cars or into ore bins from which it can be discharged into cars, then hauled in these cars to ore docks, where the drop bottoms of the cars are opened and the ore falls into pockets, from which it is run into the hold of the vessel, and in this whole process the only labor necessary is to open the doors of the bins or the bottoms of the railroad cars.

The ore shipping docks on Lakes Superior and Michigan (the largest in the country, if not in the world), in connection with the ore receiving docks at the lower lake ports (fitted with bridge tramway plants), the railroad cars, and in some cases vessels specially constructed for this purpose, have aided materially in reducing the cost of transporting iron ore to points of consumption. The furnace manager, by means of advanced methods, cheaper or richer iron ores, improved facilities, and larger output, has lessened the cost of pig iron, which in turn has lowered the price of manufactured iron and steel, which has been one of the most important, if not the most important factor in bringing this country up to its present degree of prosperity.

In addition to the seventeen shipping docks erected to handle iron ores from the Lake Superior region, there are others of less magnitude on Lake Champlain, on the Mississippi River, and elsewhere, but the proportions of the docks on Lake Superior and Michigan and the quantities of ore handled by them are much greater than the others, and the same holds true concerning the ore-receiving docks at lower lake ports, for from this region was obtained 52 per cent. of all the iron ore mined in the United States in 1891.

The ore shipping docks consist of a wooden structure, built on piles. The top of the dock is from 38 feet to 51 feet 10 inches above the ordinary water level and wide enough to accommodate from two to five lines of railroad tracks. The ore docks have from fifty to 300 pockets, holding from 80 to 170 tons of ore each. The pockets are sheathed with plate iron and slope downward toward the water side of the dock. At the bottom of each pocket is a door which is controlled from the top of the dock. When it is desired to load a vessel, plate iron chutes, usually semi-circular in form, are lowered into the hatches of the boat, the doors which connect these chutes to the respective pocket are raised, and the ore discharges itself into the hold of the vessel.

Marquette, Mich., is the port from which the first Lake Superior iron ore was sent, and up to the close of the year 1891 there have been loaded into vessels 17,616,880 tons at this port, which in 1891 ranked third, with a shipment of 1,056,027 long tons, all from the Marquette range.

In 1865, Escanaba, Mich., claimed a share of the shipments from the Marquette range, this port and Marquette keeping company until 1879, when Escanaba took a liberal lead, chiefly by reason of the development of the Menominee range, commencing in 1877, and this lead has been continually maintained. In 1891, 3,058,590 long tons, or nearly one-half of the lake shipments, were sent from this port. Of this the Marquette range contributed 1,154,645 long tons, the Menominee range 1,480,248 tons, and the Gogebic range the balance, 423,697 long tons. Since 1865 there has been handled at the Escanaba docks a total of 29,963,257 tons.

The following will indicate how rapidly ore is handled by these docks: one steamer was loaded with 1,659 long tons of iron ore in forty-five minutes; others with 3,027 long tons in three hours, 3,132 long tons in four hours, 2,379 long tons in two hours, 1,927 long tons in two hours 2,502 long tons in two hours, 1,850 long tons in forty-five minutes. In this last case just one hour elapsed between the arrival of the boat at the dock and its departure. The record for the most rapid loading is that of 980 tons, which were run into a steamer in four and three-quarter minutes. The maximum quantity handled at the Escanaba docks into vessels in twenty-four hours was 42,320 long tons.

The nearly simultaneous development of the Gogebic iron range in Michigan and Wisconsin and the Vermillion iron range in Minnesota caused the erection of shipping docks, three for the former at Ashland, Wis., and two for the latter at Two Harbors, Minn., both ports making their first shipment in 1884. Ashland, however, soon outstripped its rival and in 1891 ranked second as a shipping port, with 1,261,658 long tons as its output. Since the docks were erected at Ashland in 1884, 7,760,-025 tons of ore have been shipped.

In 1891, Two Harbors, Minn., ranked fourth, 890,299 long tons being shipped, and the total from 1884 to the close of 1891 was 4,030,899 long tons. Receiving docks are also projected at Duluth, Minn., to accommodate the anticipated increased shipments from the Mesabi Minnesota mines.

Gladstone, Mich., made its first shipment of ore in 1889, and serves as an additional and competing shipping point for the mines of the Menominee range. In 1891, 177,866 long tons were shipped.

The length of the seventeen ore-shipping docks, independent of approaches, varies from 400 feet to 1,800 feet. The aggregate of all being 19,342 feet, or (say) three and two-thirds miles. They contain 3,189 pockets, have a total capacity of 385,350 long tons, and cost, approximately, $4,500,000.

In connection with these docks the railroad companies own a total of 12,526 cars, built for use in transporting iron ore, with an aggregate capacity of 187,550 tons of iron ore, their total cost being estimated at $3,600,000.

Six mining companies on Lake Superior own a total of thirty-three vessels, mostly steamships, with an aggregate tonnage of 80,750, especially devoted to the transportation of iron ore, and maintained by the iron-ore producers.

Receiving Docks.—The bulk of the lake shipments of iron ore are taken to the lower lake ports—Cleveland, Fairport, Ashtabula, Toledo, Sandusky, Huron, Conneaut and Lorain, O.; Erie, Pa., and Buffalo, N.Y., for distribution to the various blast furnaces in Pennsylvania, Ohio, West Virginia, New York, etc. The remaining portion going direct to furnaces situated near to or on the Great Lakes, such as Milwaukee, Wis.; Chicago, Ill.; Detroit, Mich.; Tonawanda, N.Y., and to individual furnaces at various points in Michigan and Wisconsin. Most of the furnaces on the lakes or their estuaries have special appliances for handling iron ore, but it is at the first-mentioned ports on Lake Erie that the larger receiving docks are located, Cleveland having four, Buffalo three, Ashtabula and Fairport two each, and the remaining ports one each.

Two of the receiving docks at Cleveland are each half a mile in length and have a storage width of 350 feet; one at Fairport has a water front of one mile and a width for storage purposes of from 180 to 350 feet. As the ore is stored in piles from twenty-five to fifty feet in height, the capacity of each of these docks is from 1,000,000 to 1,500,000 long tons, and the average storage capacity of the receiving docks is 300 to 500 tons per foot of water front. During the shipping season, from May to October, the ore is brought to these ports, unloaded, a portion being handled directly to railroad cars and the balance stocked, being shipped to the blast furnaces during the winter months. The largest stock on hand at lake ports in the past nine years was on December 1, 1890, when 3,893,487 long tons were on the docks. The largest stock of ore at the opening of navigation was that on May 1, 1891, when the heavy stocks of the previous year had been reduced to 2,662,223 tons.

Mr. George H. Ely, in a paper, entitled "The Great Lakes of North America,"* gives some interesting figures in regard to the capital invested in iron ore mining and transportation in the Lake Superior region. The amount of capital invested in the iron ore lands, shipping and receiving docks and their equipment, in railroad cars, vessels, etc., was over $175,000,000.

Concentration of Iron Ores.—Considerable interest has for several years been exhibited in the concentration of magnetic iron ores by means of magnetic separators. This is not a novelty, as the United States Patent Office has issued nearly 150 patents (some of them half a century old) for various forms of magnetic separators. The revival of interest in the concentration of lean magnetic iron ores is fortunately at a time when improvements in machinery for reducing in size and handling large quantities of material are supplemented by advanced knowledge of electro-magnetic appliances. The extent to which the process can be applied commercially to many ores, can be decided only after a thorough investigation, embracing the chemical and physical characteristics of the ore, the quantity accessible, the facilities for obtaining it, and the available market for concentrated ore.

This method of beneficiating iron ores is confined to magnetite, or possibly to some ores which can by roasting or other process be made sufficiently magnetic to permit of their concentration by the appliances mentioned. Most of the work done has been in enriching lean magnetite, although some ores carrying high percentages of iron have been fed to magnetic separators for the purpose of reducing the amount of phosphorus and sulphur. The predominance of magnetic iron ore in New York and New Jersey, and the existence of large deposits of this class of ore in Pennsylvania and North Carolina, have naturally attracted to these States most of the development in concentrating plants.

There is no question but what the amounts of sulphur, phosphorus, silica, and in some cases titanium, existing in magnetites can generally be considerably reduced if the material is sized and passed through magnetic separators; the degree of perfection reached being influenced by such reduction in size as will actually permit the mechanical separation of the pure magnetite from the other ingredients. In some of the titaniferous iron ores, this element is so combined as to be magnetic, and similarly the sulphur in other ores is in such combination as to make it partially magnetic. It may be possible with improved machinery and greater knowledge to separate various materials from each other, which differ but slightly in magnetism, but present practice is confined to separating magnetic from non-magnetic material, and the results achieved depend largely upon the comminution of the material, the rapidity with which it is fed on the separator and the perfection of the machine.

We may consider the term "concentrates" as applied only to ore which has been comminuted by means of crushing machinery and then passed through water-jigs or magnetic separators to remove materials which lower the grade of the ore.

In jigging, the crushed ore is agitated, water being

* The lecture was illustrated by numerous lantern slides.

* International Congress on Inland Navigation. Paris, 1892.

introduced, which removes the lighter material, while the heavier iron ore sinks and is conveyed from the jig as it is separated. It is in this way that at Lyon Mountain, N.Y., the Chateaugay Ore and Iron Company treats the lean magnetite taken from the mines, and a similar method is followed at Iron Mountain, Mo., for the separation of the leaner red hematites.

Magnetic separators have been in use for forty years, but it is only lately that this system has attracted much attention. Although the forms of magnetic separators vary, they may be classed under three general heads:

(1) Altering the trajectory of falling material by introducing the attraction of a magnet, to draw the magnetic portion away from the non-magnetic. Six of this class of machines are now used.

(2) Feeding the ore to a revolving drum or drums, in which is a magnet core, the shells of the drum being either of alternate magnetic and non-magnetic strips, or entirely of magnetic or non-magnetic material. In some of these drums the magnet core is wound so as to exert a constant polarity, in others a series of magnets in alternate polarity compose the core, and in some opposite drums are of opposite polarity. When two drums are used, they are placed so as to revolve toward each other, the ore passing between them, or they are arranged tandem, the drums revolving in the same direction, but sometimes at different speeds and with different degrees of magnetic force, so that the ore fed from one drum to the other receives successive treatment. Machines are also arranged with more than two drums. About thirty of this class are in use.

(3) Belt machines in which the ore is fed to a belt or series of belts passing under or over magnets or magnetic drums, the machines working sometimes in water and sometimes dry. In some of the machines the polarity is maintained continuously by means of pole pieces, in others the material is constantly submitted to magnets of alternate polarity, the belts being placed so as to run either vertically, horizontally, or on an incline, according as the conditions require. There are between twenty-five and thirty of this class now at work.

These separators are used either at the mines to enrich the ore, at steel works and rolling mills to remove the magnetic particles from slag and dirt, to separate iron ore from pottery clay or from emery—and in one instance iron ore occuring as a hematite with zinc ore is treated in a roasting furnace after being comminuted, and becoming magnetic, can be thus separated.

There is apparently a present field for magnetic separation in the States of New York, New Jersey, Pennsylvania, Virginia, North Carolina and Michigan, where there are large deposits of lean magnetic ores. The prejudice against the use of concentrated ore by some blast furnace managers has been largely overcome by practice, which has proven that properly concentrated ore contributes to the good working of the furnace, and in the future this class of ore may be used largely in place of some of the higher-priced ore brought to eastern blast furnaces. This class of ore has also been used in most of the direct processes, and any development of these will encourage a corresponding demand for concentrates.

During the year 1891 there were produced 16,802 long tons of hand-picked or cobbed ore, 98,546 long tons of magnetically separated ore, and 110,777 long tons of jigged ore.

Conclusion.—In presenting for your consideration the subject of this evening I have relied mainly upon the eye believing that in this way it would be possible to convey more information concerning typical features in an attractive manner than to weary you with theories and detailed statistics. Most of the time has been devoted to iron ore, because nearly all that we use or import is smelted to produce pig iron, and but a portion of the coal mined or limestone quarried enters into the production of iron. But the small attention given the fuel and flux must not be considered as a gauge of their importance. The mining and quarrying, the preparation, the handling of the raw materials entering into the manufacture of pig iron supplies work for an army of laborers, miners, mechanics, railroad men, sailors, clerks, engineers, superintendents and managers, and demands the investment of many millions of capital.

The Luhrig Process of Washing and Treating Coal.

By Mr. James I. Anson, Darlington, (Read Before the Cleveland Institution of Engineers.

In this paper it was pointed out how the coal owners of Saxony had been driven by the development of their trade, thei ncreasing demands of which the better seams soon became inadequate to supply, to seek for a method of treatment which would enable them to put the produce of their inferior seams upon the market in such a state as would satisfy the requirements of the iron manufacturer and other users of fuel, with whom coal of a considerable degree of purity became from year to year more and more of a desideratum. The earlier and rougher methods of coal-washing could only accomplish very imperfectly the purification of small coal for cokemaking. But Mr. Luhrig solved the problem with signal success so far as the elimination of mechanically separable dirt was concerned. Certain modifications and improvements have since been introduced, but every plant is specially designed to meet the requirements of the particular place, so that practically no two are precisely alike. When Mr. Rathbone wrote, he stated that the system was very generally adopted in Germany, and was fast making its way into France and Belgium, while it would not be long before it was largely adopted in England, but as regarded the last named such had not been the case. But the same causes which led the German coal owners to face the problem of the adequate cleaning of fuel—viz., the working out of the better seams, on the one hand, and the demand for a purer product, on the other, were now forcing the problem upon the attention of the English coal owners. Messrs. Merry and Cuninghame were the first to adopt the Luhrig process in Great Britain, and the success which had attended the working at the Motherwell and other collieries belonging the firm led to the formation of the Luhrig Coal and Ore Dressing Appliances Company, of which Mr. A. Cuninghame is managing director. On the Continent, about two hundred Luhrig plants were in successful operation, and a considerable number in Scotland and Yorkshire, while others were in course of construction. At Maryport the system had been successfully applied to coal for coke-making. In Northumberland and Durham the system was, so far, unrepresented, but before long a complete plant for dealing with 1,000 tons a day will be in operation at the new Randolph pit of the North Bitchburn Coal Company. On the vital importance of a clean fuel in manufacturing operations, whether for direct metallurgical process or for the raising of steam, it was not necessary to dwell. Every blast furnace manager was fully alive to the necessity of using a coke as low as possible in ash and sulphur, and the frequent analysis to which coke was now usually subjected, both to ensure accuracy of results, and as a check upon the coke manufacturer, bore testimony to the fact that the question was most important. It was one thing, however, to stipulate for the supply of fuel containing a specified maximum of impurity, and another thing to get it with unquestioned regularity. Mr. Hawdon, in his presidential address to that institution in November, had remarked that as often as not 9 to 10 per cent. of ash was contained in the coke supplied nowadays as good blast furnace coke. The days were fast passing away of 5 per cent. ash in Durham coke. But if pure fuel was required in the blast furnace, it was equally important to have it in the puddling furnace, the heating furnace, and under the boilers. Yet, where did the iron and steel maker keep such careful watch upon the percentage of impurities in the coal supplied as the blast furnaceman kept upon his coke. The one was as important as the other. It had been estimated that the extra amount of coke containing 15 per cent of ash required, as compared with one containing only five per cent., amounted to about 17 per cent., to say nothing of the extra limestone needed in the blast furnace to flux the added 10 per cent. of ash. The comparative efficiency of coal containing 2 per cent. of ash as against one containing 14 per cent., was equivalent to a money value of 1s. 6d. per ton on the basis of a coal costing 7s. per ton. It might perhaps be said that the treatment of coal in such a way as to raise its purity to the desired point might be a costly process, and would so far increase the cost per ton that it might after all be better to use an inferior fuel at a lower price. By the adoption of a well considered scheme of handling, screening, washing, and loading coal as it came to bank, the whole of these operations could be achieved at an almost nominal cost per ton. At Motherwell, by the Luhrig process, the labor in handling, screening, handpicking, washing, and loading, did not exceed a half-penny per ton, whilst the saving in waste was an important factor. The Luhrig Company guaranteed under penalty that there should not be more than 2 per cent. of coal left in the final refuse, and it was found at Denaby Main that in daily practice this did not exceed one-half per cent. The author then considered the first principles on which the operation of every system of coal washing more or less depended, and showed that in order to effect a separation by washing, the bodies must be either of different specific gravities if of equal sizes, or of different sizes if of equal specific gravities. In the case of coal it was desired to separate the heavier dirt from the lighter coal. That could only be efficiently done when the mixed material was reduced to an approximately uniform size before washing, a principle which was rigorously carried out in the Luhrig system. This system of treating coal at the pit mouth was not one for washing only, but for the whole treatment of the coal, automatically and continuously, from the point at which it was delivered from the tubs to that at which it was delivered into trucks, storage hoppers, &c., including screening, hand picking of large coal, washing of nuts and small in as many sizes as might be reqnired, and automatic loading. In many cases only the washing plant with its attendant appliances was required. The plant in operation at Motherwell was a type of a complete arrangement for dealing with about 1,500 tons a day, including the whole of the processes involved in both dry and wet separation, automatic handling and loading. The plant treated the whole output of three pits, which was brought to one spot by endless rope haulage.

The tubs were run into tumblers, or kick-ups of an improved type, and the contents discharged over vibrating screens pierced with 2 in. round holes. All the coal above 2 in. passed from these screens on to long picking belts, formed of links in the usual way, but in place of plates to carry the coal there were steel bars with spaces between, so that any small coal due to breakage might fall through on to a table below the return belt. Cross shoes of angle iron, with a plate about 8 in. high, were attached to this belt at intervals, and as these were reversed and travelled backwards towards the screens they acted as scrapers, which collected the small coal which had fallen through and delivered it into the same hopper as received all the coal which passed through the screens. In cases where it was desired to pass unscreened coal over the picking belts, plates were used in place of the open bars. As it was carried along by the belt the large coal was picked by hand in the usual way, and at the end furthest from the screens the belt was carried round a movable arm which could be lowered into the trucks, into which the large coal was gradually and automatically delivered, the cross shoes preventing its slipping down with a run, and thus saving breakage. Any pieces of shale or dirt with inter-grown coal were thrown into shoots, which carried them to a stone breaker, from which they were delivered to the main hopper under the screens and underwent the same subsequent treatment as the rest of the coal, a large amount of coal being recovered in this way which ordinarily went to waste. With regard to the coal which had passed through the 2 in. screens, this fell into a large hopper beneath them, of about 100 tons capacity. Into this hopper had also been delivered the small coal due to breakage recovered from the picking belt and the mixed coal and dirt which had been passed through the stone breaker. The contents of this hopper were taken by an elevator to the top of the washery building and delivered down a shoot into a large sizing drum or revolving screen having concentric shells of different meshes. Here it was sorted into treble nuts 2 in. to 1¼ in., double nuts 1¼ in. to ⅞ in., single nut ⅞ to $\frac{5}{16}$ in. peas, and small $\frac{5}{16}$ in. and downwards. From the sizing drum each size of nuts was conveyed down a shoot into its own washer—a wooden box with a vertical partition extending for a portion of its depth, dividing it into two compartments which communicated with each other below. In the back compartment was a large wooden piston, actuated by an eccentric on a line of shafting which ran above the back of the washers, by which the necessary impulse was given to the water, the stroke of the piston being proportioned in each case to the size of coal to be washed. In the front compartment was a sieve on to which the coal was delivered from the sizing drum, an opening being provided in the front and near the top of the washer for the washed coal to flow out with the washing water, whilst near the bottom of the space above the sieve was another opening, adjustable by means of a sliding shutter, out of which the refuse passed. Any small dirt which passed through the sieve fell to the bottom of the washer, from which it was let out from time to time by a valve which passed it into the channel through which the rest of the refuse was conveyed to the refuse pit. The dirt or shale, together with such coal as might be adherent to or integrous with it, was carried by a spiral conveyor to an elevator, by which it was taken to a pair of crushing rollers, whence it descended again through a shoot to one of the washers, in which it was treated for the recovery of the intergrown coal. As the washed nuts left the front of the washers, they were delivered over perforated draining shoots, to which a shaking motion was given similar to that of a shaking screen, into loading hoppers. The small coal, $\frac{5}{16}$ in. and downwards, as it came from the sizing drum, met the overflow waters from the nut-washers and was carried into a grading box consisting of a wooden trough, under which was a series of inverted pyramids, in which the small coal was successively deposited in constantly decreasing sizes, the largest coal coming to rest first, the smallest at the further end of the series. From the bottoms of these compartments the coal passed to the small coal washers, which were like the nut washers, but in each had a layer of felspar crystals resting upon the sieve or grating through which the upward current of water was propelled by the pulsation of pistons of very short stroke. The layer of felspar slightly lifted and opened out at each pulsation of the water, closing again with the downward current. In that way the fine dust was allowed to settle down through the layer of feldspar. By that device, the use of a very fine mesh which would quickly clog was avoided. The washed fine coal flowed with the washing water down a channel to a revolving drum made of copper sheets pierced with holes $\frac{1}{64}$ in. in diameter, in which it was separated from the finest sludge, which was carried with the water in which it was suspended into the sludge recovery tank. The sludge recovery was a special feature of the Luhrig process, and it obviated the use of settling ponds, with the attendant cost of labor in clearing these. The water employed was used over and over again. The guarantees of the company at Motherwell, taking that as a sample, were:—(1) Plant to be capable of treating 1,500 tons of coal per day of ten hours on basis of coal containing 23 per cent. of ash; (2) ash contained in washed coal $\frac{5}{16}$ in. to $\frac{1}{16}$ in. not to exceed 6 per cent., and for every 1 per cent. of ash left in the coal beyond that, the patentees to forfeit £100; (3) the rubbish or dirt washed out not to contain more than 2 per cent. of fine pure coal, and for every 1 per cent. above that, patentees forfeit £100; (4) cost of labor guaranteed not to exceed $\frac{8}{10}$d. per ton of coal handled, patentees to forfeit £150 for every 4-10ths exceeded, this to include labor in hand-picking, sorting, working and loading into trucks. However, the ash did not exceed 2½ per cent., the coal in the dirt 1 per cent., and the labor ½d. per ton. It had been proved practically that efficiency in results could be obtained at very small cost and with practically absolute regularity in working.

English mail to hand advises a better market for Canadian phosphate. Quotations for 80% having advanced to 10½d.

Messrs. Eugene Munsell & Co., of New York, report that the demand for Canadian amber mica for electrical purposes continues to steadily increase.

LEGAL.

A. A. Hayward and the Lake View Mining Co. vs. the West Waverley Gold Co., Ltd.

MOTION FOR AN INJUNCTION.

Before Mr. Justice Meagher in Chambers, on Tuesday, the 25th day of April, at Halifax, the plaintiff moved for an injunction to restrain defendant company from discharging the tailings from their stamp mill into Muddy Pond at Waverley.

It was claimed by plaintiff Hayward, one time manager of the Lake View Mining Co., that the tailings discharged into the pond backed up the water so that it flooded back into plaintiff company's mine. Defendant company produced affidavits showing that the level of the water had not been raised at all, and that the shafts of the plaintiff company were from eight to ten feet above the level of the pond.

The injunction was denied, Mr. Justice Meagher saying: "The motion for a restraining order is refused. The facts relied on by plaintiffs to show danger of their mine being flooded or affected by water being forced into it through the defendants operations, have been most completely met by the proof produced by defendants."

An order to serve notice in the matter of the injunction was obtained by plaintiff Hayward during the absence in the United States of the manager of the defendant company, and it was hoped to rush the matter through before he could return. This scheme failed.

An action for trespass and damages has been entered in the Supreme Court of Nova Scotia.

CANADIAN COMPANIES.

The Ophir Mining Co.—This company with headquarters at 418 Phœnix Building, Chicago, has been organized and is now actively operating the Ophir Gold mine near Bruce Station, Ontario. The property contains 154 acres and is situate, Lot 12, 3rd Concession of Galbraith, twelve miles north and three miles east of Bruce Mines, district of Algoma. A force of 30 men are employed under direction of Supt. W. R. Wallace. An idea of the value of the ore may be gathered from the following returns of mill tests made by Prof. Fred. F. Sharples at the Michigan Mining School, Houghton, Mich.:—

First Sample. Total oz. Present.
Amnt. of ore, 1,525 lbs..................
Assaying silver, 2·3 oz. per ton..........Silver, 1·75 oz.
" Gold, 2·7 oz. per ton............Gold, 2·6 oz
Concentrates, weight 140 lbs...........
Assaying silver 6·02 oz.... ....Silver, ·421 oz.
" Gold, 3·33 oz. ....Gold, ·233 oz
Tailings, weight, 1,300 lbs.......
Assaying, silver 1·22 oz........... .....Silver, ·79 oz.
" Gold 1·57 oz..................Gold, 3·73 oz.
Gold and silver caught on copper plate (by difference)...........Silver, ·54 oz., Gold, 2·00 oz.

"The amalgam was not removed from the copper plates at the end of this run, as we intended to continue on the following day, but an examination showed that there could not have been 2 oz. of gold upon them. This led us to think that the sampling of our ore had not been carefully attended to, so on the second run particular attention was paid to this, with the following results:—

Second Sample. Total oz. Present.
Weight of ore, 2520 lbs................
Assaying silver, 2·05 oz. per ton.........Silver, 2·58 oz.
" gold, 3·5 oz. per ton... ......Gold, 4·41 oz.
Concentrates, 2,371 lbs................
Assaying, silver, 6·12 oz .... Silver, ·73 oz.
" gold, 2·68 oz........... .....Gold, ·318 oz.
Tailings, 2,200 lbs.................
Assaying silver, 1·21 oz..................Silver, 1·33 oz.
" gold, ·313 oz..................Gold, ·344 oz.
Gold and silver caught on copper plates (by difference)..........Silver, ·55 oz., Gold, 3·748 oz.

"According to our assays the amalgam from the copper plates should have yielded, when retorted, a button weighing 6·83 oz. The button we obtained weighed 5·33 oz. This button assayed 77·04 per cent. gold, consequently the amount of silver that we recovered upon the plates was very nearly what our assays of ore, concentrates and tailings led us to expect, while the gold found was about 1·5 oz. short of the amount that our assays called for. A small amount of this gold was left in the retort after distilling the mercury, probably a small amount remained sticking to the copper plates, and possibly a very small portion was not removed from the mortar. But the losses from these sources do not account for the loss of 1·5 oz. of gold. It is a well known fact that when free gold is present, in comparatively large pieces, it is impossible to get an average sample of the ore, and I believe this to be the trouble in our assays of the ore that we fed to the stamp. This idea is strengthened by the fact, that the silver assays and the amount recovered agree very closely, and further that the free gold does not occur in the ore in quite large pieces.

"During a close examination of some of the pieces of the ore, several small pieces were found carrying quite large pieces of the free metal, these I will forward to you with the button of metal. From these facts I should say, that the amount of metal recovered on the plate, together with the assays of the concentrates and tailings would be of greater value than the assay of ore alone. The runs that we made were upon five of the seven barrels that you sent. We wished to check our results with assays before working the remaining two. We used a 40 mesh sieve, and expected that we would find it necessary to use a coarser one in making another run, for we could see a quantity of galena and pyrites, particularly the former going into the tails.

"Our results show that it would not be advisable to use a coarser screen than this. It will be noted that our assays of the concentrates are rather low, and of the tailings rather high. Proper adjustment of the concentrator will overcome this to a great extent. I believe it is almost impossible to get any concentrator adjusted until several tons have been run through.

When crushing to 40 mesh, it will be noticed that a large amount of galena passes into the tails. To ascertain what loss this occasioned, I assayed some of the galena (as nearly pure as I could get it) and found it to contain 23·5 oz. of silver per ton, with only a trace of gold, and as the amount of galena is comparatively small, the loss from this source is not great. To ascertain the nature of the pyrites, I assayed samples and found them to contain 14 ozs. of gold per ton, with no silver. This shows that every means should be taken to prevent the loss of pyrite."

The mill now being built by the Doty Engine Co. of Toronto, will contain 30 stamps of 850 lbs., and, operated by 100 h.p. boiler and Corliss engine, will have a capacity of 50 tons per 24 hours. Ten frue vanners are in place. The mine itself will be equipped with two 50 h.p. boilers, Ingersoll compressor and drills, Blake rock breaker, etc. No hoisting engines will be used, the ore being handled by tram cable. Superintendent Wallace describes the workings to date as follows: The vein has a dip of about 40° south to a depth of 100 feet from the lower outcrop, here it comes in contact with a fissure in the syenite which takes it up and this fissure has a trend of 15° N. of W. and outcrops at intervals for a distance of 1,200 ft. from the present workings. East of this for 450 ft. the surface rises abruptly and along a cliff until the summit is reached (about 300 ft. elevation), an immense chimney of ore is exposed, with three distinct folds, the average width of which is 35-feet, through which I have made three cross-cuts and along which I am now drifting. At the lower part of where this chimney outcrops I have sunk on the vein 86 feet following the dip as above stated, about 40° south of this 170 feet and on the fissure I have sunk a shaft vertical and with the fissure, here at a depth of 90 feet I have reached a large body of high grade ore and have the drift within about 30 feet of this point, (the foot of the shaft), making the following estimate of ore, *i.e.* 200 feet in depth (which gives a margin of 50 feet), 30 feet in width, and 450 feet in length by actual measurements, all in sight we have allowing two ton to the yard which allows another third margin, and at half the value reported by Prof. Sharpless, we have such a value as would seem fabulous. And yet I do not believe half of the magnitude of this ore body has been estimated, nor can it be at present understood, but all the figures given can be verified anytime."

The Tulameen Improvement and Hydraulic Co. Ltd.—This company has been registered (in 1891) under the laws of British Columbia, with a capital of $60,000, for the purpose of acquiring and consolidating certain leases known as the "Tulameen" the "Hines Creek" and the "Eagle Creek," claims situated on the Tulameen River, in the Yale division of British Columbia. The workings are distant from Kamloops station on the line of the C.P.R., about 125 miles by wagon road and trail. The claims owned by the company extend from Eagle Creek a distance of two and a half miles down the Tulameen River, and contain large benches or alluvial deposits of platinum and gold bearing gravel.

Platinum was first discovered in the gold placers of this river and its tributaries in 1887. Up to that time it had been thrown away as "white iron" by the few whites and Chinamen mining in the vicinity. Since 1887, about 1500 to 2000 ozs. per annum have been mined and sold from the shallow diggings worked by hand. This can be verified by the official Mining Report of British Columbia for 1891. The platinum was sold to Baker Bros., of Newark, New Jersey, and Johnston Matthey, of London. In the shallow places referred to as worked by hand, the daily amount of gravel worked averaged from 3 to 4 yards per man, and the object of the present company in obtaining leases of the larger bench deposits, is to carry the water from Eagle Creek on to the ground and work from 3,000 to 5,000 yards per diem.

The following excerpts from the report of Mr. George Attwood, M.E., F.G.S., will be of interest:—

"From all data obtained, gold was first discovered and washed in and about the bed of the Tulameen river in the year 1886, and large quantities of platinum were then found and often thrown away as it was frequently unsaleable. A large amount was sold for 50 cents an ounce; but later the agents of American firms bought the platinum up from 50 cents an ounce to seven or eight dollars an ounce. Mr. Thompson, who has a store at Granite Creek within 15 miles of the mines and who trades in gold dust, etc., estimates that from 14,000 to 20,000 ounces of platinum have been produced in the district and that it has nearly all come from the neighborhood of the T. I. & H. Co.'s claims as the platinum bearing ground appears to be limited to that portion of the Tulameen river. Eagle Creek supplies the water for the mining work and the supply at the time of inspection was fully three times in excess of what was being used. The T. I. & H. Co., own the exclusive water rights. In Eagle Creek owing to its height above the Tulameen river and its gravel benches it is of great value as it provides the necessary power for hydraulic piping.

For cutting timber and making boards, &c., a saw-mill has been erected near the junction of the Tulameen river with Eagle Creek. The power employed consists of an overshot wheel 20 feet in diameter with a four foot breast which drives a 30 inch (in diameter) circular saw having a capacity of making from 1,000 to 4,000 feet of boards a day. Across the Eagle Creek, a dam has been constructed of heavy stones and logs in a deep gorge which forms almost a natural dam, is about 25 to 30 feet across and is about ten feet deep in the centre. A water flume about one mile in length carries the water from the dam to the present point of hydraulic working. The flume is made of one and one-half inch plank and is five feet wide in the clear, and twenty inches high except a short distance at the lower end where it is about eleven inches high. The general grade of the flume is one-half an inch in twelve feet, although it is not quite as steep in some places. The foundation of the flume had to be made for some distance, by blasting a bed out of the solid rock around the mountain side and the work has been well done. For saving platinum and gold a bed rock flume has been constructed 160 feet long, about 43 inches wide at the bottom and 27 inches high with 8 inches fall in twelve feet. The flume is provided with wood block riffles 5 inches high and three abreast, and with two under currents near end for saving the finer species of metal. At the end of the flume a penstock is in place and to which is attached about 300 feet of steel pipe in 10 in. in diameter No. 14 sheet, and having a monitor and justable nozzle which can be moved by hand and by which the stream of water can be directed on the gravel bench at any angle with a nozzle 4 in. in diameter. The pressure of water now being used is about 110 feet vertical and the quantity about 350 to 400 miner's inches. The Tulameen river has from all appearances, gradually cut its way through the country rock until its present level is far below what it was in ancient times, and in doing so it has left banks sometimes on one side and sometimes on the other of large benches of gold and platinum bharing gravel. The benches vary in length and width according to location, and out of the four miles on the run of the river, fully one-half (say two miles) is covered with the gravel.

The cost of removing one cubic yard of gravel by the use of free water which the T. I. & H. Co., Ltd., enjoy should never exceed ten cents per cubic yard, and with proper management 6 cents a yard should cover all the working expenses. To estimate the quantity of platinum and gold bearing gravel on the benches belonging to the T. I. & H. Co., Ltd., is a very difficult matter, but a walk on the ground will soon convince any one that the supply is enormous and that it will take a number of years to exhaust the same. The sum of $12,000 will place the property in a strong position and enable a good profit to be made. My opinion is a favorable one and I consider the property to be one of great value.

There are some gravel benches between the Bear Creek bench and the Otter Flat on the Tulameen river which are likely to contain platinum and gold. I have suggested that leases should be obtained for the same so as in order to control the platinum belt.

ANALYSIS.—No. 1—"Home Rule bench," one-fourth cubic yard; 15·50 grains of platinum and fine gold. No. 2 "JerryO'Donnell bench," one-half cubic yard; 11·70 grains (7·80 gold and 3.90 platinum). *Upper Bench*—3 cubic yards; 17.70 grains of platinum and gold; about 40 per cent. platinum some mercury on gold from pan.

The directors of the company are Capt. R. G. Tatlow, Vancouver; Joseph Armstrong, New Westminster; Dr. McInnes, Victoria; head office; J. Walker, secretary, New Westminster, B.C.

New Brunswick Brown Stone Co.—*Is applying for* charter of incorporation with the object of carrying on a general business for quarrying, manufacturing and purchase and sale of building and other stone. Directors: Stephen Clarke, Sackville, N.B.; Wm. Clarke, Sackville; Josiah Wood, Sackville; Wm. Milner, Sackville, and Henry A. Powell, Sackville. Capital, $10,000. Head office: Sackville, N.B.

The Cown Oil Co.—Is applying for charter of incorporation under New Brunswick Statutes. Capital, $50,000 in shares of $100. Directors: Geo. R. Sangster, Moncton; John W. Lowe, Stonehaven, and W. P. Whitehead, Fredericton, N.B. The objects of the company are to acquire lands producing or bearing oil, the sinking of oil wells and the working of such oil, the selling and dealing in oil, the erection of works and buildings, etc.

General Mining Association Ltd.—Subjoined is an excerpt of the annual report of the General Mining Association Limited, presented to the shareholders on the 21st April:—

The directors present to the proprietors their annual report, together with the accounts of the year ending 31st December, 1892.

The sales of coal were as follows:—Sydney mines, 170,080 tons in 1892; 151,584 tons in 1891—increase, 18,496 tons. From the colliery worked by the Low Point, Barrasois and Lingan Mining Company:—Victoria mines, 108,660 tons in 1892; 96,990 tons in 1891—increase, 11,670 tons.

The profit on the year's trading, as set forth in the accounts, amounts to £13,284 18s. 2d.; brought forward from 1891, £1,060 9s. 2d., making £14,345 7s. 4d., out of which the directors propose a dividend of 10s. per share, £13,734 10s., leaving balance to carry forward, £610, 17s. 4d.

There was a brisk demand for coal at the opening of the season, and large shipments were made during the first two months after navigation opened. Enquiry fell off somewhat in the summer, but autumn brought an average demand, which increased towards the close of the year, and, as the harbour remained free from ice, considerable shipments were made at both collieries in December, towards the close of which month, however, an unfortunate accident to the boilers at Victoria brought operations at that colliery to close.

Though prices generally were hardly so good as in the previous year, and increased royalty was levied on much of the coal sold, still the results have, as a whole, been satisfactory, admitting of a dividend of 10s. per share.

At Victoria mines the year's resul has again, unfortunately, not come up to expectation. The Board have have made now, however, a change in the management, which they hope may lead to better results this year.

The sale of the Bridgeport property was, as the shareholders are aware, carried through during 1892, but as the purchase money has not yet been fully paid, the Board do not recommend dealing with it until later.

There is as yet nothing further to report as to the proposed sale of the properties of the association."

New Hot-Blast Stoves.—Messrs. McClure & Amsler of Pittsburgh, have designed a hot-blast furnace which is a modification of the Massicks and Crooke's stove, and a number of this modified form of stove have been erected in the United States. The main object aimed at is to effect at the top of the stove a connection between the vertical flues and the stack flue, so constructed as to obviate the liability to fracture of the walls by expansion and contraction. This is effected by making the connecting passage in the form of an arch made separate from the crown of the stove, so that there is an intervening space instead of flues in the crown itself. In this pipe stove there is no combustion chamber beneath, but there is a small one at the end where the gas enters, is ignited, and passes into the oven through slots in the partition wall. There are thirty pipes in each section of the ovens as erected at the Grand river blast furnaces, Kentucky, each pipe having 65 square feet of heating surface. At Durham where these pipe stoves have been in use since 1876, it has been found that 100 pipes, or 6,500 feet of heating surface, will heat 16,000 cubic feet of air per minute, and that with regular running a temperature of 1000° F. can be maintained. At the Grand river, the double stoves, each with 3,900 square feet of heating surface, maintained the above mentioned temperature without difficulty during a run of ninety days, 8,300 cubic feet of air being blown per minute.

Keeping Open Haulage Roads.—Mr. W. H. Chambers* describes the methods adopted for removing the posts of coal along the main haulage roads at the Tankersley collieries. The coal is here worked on a modified long-wall system, leaving posts from 20 to 40 yards thick on each side of the main road. The shaft is 100 yards deep, and from it there is an incline about 1,000 yards long, with a travelling road parallel to it, and 10 to 12 yards of post between them. On either side of these roads posts 25 to 30 yards had been left. From the bottom of this incline levels have been driven some 800 yards or more, with posts in the main part of their lengths. There is also a second incline. In the main incline and levels there is a double line of rails with endless over-rope haulage. As the weight was coming on, owing to workings in another seam, and as the coal in this seam was becoming worked out, it was necessary to take some steps to keep these roads in good condition. Three methods were adopted. In the first of these, the low side posts were taken out from the far end, keeping the packing well up to the coal. A ripping of three feet supplied packing material. After about six months the top side was taken out in 40 yard pieces, and another ripping of 3 feet made to supply packing. Steel bars were set where the roof required it and the work was done without stopping the haulage. In another level the top side was taken out first. In the main incline, 6 or 8 yards of coal on each side was first taken out, 3 feet of the roof ripped down, and a pack 4 yards wide put in. Then the other portion of the coal was worked out 25 yards behind in bank form. In the second incline, the whole of the coal was taken out at once in several places.

*Paper read before the National Association of Colliery Managers, Leeds, April 30, 1892; The Colliery Manager, vol. viii, pp. 86-87.

The Microscopic Examination of Coal.—J Wiesner* states that the chief constituent of lignite is a substance which is brown, transparent, and is decolorised by chromic acid, leaving a residue which shows the reactions of cellulose. As, however, this does not withstand the action of chromic acid, it follows that lignite is completely decomposed by chromic acid, or rather by the mixture of potassium bichromate and sulphuric acid, which the anthor employed. The other kinds of fuel which were examined ranged from anthracite through coking coal to charcoal, lamp black and graphite. These all contained some of this substance, destructable in chromic acid, which was observed in lignite, though usually in very small quantities. Examined under the microscope in the form of a fine powder, the chromic acid solution in contact with the fuel becomes in the first place brown and finally green. The residue, even after having been treated for some weeks with fresh solution, shows no sign of any change. It behaves like amorphous carbon, and at the ordinary temperature is only attacked by chromic acid with extreme slowness. Anthracite consists in the main of the black material scarcely at all affected by a chromic acid solution. It also contains a transparent, deep-brown colored substance, which is slowly oxidised by chromic acid, but leaves no cellulose residue. Bituminous coal appears to be a mixture of lignite and anthracite leaving a small quantity of cellulose after the chromic acid treatment. Brown charcoal is completely decomposed by chromic acid, cellulose being readily observable. Black charcoal, on the other hand, is scarcely attacked.

Devices for Preventing Over-winding.—A. Kast† observes that of the hundred and one cases in which the winding-rope or chain broke in the kingdom of Saxony between the years 1884-1891, it was proved that no less than twenty were due to over-winding. In consequence it was ordered in 1890 that at those Saxon mines where men are continually being hoisted or lowered in cages, some safety device should be introduced by which, in case of over-winding, the steam would be automatically shut off and the cage brought to a standstill. Automatic signals were also suggested, and the author describes two newly devised mechanical arrangements for throwing the engine out of gear in case of over-winding, steam being shut off and the break applied.

Canadian Oil Shipments.—We give in the following table the shipments of crude, refined and crude equivalent leaving Petrolea, Ont., for the first 4 months of 1893, compared with the shipments for the corresponding period of 1892:—

	1892			1893		
	Crude.	Ref'd.	Crude. Equiv.	Crude.	Ref'd.	Crude. Equiv.
January..	17,441	24,751	79,218	23,671	28,834	96,756
February.	14,577	18,073	59,759	22,905	19,809	77,072
March...	16,570	19,469	65,217	17,891	22,405	73,903
April....	12,542	15,145	51,704	16,131	16,532	57,460

**Monatshefte fur Chemie, vol. xiii, pp. 371-410.*

† Oesterreichische Zeitschrift fur Berg und Huttenwesen, vol. xl., pp. 407-411, with illustrations.