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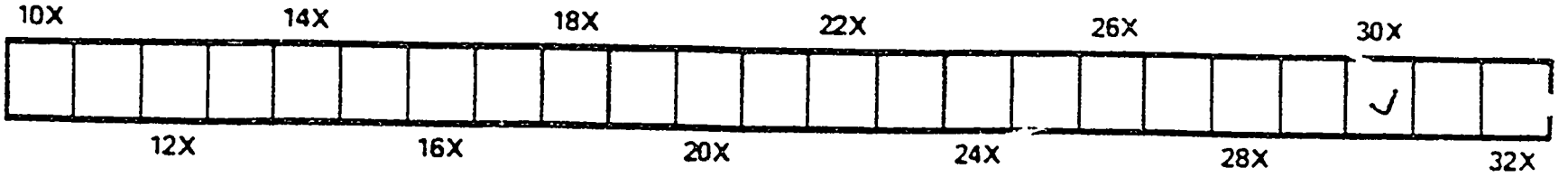


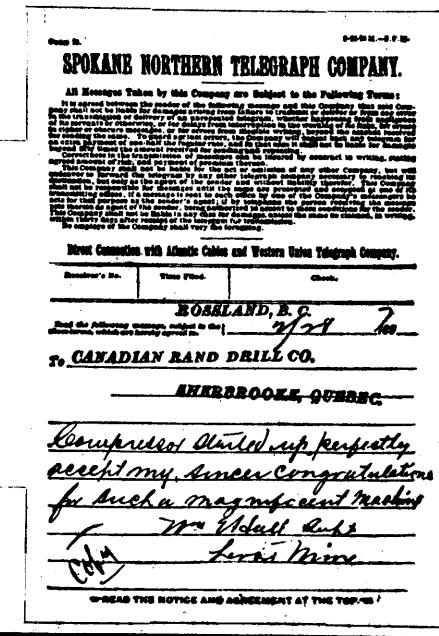
FIFTEENTH YEAR OF PUBLICATION.

The Canadian Mining Review

Established 1882

VOL. XVI.—No. 6. MONTREAL—OTTAWA—HALIFAX. JUNE, 1897.

The Compressor and what was said of it after it had been put to work and a thorough test.



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SHERBROOKE, QUEBEC.

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Mr Eldredge Supt
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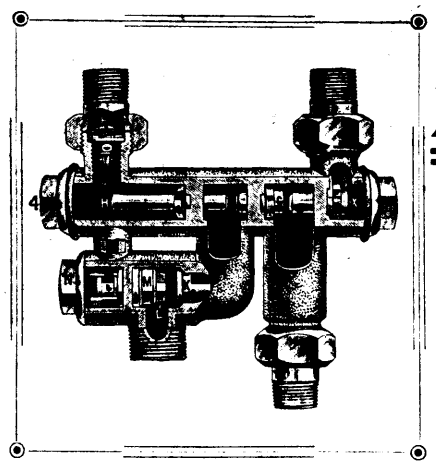

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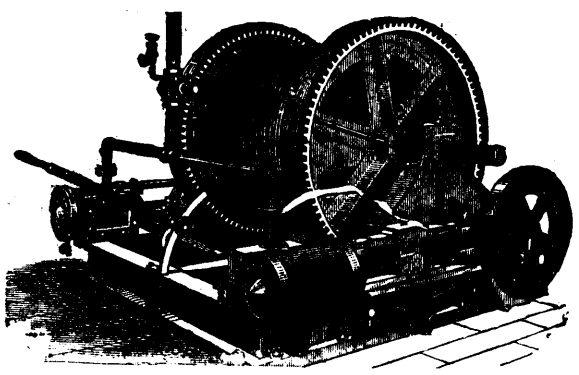

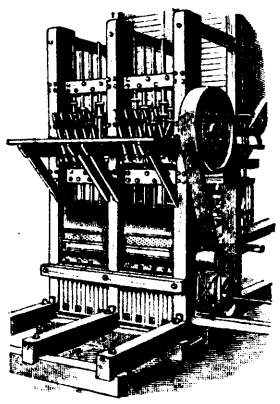

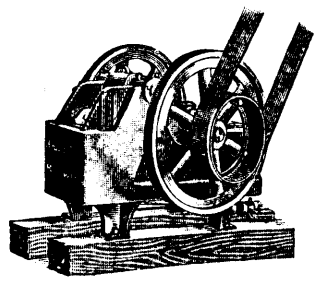

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(B) Chemistry and Mineralogy (B.Sc.)
(C) Mineralogy and Geology (B.Sc.)

3—Post-Graduate Course for the Degree of

Doctor of Science (D.Sc.)
For further information see the calendar of Queen's University for 1897-97, p. 128.

4—Prospector's Course.

The School offers to Mine Foremen, Assayers, Prospectors and Mining Men generally, Special Courses of Instruction beginning January 6th, 1897, and continuing eight weeks.

5—Extramural Classes for Prospectors and Mining Men.

Lecturers will be sent to Mining Centres to conduct Classes in Elementary Chemistry, Mineralogy and Geology as applied to the discovery and winning of valuable minerals.

The School is provided with well equipped Laboratories for the study of Chemical Analysis, Assaying, Blowpiping, Mineralogy, Petrography and Drawing. In the Mining Laboratory recently built the operations of Crushing, Amalgamating, Concentrating, etc., can be studied on a large scale.

The BRUCE CARRUTHERS SCHOLARSHIP (value $200 per annum) will be awarded in May. Its object is to aid one who has had some experience in amalgamating, etc., in acquiring a good education in Mining Engineering. The conditions of the award will be made known on application to the Director or the Bursar.

FOR CALENDAR OF THE SCHOOL AND FURTHER INFORMATION APPLY TO

WM. MASON, Bursar,

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PROVINCE OF NOVA SCOTIA.

Leases for Mines of Gold, Silver, Coal, Iron, Copper, Lead, Tin

—AND—

PRECIOUS STONES.

TITLES GIVEN DIRECT FROM THE CROWN, ROYALTIES AND RENTALS MODERATE.

GOLD AND SILVER.

Under the provisions of chap. 1, Acts of 1892, of Mines and Minerals, Licenses are issued for prospecting Gold and Silver for a term of twelve months. Mines of Gold and Silver are laid off in areas of 150 by 250 feet, any number of which up to one hundred can be included in one License, provided that the length of the block does not exceed twice its width. The cost is 50 cents per area. Leases of any number of areas are granted for a term of 40 years at $2.00 per area. These leases are forfeitable if not worked, but advantage can be taken of a recent Act by which on payment of 50 cents annually for each area contained in the lease it becomes non-forfeitable if the labor be not performed.

Licenses are issued to owners of quartz crushing mills who are required to pay Royalty on all the Gold they extract at the rate of two per cent. on smelted Gold valued at $19 an ounce, and on smelted gold valued at $18 an ounce.

Applications for Licenses or Leases are receivable at the office of the Commissioner of Public Works and Mines each week day from 10 a.m. to 4 p.m., except Saturday, when the hours are from 10 to 1. Licenses are issued in the order of application according to priority. If a person discovers Gold in any part of the Province, he may stake out the boundaries of the areas he desires to obtain, and this gives him one week and twenty-four hours for every 15 miles from Halifax in which to make application at the Department for his ground.

MINES OTHER THAN GOLD AND SILVER.

Licenses to search for eighteen months are issued, at a cost of thirty dollars, for minerals other than Gold and Silver, out of which areas can be selected for mining under lease. These leases are for four renewable terms of twenty years each. The cost for the first year is fifty dollars, and an annual rental of thirty dollars secures each lease from liability to forfeiture for non-working.

All rentals are refunded if afterwards the areas are worked and pay royalties. All titles, transfers, etc., of minerals are registered by the Mines Department for a nominal fee, and provision is made for lessees and licensees whereby they can acquire promptly either by arrangement with the owner or by arbitration all land required for their mining works.

The Government as a security for the payment of royalties, makes the royalties first lien on the plant and fixtures of the mine.

The unusually generous conditions under which the Government of Nova Scotia grants its minerals have introduced many outside capitalists, who have always stated that the Mining laws of the Province were the best they had had experience of.

The royalties on the remaining minerals are: Copper, four cents on every unit; Lead, two cents upon every unit; Iron, five cents on every ton; Tin and Precious Stones; five per cent.; Coal, 10 cents on every ton sold.

The Gold district of the Province extends along its entire Atlantic coast, and varies in width from 10 to 40 miles, and embraces an area of over three thousand miles, and is traversed by good roads and accessible at all points by water. Coal is known in the Counties of Cumberland, Colchester, Pictou and Antigonish, and at numerous points in the Island of Cape Breton. The ores of Iron, Copper, etc., are met at numerous points, and are being rapidly secured by miners and investors.

Copies of the Mining Law and any information can be had on application to

THE HON. C. E. CHURCH,

Commissioner Public Works and Mines,

HALIFAX, NOVA SCOTIA.

15th YEAR OF PUBLICATION.

The Canadian Mining Review

Established 1882

Official Organ of the Mining Society of Nova Scotia; The General Mining Association of the Province of Quebec; The Asbestos Club; and the Representative Exponent of the Mineral Industries of Canada.

B. T. A. BELL, Editor and Proprietor. Published Monthly. OFFICES { Slater Building, Ottawa; Metropole Building, Halifax; Windsor Hotel, Montreal.

VOL. XVI., No. 6. JUNE, 1897. VOL. XVI., No. 6.

Capital for Mining.

It is proverbially difficult to get capital for mining operations. Most capitalists have, at one time or another, "taken a flyer" in a mining proposition, and in the majority of cases it has led to the illustration of the maxim, "once bit, twice shy." But there are tides in financial enthusiasm, and now and then a period comes when past losses seem to be forgotten, and when, stimulated by the brilliant success of some fortunate mining enterprises, the wary capitalist again ventures to try his luck in "digging."

Such a period has now arrived, and it may be opportune to offer a few reflections that may be serviceable in guiding Canadians how to profit by the golden opportunity of securing capital for the promotion of their mining industry.

Up to the present time the recent development of mining in British Columbia has been largely due to American enterprise, but during the last few months a great interest has arisen in England in favor of gold mining in Ontario and British Columbia, and up to the month of May some forty companies had been registered in London, proposing operations in British Columbia.

This interest is due to the following facts: For two years previous to the Jameson raid, great fortunes had been made by the rise in value of the mining shares of South African and West Australian Companies, and some money had actually been received from dividends. But the political troubles in South Africa, and poor results from West Australian operations, had led to a great decline in the market value of shares, and stopped speculation in those quarters. The decline of American securities, and the instability of financial affairs in the United States, had checked investment in that direction, and a plethora of capital accumulated in London. This found some outlet in bicycle and other industrial companies, but the memory of African mining profits kept attention eager for the discovery of new fields for mining speculation. Then came news of actual dividends being paid by British Columbia mines, and of some successes in Ontario. The prospect of a new field of operations under the British flag was eagerly hailed, and kindly attention was given to Canadian proposals.

A study of the situation leads to the following observations: In consequence of this favourable inclination, London has been flooded with offers of Ontario and British Columbia properties, many of which are undeveloped prospects that the shrewd English investor is wary of. Some of these have secured working capital, but it is very doubtful if any considerable number have been sold, and it is very well to warn our Canadian prospectors and promoters that there is a very small chance of getting any cash in England for undeveloped properties. There are, however, two classes of enterprises that have succeeded, and are likely to succeed. The first class is one that but few can be privileged to enter. It is those companies who can secure eminent public Canadians as directors or managers, such as Prime Ministers, Lieutenant-Governors, Agent Generals and other well known officials. The belief of the English people in the probity of public men in their own country is such that they will subscribe capital to be handled by those who are honoured with office in British Colonies—a very high tribute to official character. Companies have been floated without any properties to offer, but with the assurance that these trusted men would buy something good with the money paid in. It is sincerely to be hoped that for the sake of official reputation, as well as for the reward of the faithful investors, something good will be found.

The second class of enterprises that may succeed at the present juncture, is where the owner of properties is willing to give away one-half or two-thirds interest for the sake of working capital. He cannot expect to get much or any cash for the property, unless he has got reports from experts favourably known to the capitalists or the public, or until an independent examination has been made by the representative of the capitalist. It is well that this should be thoroughly understood by those who are disposed to go to London to sell mining claims, and much disappointment and loss would be saved if owners would delay going to London until their properties were sufficiently developed to bear endorsement, as capable of becoming productive mines at an early period. But if they are content to take one-third of the shares of a company in exchange for their properties, with the assurance of a fair amount of working capital, then, if they have good references for themselves and good reports on their properties, let them go, with good hopes of success. This, too, is the fair thing to do with improved properties. Let the owner be willing to risk his mineral claim against the investor's capital for working, or at most, if he cannot afford to do this, only ask for his bare expenses in cash in addition to the shares. It may seem to be be giving away too much, but few who have not been to London know what it costs to obtain capital there, even privately, or can realize the enormous expense of floating a public company.

Should mine owners be willing to adopt this policy at the present juncture, a large development of Canada's mineral industries might ensue, which would be of vast benefit to the Dominion; for success in any business in a country leads to a favourable inclination to invest in its undertakings generally.

But it is greatly to be deprecated that improved properties should be sold outright, as the failure of these would be most discouraging to

investors, and would be detrimental to Canada's mining development. Investors, of course, dislike even to lose working capital, but they are particularly averse to paying money to the owners of improved properties for the privilege of risking the working capital, by which alone the properties can be proved. They are quite right in asking the owner to risk his interest against their money.

The success already secured in British Columbia and Ontario gives assurance that there is a good chance for the profitable development of well selected lands, and if the boomer and wild cat promoter can be kept out of the field, and owners will be content to take the chance of future prosperity from the working of the properties, there is every reason to believe that Canada will speedily take a front place among the mining countries of the world.

Gold Mining in Nova Scotia.—A Great Field Open to Capital, Enterprise and Good Management.

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

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

In the Geological Survey report above referred to, practical recommendations were made, by which the production of gold in Nova Scotia might be largely augmented. Again, in 1871, Professor Hind addressed a very detailed and exhaustive report in seven chapters, to the Chief Commissioner of Public Works and Mines, in which similar recommendations were made.

Again, in a paper by the same author, read before the Society of Arts, London, 25th May, 1870, the subject was discussed, and even now the remarks then made by Mr. Sopwith and the chairman, the late Sir Warrington Smyth, are still applicable to gold mining in Nova Scotia.

Mr. Sopwith said he had just returned from Nova Scotia, and he could to the utmost corroborate the statements made by Professor Hind, as to the manner gold mining was conducted there. One of the most important points in any large gold producing country was the treatment of the tailings and the arsenical pyrites, from which the gold is more difficult to separate than from any other metals with which it is found combined. He might mention that in the Montague mine, which was one of the most interesting in the Province, and was in the neighborhood of Waverley, there was found in the foot-wall of the lode masses of arsenical pyrites, about the size of two fists joined together, at very short intervals, and this really amounted to a very considerable portion of the lode, which was only two inches thick. It was very probable that the pyrites would give from £80 to £120 per ton. Sir. Warrington Smyth said: It appeared quite clear that there was throughout this district a sufficiently large portion of gold in these quartzose deposits, whether beds or veins, to pay well for mining enterprise, and the question might therefore be asked why had it not succeeded better? For a number of years 600 or 800 men had been engaged in this work, but only a few mines had been successful. Was it not possible, instead of these 600 or 800 men, to employ 6,000 or 8,000, or even more, in raising gold ores to the advantage of all concerned? Undoubtedly it ought to be so, for there was no doubt that in Nova Scotia there was a gold field such as was seldom to be met with, and there ought to be machinery and appliances brought to bear upon these mines, such as would ensure a very handsome return to capital invested in undertakings intended to last over a long series of years. This was really a point of almost imperial importance, for it appears that up to the present time the auriferous resources of the country had been developed to a pitifully small extent; and no doubt this was because the undertakings had been conducted by persons unprovided with money, or with the intelligent guidance which it might be assumed they would have had if the matter had been taken in hand by persons better provided with money, without a good supply of which no mining can be successfully carried on. He could not help remarking when mention was made of the large quantities of ore which had been crushed in order to extract the gold, that it was not above two-thirds of the quantity which one single tin mine was in the habit of stamping per annum. This showed that the work in Nova Scotia had not been undertaken upon such a scale as to render any great success probable.

Mr. Robinson remarked on the number of shafts sunk, and gave an instance of 54 shafts sunk to extract quartz from a lode 1,500 feet in length. It must be remembered that these remarks were made in 1870, and with a few exceptions since, as the mine at North Brookfield and the Richardson at Country Harbor, are still very largely applicable; and we may still ask why, in such a gold country as Nova Scotia, are there still so few people — only about 4,000 according to late statistics—employed in this industry? and why, after over 30 years of work, is the quantity of ore treated still so small, and the yield of gold no larger, than it was in 1867, and this, notwithstanding that the number of tons treated has more than doubled, 31,385 in 1867, and 65,873 in 1896.

The answer is not far to seek, or very mysterious, and may be explained as follows:

1. Want of attention to the recommendations of such scientific and practical writers as Marsh, 1861, Silliman, 1864, Selwyn, 1869, Hind, 1870, and many others.

2. Want of reliable and competent metallurgical chemists and assayers connected with and paid by the mines.

3. Always giving way to the temptation to carry out a hand to mouth policy, than which nothing is more effectually ruinous to successful mining. Paying all the proceeds out in wages and dividends, whereby the manager soon finds himself with an empty treasury and an exhausted mine, and the stock-holders looking only for dividends refuse to put up the money requisite to develop new ore ground, and having no reserve fund and no capital the mine is closed.

This has been the frequent history of gold mining in Nova Scotia. Good reserves of capital, and the unremitting exploration of new ore ground, is the only remedy, but has been neglected. The amount and richness of ore ground in Nova Scotia is such that disaster can follow only from a gross neglect of the fundamental principles of all good mining, that exploration must always keep ahead of extraction and payment of dividends.

The ruinous system and methods hitherto prevalent has destroyed the confidence of the investor and insufficent capital is the result.

4. Entire neglect of tailings, pyrites and pyritous residues, which often contain a large percentage of the gold contents of the mine.

5. No attempt to follow up and develop the alluvial gold.

In Professor Silliman's report we find the following statement respecting the matter:

"The alluvial detritus in the bed of Copper Lake near Tangier, has been found by experiment to yield not less than $122 to the ton; 33,000 tons of this soil are computed to exist in the bed of the lake.

"The Boulder lot at Sherbrooke, has yielded a considerable amount of gold from the glacial drift and is rewarding its owners handsomely. Probably too little attention has been given to this source of gold, the quartz-veins alone having been the chief objects of attention."

The reasons that have been advanced by theorists for the absence of alluvial gold deposits in Nova Scotia have prevented any systematic and intelligent efforts to find it. The long narrow lakes in Nova Scotia certainly represent the "flats" and "gullies" in Australia, and there is not much doubt that many of these lake beds will prove, if properly tested, rich in alluvial gold. It is utterly incredible that none of the detritus from the richly auriferous veins of Nova Scotia, which must have accumulated in post-tertiary and pre-glacial and later times, as it has in all other countries in the existing depressions of the surface, should not still remain in part of these depressions as it does in the perfectly analogous depressions of British Columbia, Quebec, Australia and California.

Whether the depressions are river courses, dry grassy flats as in Australia, or lake bottoms, does not affect the conclusion that alluvial gold must exist in Nova Scotia as it does in all the other countries named.

That gold veins could be profitably worked to as great depths as any other mines, is amply proved by work now carried on in Victoria, Australia, at a depth of more than 3000 feet.

That this would be so was predicted by Selwyn in 1858.

There is certainly no reason why Nova Scotia should not present similar results, but better mining methods must be adopted.

NOTE.—See Murchison's Siluria, 1859, Chap. xix and appendix page 567. Ed. 1859.

The Duty on Mining Machinery.

"SIR:—Having been absent from the country for some months, I have not been fully informed of events in Canada; but I understand that the new Liberal Government offered to make the admission of all mining machinery into Canada free of Customs duty, and that the General Mining Association of the Province of Quebec through its council petitioned for the imposition of duty upon some articles, and that this petition was granted. As an original member and an officer of the Association I should like to ask how those who adopted this action can explain the anomaly of a mining association begging for its industries to be taxed. The Association was formed to protect the mining industry against governmental invasion, how is it that it is used to prevent governmental assistance?"

Respectfully,

ROBT. C. ADAMS,
Past President.

JUNE 16, 1897.

Captain Adams labors under a misapprehension which I am pleased to have the opportunity to rectify. The first tariff item specified for free entry only machinery "exclusively used and required in mining" thereby excluding air compressors, pumps, rock drills, hoisting engines, and machinery used in other industries. That this was the interpretation of the clause was confirmed by a statement made to me by the Hon. Mr. Patterson, Controller, and Mr. James Douglas, Dominion Appraiser, of Customs. As it stood the phraseology of the item was ambiguous and liable to misinterpretation and with a view to preventing a repetition of that friction and annoyance at ports of entry which characterised the rulings on the law of the previous Administration the Federated Institute suggested to the Government the desirability of clearly specifying what machinery they intended to make dutiable and to admit everything else free. The Government consented to this but requested a free list for the guidance of the Department which was subsequently prepared by a special committee and incorporated in the revised Tariff. Everyone conversant with the facts will admit that in this matter the Federated Institute has rendered a distinct service to the mineral industries of the country.

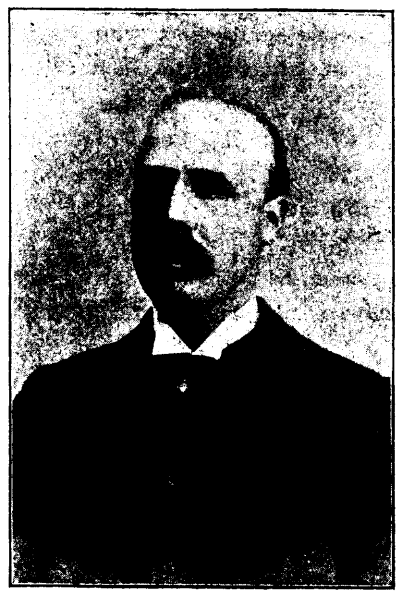
B. T. A. BELL,
Secretary
Federated Canadian Mining Institute.

Presentation to Mr. William Blakemore.

As soon as it became known that Mr. Blakemore was about to relinquish his position as mining engineer to the Dominion Coal Co., Ltd., there was a widepread desire manifested among the officials of the Company to recognize their appreciation of his services, and his general courtesy to themselves, by presenting him with some tangible evidence of their respect. The outcome of this was a very pleasant gathering at Sterling House, on the 1st instant, when the managers of all the mines attended, to hand to Mr. Blakemore an address, accompanied by a magnificent solid silver salver, bearing the following: "Presented to William Blakemore, Esq., Mining Engineer, by John Johnston, Robert Robson, J. C. Mitchell, James Purvis, J. G. S. Hudson, T. J. Brown, James McVey, P. Christenson, managers Dominion Coal Co., Ltd., Glace Bay, C.B., May 22nd, 1897."

The address, which was read for his colleagues by Mr. John Johnston, was as follows:

To William Blakemore, Mining Engineer: It is with feelings of sincere regret that we, the undersigned superintendents of the Dominion Coal Company's collieries, have heard of your intended departure. During the three years in which you have been identified with the general management of the Dominion Coal Company, Ltd., in which



MR. WILLIAM BLAKEMORE, M. E.

we have, officially, been under your jurisdiction, we have always found you anxious to carry out to the best advantage the arduous duties which your office made incumbent upon you.

You arrived at Cape Breton at a most important period of its mining history, when its coal mining resources were to be carried forward by leaps and bounds, to the practice of other countries, and our mines had to be equipped, enlarged, and new methods introduced, which would make their output parallel with the best collieries of the continent.

To do this under existing circumstances was, indeed, a task which would call forth the best professional abilities of whomsoever undertook the work.

Knowing the amount of work which has been done, and the difficulties which have been surmounted, we, the superintendents who carried out the work, knowing you are severing your connection with us, wish to express to you our appreciation of your ever courteous and gentlemanly conduct toward us, which made the carrying out of the instructions an agreeable and pleasant task.

We now feel that, as you are about to sever the pleasant connections which have always existed, we are called upon to express to you our deep regret at the necessity which calls you away from our midst.

We would also like to express to you our regret, not merely as officials of the Dominion Coal Co., Ltd., but that you will be missed in the community in which you reside, as a broad minded and public spirited citizen, ever ready to undertake and work out the good of the community, in religious and social duties. We trust that what we must consider as our loss will be another's gain, and that whatsoever changes you meet they will always add to your success and happiness in life.

We therefore ask you to accept this address and accompanying silver salver, as a slight earnest of the good will which we feel toward you, and as a mark, inadequate though it may be, of our appreciation of your kindness toward us, and the courteous manner in which you have discharged the duties of your office.

We are, sincerely yours: John Johnston, James McVey, Robert Robson, J. C. Mitchell, James Purvis, J. G. S. Hudson, Peter Christenson, T. J. Brown.

Dealing with Water in Pits during Sinking and in Permanent Work.

By JOHN BELL SIMPSON, M. Inst. C.E.*

The principal method of dealing with water in sinking, is by lowering a bucket set of pumps into the shaft, attached to the beam of the pumping-engine, or to quadrants actuated by beam or horizontal engines. Considerable depths are reached in this way, and there is not much difficulty in dealing with feeders of water up to 1,000 gallons per minute with each column of pumps. When greater feeders are met with, it is necessary to have two or more columns of pumps, either placed in the same shaft, or in the second shaft, closely adjoining. Generally there is not much water in the strata below 100 fathoms in depth, and if the feeders are considerable and impervious strata are reached, it is customary to encase the shaft with cast-iron tubbing, by which the water can be kept back when it is met with, and the sinking continued without water. One of the most difficult sinkings was at Murton Colliery, near Durham, in 1841. In passing through a quicksand of 30 feet in thickness, 9,300 gallons per minute had to be drawn. Three pits in this instance were necessary, and six engines, of an aggregate horse-power of 1,580, were applied with eighteen sets of pumps, nine of which pumped directly to the surface. Six were 19 inches in diameter, and three 16 inches. By these means a depth of 75 fathoms was reached, where tubbing was got in, and the feeders successfully tubbed back.

In some districts of the French and Belgium coal-fields, the cretaceous formation overlies the coal measure, and it contains immense quantities of water, making sinking by pumps quite impossible; but the very ingenious system ot Kind and Chaudron, of boring the shafts from the surface, and when the impervious strata are met with, making a water-tight foundation thereon, and lowering in the cylindrical rings of tubbing, has in many instances been successfully applied. There is another method which has been applied on the Continent, viz., that of freezing the rocks, on the systems of Poetsch and Gobert, both of which are said to be successful. It would appear that the chief methods of dealing with water during sinking are as follows;—1. By lowering pumps into the shafts, actuated by engines on the surface. 2. By suspending steam engines and pumps, and lowering them as required. 3. By the Kind and Chaudron system of boring the shafts, and tubbing them from the surface. 4. By the system of Poetsch and Gobert, of freezing the rocks.

The machinery used in sinking is often designed with a view to its being permanently continued. This, however, cannot always be done. In some instances the permanent winding-engine for coal is applied during sinking, and afterwards the pumping arrangements are detached from it when either the feeders have been tubbed off, or as more frequently is the case, when an independent engine has been erected. The pumping-engines chiefly erected at collieries, until recent years, have been a double or single-acting beam-engine, with or without condensing, of the Boulton and Watt type. None of them were economical in the way of fuel. The author, about twenty years ago, made experiments on ten large engines to ascertain their duty, and found a consumption of from eight to 20 pounds of coal per indicated horse-power per hour. The average was 15 lb. The coal was small and of inferior quality. In Cornwall, however, the miners, having to pay such a high price for their coal, had their well-known Cornish engines which gave a very high duty, and with good coal often under 3 lb.

LANDING STOPS FOR MINE CAGES.—The stops for keeping a winding cage at the level of a landing may be divided into two classes, rising and falling, with the former of which it is necessary to draw up the cage a little, in order to permit of the stops being taken off and of the cage being let down to a lower landing, while falling stops are made so as to be taken off under the load by the men appointed for that purpose. Falling stops have, observed M. Louis Eloy in a paper before the Association of Liége Engineers, the great advantage of saving time and steam, while causing less strain on the engine, since a drawing up of the cage previous to letting it down is avoided, as well as too frequent reversal. For an equal degree of safety, falling stops should be preferred, at any rate on the surface, the engineman of course keeping his rope taut. After stating the principle of the Stauss stops, the author describes several forms of Wilmotte stops, which he considers fulfil the following conditions as enumerated by their inventor;—(1) Stops should be simple, easy to handle and of exact working, causing neither fatigue nor hesitation to the men in charge, and susceptible of being taken out and replaced, in case of repairs being required, without interfering with the work of winding. (2) In normal working the stops of intermediate landings should always be "off," *i.e.*, not projecting into the free space of the shaft. (3) When the cage has to be stopped at a given landing, all that the man working the stops should have to do is to bring the stops under the cage, and, on the latter leaving them they should assume the "off" position of themselves, without any movement of the man in charge or the aid of a counterweight. (4) Their construction should be very strong, as they have to act as an anvil, not subject to wear, and free from any arrangement likely to be put out of form, because play in the joints may cause a difference of level between cage and landing very unfavourable to duration of the plant and facility of the "manœuvres" at the landing. That the metal used for stops should be liable to neither breakage nor be put out of form under the impact of the cage, and that the arrangement should be easy to erect, inspect and maintain, while it should also be sufficiently elastic to permit of application to any shaft, and this as cheaply as possible.

* Abstract of a paper read at the recent Conference of the Institution of Civil Engineers.

Mining at Great Depths.—Continued.

By Bennet H. Brough, A.R.S.M.*

Determinations are best made during the progress of a bore-hole, by preparing at the bottom of the hole an isolated water column, by the aid of an indiarubber plug. The form of plug designed by Dunker consists of a bag of stout indiarubber, 0.35 inch thick, filled with water and pressed between two wooden discs, the upper of which is connected with the boring rods, whilst the thermometor is fixed to the lower one. Rotation of the rods in one direction screws the discs nearer together, and rotation in the other direction forces them apart. The indiarubber ball can thus be made to swell out and plug the bore when the desired depth has been reached, and can be reduced to the original size for raising or lowering. The necessity of adopting some such means of preventing the circulation of water in the borehole is apparent. Indeed, many of the published observations have shown so palpably the existence of convection as to render them useless.

The accompanying table, compiled by Professor Everett, shows in concise form the results of underground temperature determinations collected by the British Association Committee up to 1882.

On comparing the results we notice that the Calumet and Hecla surpasses all other deep mines or boreholes, so far as our present records extend, in slowness of increase. In this case, however, the coolness of the rock is undoubtedly due to the proximity of the cold waters of Lake Superior. On the other hand, the Comstock results are abnormal, owing to the fact that the surrounding rock is heated from the lode probably by volcanic action. Immense volumes of hot water formed an obstacle to deep mining, and there is no doubt that this water is the vehicle of heat.

At the Calumet and Hecla Copper Mine the rock temperature observations were made at various depths, with the aid of slow registering Negretti and Zambra thermometers placed in boreholes drilled slightly upwards to a depth of 10 feet, and plugged with wood and clay. In these holes the thermometers were left from one to three months. The highest rock-temperature obtained at a depth of 4,580 feet was 79° Fahr., whilst the rock-temperature at a depth of 105 feet was 59° Fahr. The difference of temperature in the column of 4,475 feet of rock is thus 20°, the increase averaging 1° for 223.7 feet. The average annual temperature of the air at the Calumet and Hecla Mine is 48° Fahr., and that of the air at the bottom of the shaft is 72° Fahr.

	Depth in feet.	Increase in Temperature ft. for 1° Fahr.
Bootle Waterworks, Liverpool	1,392	130
Przibram Silver Mines, Bohemia	1,900	126
St. Gothard Tunnel	5,578	82
Mont Cenis Tunnel	5,280	79
Talargoch Lead Mine, Flintshire	1,041	80
Nook Colliery, Manchester	1,050	79
Bredbury Colliery, Manchester	1,020	78½
Ashton Moss Colliery, Manchester	2,790	77
Astley Colliery, Dukinfield	2,700	72
Schemnitz Mines, Hungary	1,368	74
Scarle Boring, Lincolnshire	2,000	69
Manegaon Boring, India	310	68
Pontypridd Colliery, South Wales	855	76
Kingswood Colliery, Bristol	1,769	68
Radstock Colliery, Bath	620	62
Grenelle Well, Paris	1,312	57
St. Andre Well, Paris	830	56
Military School Well, Paris	568	56
Kentish-town Well, London	1,100	55
Rose Bridge Colliery, Wigan	2,445	54
Yakoutsk, Siberia	540	52
Sperenberg Borehole, Berlin	3,492	51½
Seraing Collieries, Belgium	1,657	50
Monkwearmouth Colliery, Durham	1,584	70
South Hetton Colliery, Durham	1,929	57½
Boldon Colliery, Durham	1,514	49
Whitehaven Collieries, Cumberland	1,250	45
Kirkland Neuk Bore, Glasgow	354	53
Anzin Collieries, France	658	47
Carrickfergus Salt Mine	570	40
Slitt Lead Mine, Weardale	660	34

The mean increase deduced from these results is 1° Fahr. in 64 feet.

Since that date numerous other important observations have been made, some of the results being as follows :—

	Depth in feet.	Increase in Temp. ft. for 1° F.	Observer.
Calumet and Hecla, Lake Superior	4,580	223·7	Agassiz.
Rand Victoria Borehole, Transvaal	2,500	82	Hamilton Smith.
Port Jackson Borehole, New South Wales	2,929	80	E. David and E. F. Pitman.
Wheeling Oil Well, West Virginia	4,462	71·8	Halloch.
Dolcoath Mine, Cornwall	2,124	70	Josiah Thomas.
Schladebach Borehole, Prussia	5,734	65	Huyessen.
Paruschowitz Borehole, Upper Silesia	6,573	62·1	Koebrich.
Comstock Lode, Nevada	2,230	33	G. F. Becker.

Temperature observations, made with great care by Mr. H. A. Wheeler at other mines in the Lake Superior region, in 1886, gave the following results, which differ considerably from those obtained at Calumet and Hecla Mines :—

Mine.	Depth in Feet.	Increase in Temperature Ft. for 1° Fahr.
Atlantic	907	99·5
Central	1,950	101·0
Conglomerate	617	95·0
Osceola	996	76·5
Tamarack	2,240	110·7
Quincy	1,931	122.0

The mean inscrease is 1° Fahr. in 100·8 feet, or, omitting the Tamarack results, which were hardly trustworthy, as the stations were too close to active mining operations, 1° Fahr. in 99 feet. The variations among the different mines are very striking, the mines nearest to the shore of Lake Superior showing the lowest increase, and those furthest away showing the highest.

The deepest borehole yet made is that put down by the Prussian Government at Paruschowitz, near Rybnik, in Upper Silesia. The boring was begun on 26th January, 1892, and was finished on 17th May, 1893, after having attained a depth of 6,572·71 feet. The total cost of the borehole, which was put down to search for coal, was £3,761, and the increase of temperature was 1° Fahr. for 62·1 feet.

In the Schladebach borehole 387 temperature determinations were made. These are of special importance, as they were taken at 58 points at equal distances down to the enormous depth of 5,734 feet. These results, like those at Sperenberg borehole and at Rose Bridge Colliery, which I have plotted in Fig, 5, are entitled to special weight, not only on account of the great depth, but also of the elaborate means employed to exclude convection.

Professor Hull has offered a geological explanation of the discrepancy of the results obtained in several localities. Strata of various rocks with different conducting powers offer more resistance to the transmission of heat in a direction across, than in that parallel to their planes of bedding. Thus highly-inclined strata, such as those at

Dukinfield (where the thermometric gradient was 72 feet per 1° Fahr.) furnish a path by which internal heat can travel obliquely upwards and outwards; whilst deep-seated horizontal strata, like those at the neighboring Rose Bridge Colliery (where the thermometer gradient was 54 feet per 1° Fahr.) offer a succession of resisting surfaces to the upward passage of internal heat. It follows, that in those districts where the strata are highly inclined (at angles varying from 30° to 60°) the underground temperature will be lower than in the case of those where the strata are nearly horizontal.

In considering the temperature it must not be forgotten that much depends on the degree of humidity. The increase of temperature tends to render the air capable of taking up more moisture, and consequently moisture is absorbed from rocks, coal dust, etc. If the air of the mine is sufficiently dry to admit of free evaporation from the bodies of the workmen, a considerably higher temperature could be endured than in an atmosphere having the ordinary humidity of a mine. On the other hand, in certain circumstances the mine may become very dry and dusty, and in collieries dangers would arise from the explosive character of dry coal dust. The only way to prevent dust from becoming dry is to saturate the air with moisture.

4.—The Increase in Mining Costs.

In working mines at very great depths, the cost of mining must undoubtedly increase. The increased cost would be due chiefly to the expenses connected with winding, pumping and ventilation. Mr. J. H. Hammond calculates, however, that in the Witwatersrand, even in present conditions as to cost of labour and supplies, the extra costs of deep level mining to a depth of 5,000 feet should not exceed 5s. per ton. Dr. Becker, too, points out that the outlay on the deep mines should be economised by sinking relatively few but capacious shafts. To sink and equip a shaft 3,000 feet deep will cost about £100,000 more than to sink and equip one 1,000 feet deep. This expense is equivalent to an annual charge of 3½d. per ton on the quantity of ore requisite to supply a 200-stamp battery. It follows, therefore, that for mines worked on a large scale the increase of expense due to depth alone, in favourable conditions, is insignificant. Indeed, experience so far shows that, as the Rand mines are becoming deeper, improved machinery is coming into use, and there results an appreciable reduction in working costs, as will be seen from the following statistics:—

Year.	Stamps at Work.	Working Cost per Ton.
1894	2,273	38s. 10d.
1895	2,546	33s. 3d.
1896 (first half)	2,890	32s. 10d.

An admirable instance of the economical results achieved in a deep mine is afforded by the Atlantic copper mine, Lake Superior. The copper-bearing rock lies at an average depth of 1,800 feet below the surface. The rock is broken down with explosives, sent to surface, crushed, hand-sorted, carried to the dressing floors, passed through stamps, thence through jigging machines and over slime tables. Finally, the concentrates are conveyed to the smelting works. This complicated series of operations was carried on at a profit, although the ore yielded but ¾ of a cent of copper, and only 5d. per lb. was obtained for the refined metal. In other words, the operations were remunerative when the company received but 6s. 6½d. for each ton of copper-bearing rock treated.

An analysis of the accounts of the Tamarack Mine has been published by Mr. A. C. Lane.* This is practically the deepest mine in the world, for ore is being mined at a depth of 4,450 feet from the surface; whilst at the Calumet and Hecla Mine, where the shaft is deeper, no ore is being extracted below 3,300 feet. The total running expenses (including cost of rock drills, fuel, other underground expenses, surface expenses, and stamping per ton raised) at the Tamarack Mine are shown in the following table.

The figures show that the effect of increasing depth has been counterbalanced by that of increased output, and of improved machinery.

Year.	Average Depth.	Cost per Ton.
	Feet.	s. d.
1894	3,100	10 3
1893	3,000	9 10½
1892	2,900	9 2½
1891	2,800	10 8
1890	2,700	12 8
1889	2,600	12 6
1888	2,500	11 10½
1887	2,400	12 6
1886	2,300	12 6½

The increase of temperature has a serious effect on the amount of work men can do. In the South Staffordshire collieries, where, owing to spontaneous combustion, working places sometimes become abnormally hot, experience shows that the men cannot work such long hours, and moreover, they usually have to be paid extra, the costs being raised quite 12 per cent. This increased cost would be counter balanced by the higher price which will be realized when coal is mined throughout the country from depths over 3,000 feet. As the shallow seams become exhausted, the rate of production will decline, and if the demand continues, the selling price must undoubtedly increase.

The cost of drainage in deep mines is not likely to be appreciably greater than in those of moderate depth. It has been proved that in most Cornish mines the volume of water encountered does not materially increase, beyond a certain point, with increased depth. The comparatively shallow workings intercept most of the water, leaving only a smaller and practically a fixed quantity to be dealt with in the sump. This is notably the case at Dolcoath and other deep mines. At Levant Mine, where the deeper workings are carried for nearly three-quarters of a mile from the cliff away underneath the sea, water is met with in very slight quantities. Again, on the Witwatersrand there appear to be no deep-seated springs, and all the water encountered underground comes from the surface. In the Lake Superior region the water in some of the deep mines has been found to be a source of annoyance and expense. At the bottom of the Red Jacket shaft, the water met with is found to be highly mineralised. According to Mr. A C. Lane, it is a strong solution of calcium chloride and other salts, which rots the miners' clothes and produces boils. Owing to this fact it has been found necessary to increase the men's wages.

Another possible source of increased expense in deep mines is the necessity of surveying operations. The importance of accurate mine plans is now generally recognized. The expense of the necessary

*"Mineral Industry," New York, Vol. iv, p. 768.

surveys is, however, not likely to add seriously to the cost of mining at great depths. At the present time the cost is trifling. In Westphalia, for example, where the mine plans are laid down with excessive accuracy and the mines are fairly deep, the annual expenditure on plans and surveys is calculated to be 8¾d. for every 100 tons of coal raised. Some difficulty might be expected in connecting the underground and surface surveys by an optical method in very deep shafts, but fortunately an ingenious method* with swinging plummets has been devised by Professor M. Schmidt, which has been applied with great success in the Bohemian and Saxon mines to a depth of 2,300 feet. There is no doubt that accurate results can be obtained with this method at far greater depths.

C.—Prospective Yield of Deep Mines.

In calculations having reference to the duration of our coal supply, the limit of depth adopted by Professor Hull in 1860, and by the Royal Coal Commissioners in 1870, in the estimates of the workable quantity of coal, was 4,000 feet; and a careful consideration of the facts that have come to our knowledge since that date tends to confirm the accuracy of this view. Mr. H. W. Hughes, the manager of Sandwell Park Colliery, and the author of the standard text-book on coal mining, is, however, inclined to assume a considerably lower limit for the thicker seams of coal. He informs me that he is quite ready to admit that mining in seams up to 6 or 7 feet in thickness could readily be carried on up to a depth of 4,000 feet. The temperature of the strata will most seriously affect the operation of working, but as ventilating appliances become more powerful, enormous volumes of air can readily be circulated throughout the working places, thus materially reducing the temperature, and increasing the comfort of the men. There seems no reason why the air introduced should not be cooled at some point underground. This would, of course, increase the cost; but the benefits resulting should compensate for the additional outlay. It would not be advisable to reduce the temperature much in the downcast shaft, especially if water were present, owing to the formation of ice, which would affect the convenience of working The reduction of temperature should take place some distance from the bottom of the shaft. In thick seams, especially those from 15 to 30 feet, the limit of depth would be considerably less than 4,000 feet. Owing to the impracticability of completely stowing or filling horizontal thick seams, and the consequent necessity of supporting the roof with timber, and of finally allowing it to break down instead of settling, as it would if the workings were packed, the effect of pressure becomes a very serious matter. Indeed, at 2,000 feet the difficulties are very considerable, and the conditions at 3,000 feet would probably be such as to render working impracticable.

Turning from coal seams to consider the prospects of deep mining of mineral deposits, we find that public opinion has greatly changed. Formerly the view was generally held that veins became richer with increasing depth. Now rumours prejudicial to deep level gold mining in South Africa and elsewhere have been in circulation.

For a long time there appears to have been an impression that mineral veins are productive to a certain depth only, and that all below is valueless. Statements relative to the disappearance of veins in depth must be received with caution, since, had the workings been continued, the vein would probably have again been found, and have again become productive. The examples of depths obtained in vein mining cited earlier in this paper, show that there is every reason to believe that true veins extend to depths to which the miner will be unable to follow them.

* Brough. "Treatise on Mine Surveying." 5th edition, 1896, p. 204.

The question, however, arises: Will mineral claims be productive at great depths? Werner, the founder of modern geology, stated in 1791 that every miner was aware that veins disappeared in depth. This view was, however, opposed by Schmidt in 1827; and even in Werner's time the fact that the lower end of thick veins was not reached by the deepest mines was shown by the 500-fathom shaft at Kuttenberg, in Bohemia, and by the Heilige Geist shaft at Kitzbuhl, in Tirol, which in the 57 years between 1540 and 1597 was sunk to a depth of 2,900 feet, always in ore.

With regard to the productiveness of mineral veins at great depths, suffice it to say that the Dolcoath lode is as rich at the deepest point reached as it ever was; that rich discoveries of ore have been made at the 2,330-foot level of the Samson Mine at Andreasberg in the Harz; that the richness of the Przibram mines has increased rather than diminished at depths below 3,000 feet; and that at the Australian gold mines there are in Victoria mines extracting with profit gold ore from depths of 2,500 to 3,300 feet.

On the other hand, it cannot fairly be supposed that the richness of mineral veins invariably increases with depth. This belief is held by many practical miners. Carried to its logical extreme, it suggests that eventually the original source of the metal will be reached. In support of this wild notion, even the unexplained terrestrial density has been quoted as a favourable argument. Its origin seems to have sprung from the once generally accepted theory that mineral veins are formed from the deposits of heated rising waters.

In New Zealand the recent discovery of auriferous lodes, at deeper levels than those hitherto worked, has given an impulse to mining, as these discoveries have shown that new lodes, containing ore of a payable character, will be found at great depths to take the place of those carried down from the surface which have cut out. Many mines, which have been given up as valueless, will now be tested to far greater depths than heretofore, and by judicious management they may yet be made to yield returns which will fully compensate the owners for their outlay.

We now come to a consideration of the prospects of deep mining in South Africa. There, as is well known, the gold of the Witwatersrand is obtained, not from mineral veins, but entirely from beds of conglomerate, known as *banket*, composed mainly of quartz pebbles embedded in an auriferous matrix consisting originally of sand, but now completely cemented to an almost homogeneous material by a later deposition of quartz. The average total yield of the conglomerate stamped is 13·16 dwt. of fine gold per ton. The output of gold from the Witwatersrand has risen from 23,000 ozs. in 1887 to 2,277,637 ozs. in 1895, and the Transvaal now produces one-fifth of the world's supply.

As the bedded character of the banket deposits became known, and as the persistency in depth and the uniformity in the gold contents became established by deep boreholes, companies were organized to work the deep-seated portions of the beds. Although, near the surface, the dip is steep, fortunately, as the reef goes down, a very important flattening takes place, so that the future of the Transvaal gold industry is assured. It is true that as yet there is but little positive knowledge as to the maintenance of the ore value at great depths. We have, however, in the Robinson deep shaft, which struck the reef at a depth of 1,807 feet; in the Rand Victoria borehole, which, at 4,100 feet from the outcrop, struck the reef at 2,343 feet, 13 inches wide, assaying 1 oz. 3 dwt. per ton; in the Bezuidenville borehole, which, at 5,800 feet from the outcrop, struck the reef, dipping 29° at a depth of 3,251 feet; in the Tracey-English borehole, which, at 4,100 feet from the outcrop, struck the reef, dipping 30° at a depth of 2,397 feet; and in the Durban Roodeport Deep, where the reef was recently in-

tersected at a depth of 1,300 feet, 8 inches in width, and assaying 3 ozs. 2 dwt. per ton, sufficient evidence that the banket extends some 6,000 feet south of the outcrop. Besides this, there is the fact that the banket has already been struck by 16 shafts all along a line of 12 miles. Moreover, a careful study of the assay results shows that the variations in ore value along the dip are similar in character to those along the line of the reef, richer and poorer areas being irregularly distributed. No indication is given of the existence of a progressive impoverishment of the bed. The erroneous idea that the Transvaal mines become poorer as the depth increases is apparently due to the decreased percentage of gold in the ore crushed. This decrease is obviously explained by the fact that the decrease in working expenses has rendered it possible to treat the poorer ores that formerly were laid aside.

The Table (p. 15; for which the *Statist* is my authority) gives the latest information regarding the deep-level companies, arranged in order from west to east.

From our knowledge of the geology of other districts, the persistency and uniformity of the Transvaal auriferous conglomerates in depth is not surprising. In the Westphalian coal-field, for example, there is a bed of conglomerate intercalated between two seams of coal, traversing the whole basin. Again, at Saarbrucken a similar bed of conglomerate serves as index bed for the whole coal-field. These conglomerates are uniform in texture and composition throughout. Judging by analogy, it is evident, therefore, that below the depth to which atmospheric agencies penetrate, no further alteration in the character of the Witwatersrand ores is to be expected. There is no ground for fearing uncontrollable quantities of water, or a very rapid increase in temperature. There are, therefore, no reasons why mining on the Witwatersrand should not be carried on at a depth of 4,000 feet, and Dr. G. F. Becker, the distinguished American mining geologist, who has recently carefully studied the question, has arrived at the conclusion that in favourable industrial conditions the expense should not exceed the present cost at 500 feet.

In view of the depressed condition of Cornish mining at the present time, the subject of mining mineral veins at great depths is one of considerable importance in this country. I am glad, therefore, to be able to publish the following statement of the views held by my friend, Mr. William Thomas, the Secretary of the Mining Institute of Cornwall, and Lecturer on Mining at the Camborne School of Mines, who has long devoted special attention to the subject.

That deep mining in Cornwall is well within the range of possibility, is shown by the energetic action taken of late by the owners of the Dolcoath Mine, at present, and for some years past, the deepest,

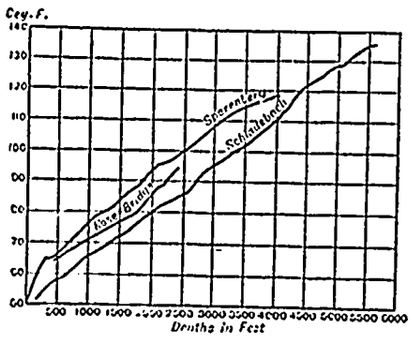


FIG. 5.

as well as the most productive, of the Cornish tin mines. The deepest of the existing inclined shafts at Dolcoath is the new Sump shaft, on which the principal Cornish pumping engine is erected. This shaft is now being sunk by two rock-drills below the 440 fathom level, and, allowing for the depth of the adit (about 30 fathoms), has reached an inclined depth of 480 fathoms, or a vertical depth of over 2,400 feet. Towards the end of 1895 a new vertical shaft of 18 feet diameter was commenced, and is expected to intersect the main lode at a depth of about 3,000 feet. There are four rock-drills employed in sinking this shaft.

At the Basset mines, too, a new vertical shaft, 16 feet 6 inches diameter, is being sunk at the present time. Both the Dolcoath and the Basset new vertical shafts are to be fitted with the best and most efficient winding and pumping machinery obtainable.

For a long period the output in many Cornish mines has been restricted, mainly because of inadequate tramming and shaft accommodation. True, in some of the smaller mines, the available reserves were too limited in quantity to warrant any outlay in the construction of better tram roads, or new shafts; but this does not apply to such mines as Dolcoath and the chief mines on the Flat Lode. At the Basset mines, and also at Wheal Grenville, there are wonderful possibilities (or, perhaps, *probabilities* is a better word to use) of deep mining along the dip of the Flat Lode. This lode dips south at an angle of 35° or 40° from the horizontal, so that vertical shafts can be made to open up vast extents of lode which, if the shafts are judiciously placed, can be worked at very low costs.

There are no difficulties peculiar to Cornwall in the way of deep mining. If pumping, winding and ventilation can be satisfactorily dealt with in the deep copper mines of Lake Superior, in the deep gold mines of Victoria, and in the deep levels of the Witwatersrand, there is nothing to prevent the same measure of success being attained in Cornwall.

WITWATERSRAND DEEP-LEVEL MINES.

Company.	N boundary: Distance from outcrop. Feet.	Dip Degrees	Depth to Reef.
Langlaagte Deep	1,500	35	Shaft No 1 struck reef, July, 1896, at 1,165 feet; No. 2 at 817 feet, in January, 1896.
Crown Deep	1,300	30	Shaft No. 1 struck reef, December, 1894, at 984 feet; No. 2, March, 1896, at 1,150 feet.
Robinson Deep	2,700	30	Reef expected at No. 1 shaft at depth of 2,300 feet; No. 2 struck south reef, July, 1896, at 1,806 feet, and main reef, September, 1896, at 1,877 feet.
Nourse Deep	500	40	No. 1 struck reef, July, 1894, at 917 feet: No. 2, March, 1895, at 1,003 feet.
Jumpers Deep	700	28	No. 1 struck reef, March, 1896, at 901 feet; at No. 2 reef expected at 1,350 feet.
Jupiter	3,700	—	Reef expected at 2,500 to 3,000 feet.
Geldenhuis Deep	1,400	27	No. 1 struck reef, December, 1894, at 565 feet.
Simmer and Jack West	4,500	—	Reef expected at 2,500 to 3,000 feet.
Simmer and Jack	0	26	Out-crop shafts, and three first series deep-level shafts developing reef; three second series deep-level shafts being sunk expect to reach reefs at 2,600 to 3,000 feet.
Rose Deep	1,700	30	No. 1 struck reef, May, 1895, at 910 feet; No. 2, March, 1895, at 714 feet.
Glen Deep	1,600	35	No. 1 struck reef, September, 1896, at 920 feet.
Simmer and Jack East	4,000	—	Reef expected at 2,000 to 3,000 feet.
Knight's Deep	2,000	—	Reef expected at 1,300 to 1,500 feet.
Knight's Central	4,800	—	Reef expected at 2,800 to 3,100 feet.

A Modern Silver-Lead Smelting-Plant.

By L. S. Austin, Denver, Colo.

Our successful plants in the west were at first erected on a small scale, and as their business has been built up, have been added to gradually as their limitations permitted. They have had to adapt themselves later to their circumstances, making the best of drawbacks, and putting up with much which, had it been originally allowed for, would not now impede them.

For such a plant as is now proposed, it is assumed that a site will be chosen possessing natural advantages which may be utilized to their full extent, and which, at the same time, may allow for future extension.

The arrangement of a plant on a terraced site has been generally considered the most advantageous; but many advocate a level site, claiming that it permits expansion, and is convenient in many respects. Even in the case of a plant treating, say, 500 tons of material per day, and saving by terrace-arrangement 40 feet of fall, the total theoretical saving is barely one horse-power. We have on the one side, then, the level site, involving the cost of installing and operating elevators, with their attendant liability to accident,* but possessing the advantages of good ventilation, accessibility and compactness of plant; and, on the other hand, the side-hill system, with fewer elevators (they cannot be done away with altogether), increased first cost of excavation and retaining-walls, less accessibility, poor ventilation, and greater extension of plant. The writer is disposed to advocate a modification of the latter plan, utilizing an extended surface with a moderate slope.

The duplication of parts in a smelting-plant is, of course, very important, since delays, even for a few hours at a time, may soon occasion a greater loss than the cost of duplicating the machinery which has caused the delay. It is accordingly better, for example, to put in two cheaper and less economical engines, to insure against a shut-down, than one larger engine, which uses proportionately less fuel, but which must be occasionally stopped for adjustment or repairs.

In a plant, especially if erected on the terrace system, the machinery-cost is not a large fraction of the total. It would, therefore, seem wise to have each machine the best of its kind, to duplicate it freely, and, by adopting the level system of building, to save the costs of extensive excavations, retaining-walls, etc., which constitute so much of the first cost of the plant, and which may occasion subsequently a heavy bill for repairs.

In operating a smelting-works the losses may be classed as follows:

1. Losses in the slag.
2. Losses in flue-dust and fume.*
3. Losses in roasting.
4. Losses by shut-downs.
5. Losses in fuel.
6. Losses in labor.
7. Losses in management.

*It is believed that elevators may be so thoroughly constructed as to have little liability to derangement. In any case, it would be well to duplicate this machinery, so that the half of it may be thrown out of action at any time for adjustment, without interfering with the usual operations.

* In considering the losses of the materials of the charge which are borne away from the furnace by the blast or draft, it is well to distinguish between the flue-dust proper and the fume The flue-dust may be defined as small particles of the charge borne along in the air-currents produced by the blast, and which settle out by gravity in flues, where the advance movement of the air is sufficiently slow to permit this deposition. This material resembles that of the charge, especially in its assay-value. The fume, on the contrary, arises from the metals, principally lead and zinc, which are volatilized at the temperature of reduction, and, passing from the furnace, become condensed as the result of contact with the cooler surfaces of the flues. It may thus be regarded as a cloud of smoke, floating along indefinitely, unless it comes in contact with the surface of the flue, or of the bags of the bag-house.

Slag.—The losses in slag caused by incorrect feeding or charging are referred to below. That arising from improper separation of matte from slag is referred to in my remarks about separators.

Flue Dust and Fume.—The loss in flue-dust and fume depends upon:

1. The nature of the ores.
2. The height of the smelting-column.
3. The form of the furnace.
4. The method of feeding.
5. The blast-pressure.

At present the tendency in the custom sampling-mills, and also of the smelting-works themselves, is to crush the entire lot of ore fine. Moreover, there are large amounts of fine roasted ores smelted, all of which add to the amount of flue-dust. It has been attempted to brick the finer portion of the charge, as well as the flue-dust itself, and this has been attended with a considerable degree of success. The endeavor is to make less flue-dust to begin with, since it has to be re-treated with considerable expense and loss.

That the height of the furnace influences the amout of flue-dust can be observed by the performance of the same furnace when carried low or when filled up. The high furnace working upon oxidized ores can be operated almost without visible smoke, even when putting through its normal tonnage.

The form of the furnace, as respects the bosh, has an important influence, especially where the furnace is a high one, as the upward volocity of the air-currents is lessened in the ratio of the increased area of the furnace at the surface of the charge.

That the method of feeding can control the amount of fine-dust, becomes evident when we consider that by a judicious placing of the materials of the charge, we can check the velocity of the escaping gases when they become concentrated in spots, so that the blast may be diffused more evenly over the entire surface. This becomes the more important, as accretions form upon the interior of the furnace.

There is a certain pressure of blast suited to a given furnace newly put in operation; and as accretions form, the suitable pressure changes. Pressures in excess of it largely increase the amount of the flue-dust without corresponding increase in the tonnage of the furnace or the cleanness of the slag.

The nature and extent of the dust-collecting arrangements will depend upon the size of the plant, the nature of the ore, and upon other considerations just named; also upon the amount of roasting to be performed. It is to be observed that, owing to the corrosive nature of the fumes arising from the roasting-furnaces, they cannot be caught in bags; and hence, to save these fumes, even in part, a system of flues would be needed. The amount of saving may in some cases hardly be sufficient to justify the increased expense, especially if it is in contemplation to put in the perfected system of bag-house and blowers. By the use of the bag-house, it is possible to dispense with extended flues and high stacks, and thus do away with one reason for the terrace-system of building.

Roasting.—Among the most serious losses in a smelting plant are those from the roasters. According to the records of a single plant, extending over a period of five years, this loss has amounted to $80,000 per year. The temperature of the escaping gases of these furnaces was upward of 1000° Fahr., while at the stack the temperature was still 600°. At this high temperature, lead, silver and gold pass away; whereas, where these gases cooled down during their passage to the stack, we might hope to effect a notable saving. Reference will be made to the utilization of this waste heat in connection with the discussion of the use of the hot blast.

Shut-Downs.—The losses arising from shut-downs have already been referred to. They are equal to the total expense of operation, less the fuel not used during the stoppage. All the profit of running is lost besides. Moreover, such delays are detrimental alike to the slag and to the furnaces; and the latter, when again started, do not work well until "warmed up."

It may be observed that any decided diminution of the blast, even for a short time, is a drawback, lessening the tonnage of the furnace and affecting the cleanness of the slag.

Fuel.—The losses in fuel resulting from incorrect charging may be considerable. Any way of lessening the amount of fuel to be used at the blast-furnace means not only the actual value of coke saved, but also the increased tonnage of the furnace, owing to the increase of productive charge in the same space. Excessive fuel brings in its train the disadvantages of over fire and increased volatilization, both of lead and zinc, with the consequent more rapid formation of accretions, which eventually terminate the campaign.

Labor.—In building a plant, the endeavor should be to reduce the item of labor as much as possible; but it should not be forgotten that this must not be done at the expense of efficiency in running. Especially at night, the importance of having sufficent labor to handle the furnaces and to make repairs speedily often outweighs other considerations.

Management.—Losses in business management may arise not only from paying too much for ores, but also from buying ores containing elements injurious to the smelting-operation. They may also arise from shortages in supply, through failure to provide supplies sufficiently in advance, or in right proportion.

Concentration of Power.—The concentration of the power-generating plant under one roof and under charge of a competent engineer is a matter of much importance. In such a case the suction-fans, or blowers, for the bag-house could be so located and operated as to save the expense of an extra engineer, and perhaps of boilers. That the sampling-mill and elevators, as well as the pumps and blowers, may be thus centrally operated by wire-rope transmission or by electric motors, is undoubted.

Delivery of Materials.—Delivery of materials to the plant, including ore, fluxes, coal or coke, may be made by tramway (wire-rope or rail), by wagons, by railroad, or by two or more of these methods combined. Ore coming in quantity from a mine by tramway is conveniently dumped in a receiving-bin with an inclined bottom. Or this bin may be made in two parts, to allow of change from one lot to another while one bin is being emptied. If now it is shoveled to the crusher, an aliquot part can be reserved for a sample; otherwise the whole may be drawn off to the automatic sampler.

When the ore arrives in wagons, and especially when in small and numerous lots, the problem of handling is not so easy. Commonly the ore has been dumped from the wagons upon the ground or upon an extended floor, thence to be handled with barrows to the sampling-mill and storage-bins. This involves considerable work in moving the ore. It is undoubtedly the easiest way for the wagons to dump the ore beneath them. There is, however, considerable floor-space needed, especially where the ore is brought in wagon-trains. A more compact way is to provide bins, alongside of which the wagons unload. Even then, however, the ore must be rehandled to the sampling-mill.

Where the materials come in and the base-bullion is shipped away by rail, the trackage required will depend upon the size of the plant. It has generally been considered advantageous to have a track set at the level of the slag-dump for loading base-bullion; but as this constitutes less than one-tenth of the weight of the materials smelted, it is a question whether it would not be well to elevate the track to the receiving-level, where empties are always available, and where the tracks which transfer materials may be run direct upon the floor of the car, making use of a piece of portable curved track. This method has proved very efficient in practice.

Where, as is the case with a modern plant, all the ore is sampled as it comes in, this unloading would naturally be done at a common point, so that the ore, as unloaded, could be automatically sampled and conveniently stored. The loaded cars beyond this common point require plenty of trackage, which may be doubled or trebled, with switches to throw all cars upon the unloading tracks before they reach the sampling-mill. The empties are treated in the same way. The outer-one of the tracks may be reserved for handling cars in or out. The track scale is naturally set at the entrance of the yard, and should be so placed that only cars to be weighed pass over it, and not, as is so often the case, located upon the main thoroughfare. These tracks, being arranged with a continuous grade past the sampling-mill, permit the unloading and dropping past of each car without the use of switch-engine or other power.

The handling of fuel and fluxes takes a somewhat different course. Much of the coke and limestone may be unloaded direct from the cars to the furnace. The coke amounts to from one fifth to one-eighth of the total materials, and is commonly stored at a greater distance from the blast-furnace because of its smaller relative amount, and as a precaution against fire It has generally been stored upon the ground, but it is better to pile it upon a floor, preferably of brick, set as row-locks, and not of wood. If care is not exercised, the coarser part of the coke may be used at one time, and the finer at another, producing corresponding irregularities in the furnace. Where the demurrage-regulations, requiring the prompt unloading of cars, are rigidly enforced, unloading-pockets may be put in to advantage. The limestone and iron ore could certainly be thus stored, and thus much labor could be saved, especially when, as often occurs, these materials constitute one-fourth ore more of charge. The method, now quite common, of storing coal convenient to boilers and roasters is certainly practical and economical of labor, and especially when we consider that it comes in as needed, and the small amount to be carried in store cuts but little figure in the total expense of handling. The handling of coal has been treated so thoroughly in the Eastern States that we have only to look there for our best examples of practice.

Sampling and Handling.—We come now to the question of the sampling and handling of the ores.

Upon sampling, some of the ores, awaiting settlement, must be reserved—each lot separately. Then, when released for use, they are distributed and layered or bedded at the appropriate bins.

Where the sampling is duplicated, the mill becomes more complex. All ores are properly passed over a grizzly to the main crusher, a precaution which has its advantage in wet or freezing weather, or when the ore is of such a nature as to be likely to clog the machinery. In some cases it is more economical to keep it away from the machinery altogether. The elevating of this crushed material to command the automatic sampler depends for its success upon a strong and thoroughly constructed endless elevator, to which plenty of height should be given.

The requirements for reliable automatic sampling are as follows:

1. The aliquot portion should be taken from the entire stream of ore.

2. This portion should be taken out as frequently as possible.

3. It should be taken evenly from all parts of the stream.

4. The stream should be a regular one, or at least should fluctuate in a regular or gradual manner.

5. The aliquot portions taken out should be mixed together before further sub-division or cutting down.

6. The re-crushing of the ore should proceed as its quantity is reduced, so that the ratio of the largest rich piece to the weight of the whole shall not exceed a specified limit.

7. The machinery should be as simple as possible, that it may be easier to clean up, and that there may be consequently less danger of "salting" succeeding samples.

Commonly the sulphide-ores are crushed at once to their final size preliminary to roasting, since they require no farther treatment, and are more accurately sampled when so fine. As a general rule, all the ore of the sampling mill should be drawn from shoots, on the principle that from the time it is dumped over the grizzly it is not to be shovelled up until it reaches the furnace. From the sampling-shoot it is to be transferred to the storage-shoot, thence to go to the roasters or to the main ore-bins, as required.

For the horizontal transfer of materials, the writer favors the use of a tram-car of good size, holding at least 2,000 pounds, the loaded car travelling on a slight down-grade, the wheels (set close together to facilitate swinging on the turn-plate) having long and well-designed bearings, and broad rims to the flanges. With a rate of travel of 200 feet per minute, on a straight track, a considerable distance can be speedily covered, and curves and turn-plates should be avoided as much as possible. Accordingly, the storage-area should be covered with long and narrow bins, say 200 feet by 15 feet each, with a central track, which will permit a side-dump car to cover the entire space pretty well. As the crushed sulphide-ore is to be layered or bedded also, it is a question whether the conformation of the ground will permit it to be so stored as to deliver at hoppers on top of the roasters. One man is often selected to attend to charging the roasters; and, where they are not too numerous, has time enough to shovel up all the ore needed, and to charge it to the hoppers.

Besides the material already enumerated, there remains much which has to be returned from the slag-floor, viz., part of the slag, the matte, the barrings, and perhaps the flue-dust. The inclined elevator, so much used in this connection, seems out of place, since it neither takes the slag from where it is made, nor delivers it to the place where it is to be used. This can evidently be done with the vertical elevator, since a track laid to any part of the dump can connect with it, and, on the floor above the load goes at once to its appropriate furnace. The same elevator, going to a higher level, also enables a higher track to convey the matte at once to the crushing-machinery, in preparation for roasting.

All materials of the charge may be brought to the furnaces by means of tram-cars of 2,000 pounds capacity. The tracks run into the bins or alongside the railroad cars, and are arranged to ensure convenient loading at all points. Under the method of using large charges, but little re-handling is done at the weigh-scales.

At the ore-bins, perhaps the following plan might be used: The bottom of the bin to be a movable one, arranged something like the bed of a gravel-waggon. The ore drops through a movable hopper at the front edge of the movable floor into the charge-car, thus avoiding the shovelling, which constitutes so large a portion of the work.

Having arrived at the furnace with the charge, it would seem that it would be well to conform to recent practice, and to charge everything into the furnace without re-handling. But at this point we have to pause and consider. It will be recalled by some among us that in the older practice of ten or fifteen years ago, with small and low furnaces, a good deal was thought of the skill of the feeder in nursing his furnace, feeding for a tuyere, and adding the various correctives considered at that time necessary for the welfare of the furnace. Can this, with our present large and high furnaces, be a thing of the past? It is not so considered by some of our metallurgists, who have not changed their ideas in this respect. While a furnace is in good condition, with no wall-accretions and no consequent over fire, with a low fuel-charge to help out matters, the need of such feeding is less apparent. In the writer's opinion, however, it must be admitted that careful and proper distribution of the fuel and materials of the charge means better, smoother and more continuous running of the furnace, and a slower development of the evils we wish to guard against. Evidently, if the materials are properly proportioned and properly fed to the furnace, we may hope that the work below can be made to conform, with expectation of favourable results. Incorrect feeding and charges, on the other hand, cannot fail to show their bad results as soon as they come down.

Height of Furnace.—As regards the modern lead blast furnace, the tendency is continually to increase its height, with the idea of improving reduction; and this (with the precautions mentioned above) is measurably true. The high shaft is certainly harder to reach, to clean, to run down and to start up; but with long campaigns such considerations cut but little figure. It is rather with oxidized zinky ores, where high fuel seems indicated, that accretions rapidly form, and stops are accordingly frequent.

Water-Jackets.—The water-jackets of our furnaces still leave much to be wished for. If of cast-iron, they are liable to crack at any time; and even when of the more expensive steel or wrought-iron, they may burn out at some corner, and thus stop the operations of the furnace until replaced or repaired.

The old brick bosh, now entirely supplanted by the water-jacket in lead-smelting, was effective in retaining the heat, and worked smoothly when not burning out. The writer has often thought that, with boshes made up as in the recent iron blast-furnaces, the water-jackets, with their larger absorption of heat and their annoyances of cracking, could be avoided. This appears not impossible, now that the type of slag to be used within them, being more siliceous than formerly, is less corrosive in its action on brick.

Air Leaks.—The air-leaks about the furnace, at the various openings and joints, and especially at the tuyere-sacks, leave much to be desired. These are defects of mechanical construction, which could be remedied without difficulty, but, perhaps, at the expense of facility for handling when it is, for any reason, necessary to stop the furnace. Such stops, however, are becoming less frequent with improved machinery, and especially with the duplication of such parts of the plant as are liable to accident or need repair. With spare engines, spare boilers, and spare pumps, stoppage may be reduced to a minimum, and the small margin sometimes left between profit and loss may be saved.

Blowers.—As regards blowers, the almost universal practice has been to use the rotary blower. They have, certainly, done very good service; and the modern rotary blower has been so carefully made as greatly to reduce its "slip," though the extended surfaces of contact are still there, and leakage of the air backwards is inevitable, and especially considerable at the pressures now prevailing. The writer has long held the view that the cylinder blowing-engine is the proper one for the lead blast-furnace, since the air-joints of piston and cylinder are those of actual contact, and the metallurgist may count on his cubic feet of air, whatever his pressure. This has not, heretofore, been so evident in such work; but, with tighter joints, and by comparison with the analysis of furnace-gases and the amount of fuel used, discrepancies show themselves otherwise not to be accounted for. A whole set of purported data respecting the air used and performance of the blast, thus becomes useless; for example, deductions as to the

increase or decrease of the tuyere-orifice, its pointing in a given direction, the amount of air entering the furnace, etc., are vitiated.

The Hot Blast in Lead Smelting.—Since the gases at the throat of a normally-working lead blast-furnace contain about 4 to 6 per cent. of CO mingled with some 14 to 18 per cent. of CO_2 and 75 per cent. of nitrogen, and since these gases are farther diluted with air which enters at the charge door, any endeavor to use them in combustion is out of the question. There remains, then, the alternative of heating the air blast externally:

1. By the slag.
2. By externally heated blast-stoves.
3. By regenerative stoves, heated with oil or producer-gas.
4. By oil-residuum: either (A) in a receiver or stove, in which combustion of the oil, gas and air is effected; or (B) by oil jets at each tuyere.

Mr. Herbert Lang has attempted the heating of the blast by means of hot slag, and claims to have obtained by this means a temperature of 500° Fahr., which is much below the temperature considered necessary in iron-practice. Whether an apparatus arranged like the slag-heated boilers at Broken Hill, Australia, would prove effective in air-heating, is a question to be solved when it is conceded that the hot-blast will prove an advantage in the treatment of lead-ores.

The pistol-pipe and other hot-blast stoves, where the heat is communicated to the air by transmission through pipes, are expensive and liable to leak at the joints; and, because of the thickness of the pipes necessary for durability, are anything but efficient. It has been suggested by Dr. M. W. Iles that the flues leading away from the roasting-furnaces afford an important source of heat, since in this case the gases issuing from the furnace may have a temperature as high as 1000° Fahr., while at the stack they still retain 600° Fahr Air-pipes placed within the flue would absorb a portion of the heat, at the same time cooling down the issuing gases, which, in their highly-heated condition, are carrying away value from the roasting ores. Other methods of utilizing this waste heat, such as we are familiar with in connection with puddling-furnaces, could also be applied.

The hot-blast stove at Nesmyth, of the Colorado Iron-Works, operated a year ago at the Omaha and Grant Works, at Denver, has given promise of success, with such improvement in proportions as will be suggested by further experience. It consists of a cylindrical brick-lined receptacle, in which oil is burned in conjunction with one-fifth of the air, thus heating the remaining four-fifths needed for the blast. The products of the blast which enter the furnace are then a large proportion of air, mingled with some nitrogen and with CO_2, in case of the combustion of the oil. Its effect then would be to diminish the intensity of combustion, but with an increased production of CO, as the result of the reaction between the CO_2 and the incandescent coke. That this would be objectionable in lead smelting, one cannot say. Experience might prove it to be a great advantage. Immediately at the tuyeres, its effect ought to be to prevent the troublesome crust which so often forms upon the surface of the lead, and which is so detrimental to the working of the furnace. We would watch with much interest experiments in this line.

Dr. W. L. Austin advocates, in his own specialty of pyritic smelting, the burning of a jet of oil at each tuyere. The products are much the same as in the Nesmyth apparatus. The application is certainly very direct, simple and inexpensive; and provided combustion can be completed before entering the furnace, it should give results as good as those of Nesmyth.

The Separation of Matte from Slag.—This is a matter which we could wish were more thoroughly settled among metallurgists. Two methods, the separating-reverberatory and the large transfer-pots, are rather suited to a plant of several furnaces than to a single furnace, where the Mathewson slag-tap, the fore-hearth, or the settling-pot are still in use. In favor of the reverberatory it is strongly urged that the time during which the slag remains entirely liquid permits the thorough separation from it of all globules of matte and lead. By any other method, the separation has to be completed during the short time the slag remains liquid, and this, too, with the formation of a considerable share of foul slag, which has to be returned to the furnace for re-melting. The latter is not necessarily considered a drawback, as metallurgists favor the re-smelting of considerable quantities of slag, often to the extent of 40 per cent. of the charge, in our Western practice. Whether the time will come when ores will be smelted with a low fuel in the blast-furnace, and all the slag thus formed retreated in a reverberatory of the type of the Argo copper-furnace, is a curious speculation. We are certainly beginning at something which looks a little like it.

The Slag Dump.—The slag constitutes 70 per cent. of the charge, so that the materials put into the furnace (including coke) are to the slag as 115 to 70. Hence these materials should be handled (as they are) with so much greater ease than the worthless material; and this consideration takes the precedence. It seems strange, however, that so much care should be taken to locate conveniently the place of deposit of that worthless material (the dump).

A modern plant ought to provide for a cheap and easy method of slag-disposal in place of, as is sometimes the case, the slow transfer by hand to the edge of the dump. The neatest method of effecting this is, again, with the assistance of the elevator, in this case large enough to hoist a slag-truck, such as that used at the Omaha and Grant Works, at Denver, and now made by the Colorado Iron Works, of the same place. This truck, having been raised to the higher level, runs away upon a descending grade until it reaches a bank or edge of a hill, at the right or left of the furnaces, where, turning a curve, it comes back, still descending, the track thus forming the edge of the dump, anywhere along which the contents of the pot can be discharged. The man in charge now drops the train farther back to the point of filling, ready for use once more. Any animal power is thus dispensed with; the height gained by the elevator being sufficient to insure all forward movement. Such arrangements preclude all anxieties as to dumping room; while a small space, reserved immediately at the front of the furnace, is used in case the elevator should need repairs.

Dr. M. W. Iles, in a private communication on this subject, says:

"Other good and practical methods suggest themselves. For example, removing the slag in pots arranged trainwise, as practiced at the Arkansas Valley Smelter, at Leadville, using a compressed air locomotive, which possesses advantages over the steam locomotive, and which has been brought to a high degree of perfection by H. K. Porter, of Pittsburgh, Pa. Or for this might be used an electric motor, in conjunction with a trolley-system. In certain favoured localities, where the slag could be removed by granulating in water, it could be conveyed to some central locality, and thence, by a simple and inexpensive bucket-hoist, placed in open cars, removed from the works and used for railroad-ballast, thus bringing an income to the company. Extreme caution should be used to thoroughly separate the matte from the slag before granulating."

Yard Floor.—To cover the surface in front of the furnaces with cast-iron plates is a precaution not to be neglected, even though expensive. The ease of keeping clean and of moving pots about quickly compensates for the expense; and, moreover, larger slag pots can be used.

Roasters.—In spite of the cheaper roasting claimed for the automatic roasting-furnaces, the long-bedded roaster still holds its own, and those works using the automatic roasters retain and use the former, notwithstanding their enterprise in adopting, and skill in handling, the

latter. In fact, where it is desired not only to dry-roast, but also to slag the product, it is hard to improve upon a furnace where a continually increasing heat is so skilfully supplemented by the care of the furnace-man. With ores particularly suited to dry roasting the case is different; and in this sphere the automatic roaster is unexcelled. A large class of ores, leady and containing zinc, lend themselves, however, to the operations of the long roaster as to no other. How future improvements in roasting will modify these ideas it is difficult to say. Certainly the cost of roasting has been reduced to a very low figure; and the product may be eventually so bricked or agglomerated as to remove every objection to such methods. There is here an inviting field for invention.

Roofs.—In these drier regions of the West, with infrequent rains, drainage becomes less important; still, during wet weather the disposal of water becomes sufficiently troublesome. The ores, when bedded, should be protected by suitable roofs, since sudden snows and rains so change the nature of the charge as to affect appreciably the cleanness of the slag. On the main furnace and other roofs, the bay or saw-tooth system of roofing can be used to advantage, and water which pours down upon the men and upon the retaining-walls, as is so common, can be led to the valley of the roofs, and thence by proper down-spouts to the ground or drain. The gutters can be underlaid with steam-pipes, to melt the accumulated snow or ice which forms in such places; and there will then be no question of keeping the buildings well drained, and free from danger of overflow.

Discussion.

Henry A. Vezin, Denver, Colo. (communication to the Secretary, February, 1897): I have read Mr. Austin's paper with considerable interest, more especially as the designing and study of such works have been an attractive occupation for me during the last twenty-five years.

Mr. Austin says that a "plant on a terraced site has generally been considered the most advantageous," and also that "many advocate a level site," while he himself advocates a modification of the former plan, by "utilizing an extended surface with a moderate slope."

Among the advocates of the terraced sites as against level ones, I do not recollect ever meeting a metallurgist who had even made an attempt to plan his works for level ground, or who had, in a lucid interval, figured *how much* he gained or lost by one or the other method. The average metallurgist starts with the assumption that it is rational to conduct his material down hill because its movement is aided by gravity, while to elevate ore or furnace-material by machinery he vaguely believes to be not alone wrong in principal, but also unneccessarily expensive.

Let us look into the expense of elevating, and see whether it really is prohibitory of the successful operation of smelting works on a level site. Hoisting or elevating material in the west, even with a consumption of coal as high as 10 pounds per hour per horse-power, can be readily performed for ¼ cent per ton, the lift being 30 feet. Add ¼ cent for repairs, and we find the total cost per ton ½ cent. Mr. Austin admits for works on a level site good ventilation, accessibility and compactness of plant. Now assuming, for the sake of argument, that the cost of elevating is four times as great as my estimate, is not the one point, *good ventilation*, cheap at such a price?

It is, however, unfortunate for the terrace advocates that the cost of elevating is not saved in their system, which involves tramming much further (usually by man-power), a great amount of shovel and barrow-work and less convenience in the general arrangements, as well as interest on the greater first cost of the works.

As to "liability to accidents," if elevators are properly constructed they are as safe as any other machinery used in smelting-works. Like the blowing-engines, they should be in duplicate when they fulfil an important office.

The advantages of a flat site over one in terraces are: (1) that the first cost of the works is smaller; (2) that the arrangement can be made more convenient, as the lay of the ground does not compel placing the different buildings or department in a certain predestined order, so as to obtain the fall required; (3) that every square foot of the ground may be at will alternatively the equivalent of an inferior or a superior terrace to every other, and hence parts of the works that, on a terraced site, must be far apart in vertical distance, can be placed on a level site side by side.

In the terrace-system the ore can only go down hill unless elevators are used; and if these are required it makes little difference whether a few more are put in or the indispensable ones are built higher. The objection has been urged that elevators, especially the platform-hoists, get out of order or break down. In cases that came under my notice, I found that the management had tried to get for $300 to $400 machinery that could not properly be made for less than twice that sum. There is no reason why elevators should not run day-in-day-out with far less chance of interruption than a steam-engine, which is the most delicate machine used in mines, mills and smelting-works, and the most liable to interruption for adjustment or repairs. I assume, of course, that the other machinery is amply strong and well made.

I may cite a few examples of the manner in which professional men deceive themselves by not asking themselves "how much?" In the autumn of 1882, during the Colorado meeting of the Institute, a very able geologist, perfectly familiar with Leadville and its surroundings, while passing the smelting-works below the town, pointed out to the other visitors the arrangement of the plants, and wound up with the words: "as if intended by nature as the site for lead smelting-works." I had kuown the arrangement of these works since 1879, or practically since most of them were built. There was always a great deal of shoveling, and much of the ore was wheeled by hand *up hill* and shovelled *up* into the bins. It would have been easy to construct works on level ground for less money, and to run them at much less cost per ton, even it had been necessary to elevate the slag to get rid of it.

General Von Helmersen, Geologist-in-Chief of Russia, who published, in 1872, a very complete geological map of the coal-fields of the Donetz, in Southern Russia, spoke of the site of the iron furnaces at Lissitchansk, in the northwestern corner of these fields, as specially designed by Providence for iron-works. His reason was that they could be arranged "rationally," *i.e.*, in terraces. As I remember the ground, it has a slope of about 15°, possibly less, and the fall from the top of ground (or furnace) to the river is 280 feet. No iron-master that I know would choose this site, even if coking coal and good ore were found in the neighborhood, which is not the case.

In 1888 the advising engineer of a wealthy syndicate hunted all over Montana in search of a site having 200 feet fall, on which copper-smelting works were to be built. It would have been very easy, with a flat site, to give this gentleman the equivalent of 2,000 feet fall, or more, if necessary, and he could then choose a place which would offer the greatest advantages as to railway-connections and power. The latter consideration probably governed the final choice, as the works were built on ground having, as I understand, an inclination of less than 3°, while the power is furnished by a river flowing past the site.

It is not probable that advocates of the two systems will ever come to an understanding as to what they really disagree about, until each has designed works according to his ideas of what is best, and then has shown the advantages that he gains, not in uncertain terms, but in the precise language of dollars and cents per ton of ore. Heretofore, whenever I have been drawn into a discussion of the subject, I have not been able to elicit from the advocates of the terrace system anything but vague declarations of general principles, or the assertion that the "rational" way to build works is in terraces.

Mr. Austin gives no reason for his preference for a "moderate" slope. If he expects to secure the advantages of both systems without the inconvenience of either, he has my sympathy; for to me it appears he will have the disadvantages of both. On the one hand, he loses the freedom of arranging his works to the best advantage, while, on the other, he must use, so far as I can see, as many, if not more elevators as on a level site.

Sampling.—No one, I presume, will dispute the correctness of the seven requirements for satisfactory automatic sampling, as laid down by Mr. Austin on page 7 of this paper. But after reading what he says, we are no nearer knowing how he intends to solve the problem than before. A strong prejudice exists against the use of automatic samplers amongst those who have either tried defective ones or else have misapplied good ones. One objection that I have heard urged by an able metallurgist against a mechanical sampler is that, when the stream of ore is interrupted the machine takes no sample. This is correct; but when no ore is passing no sample should be taken. The machine alluded to I sketched out about twenty-five years ago; but it was never applied until within the last few years. It consists of one or more scoops attached to a vertical revolving shaft. In passing through the stream of ore the scoops cut out an equal portion from each part of it, and thus assure a correct sample of the whole. These scoops can be arranged to take a cut out of the stream every second, or less, if necessary, and to take any proportion up to one-half of the ore. As regards the continuous stream of ore, there should be no difficulty in maintaining a uniform stream, fluctuating only proportionally to the rate of feed to the crushing-machinery. But assuming that the stream, through carelessness or design, is intermittent, the chances are entirely in favor of the sample being correct if taken every second. Not the least advantage of this sampler is the fact that it is not hampered by any patent rights.

Another objection urged against a good sampling-machine is that the coarse pieces of ore which strike the edge of the scoop are assumed to jump off and go with the rejected portion of the ore—that is, most of them do so, and hence the sample does not contain its due proportion of lumps, and may be richer than the average of the ore. To remedy this alleged fault, I propose having the rejected portion caught by the scoop, and the part that falls taken as the sample. For this purpose the scoop is made as large as necessary to take the proportion (⅓, ¼, ⅕, ⅛, etc.) of the stream that is to be rejected. This arrangement should satisfy the most anxious metallurgist.

In several cases the machine above alluded to has been arranged to take duplicate samples, so that they might check each other. One machine took ¹⁄₁₆ of the steam once every six seconds; the other the same amount just as often, but three seconds later, or half-way between the scoopfuls of the first. The samples checked so closely that the method was soon abandoned, and the two sixteenths were run together. If the resulting samples is so large that it can safely be cut down again, the largest pieces being 1½ inches in diameter, it is shoveled into the crusher again, so as to pass as a continuous stream over the sampler. If this takes ⅛, the second sample is ¹⁄₆₄ of the original lot. This proportion has furnished perfect samples in treating Cripple Creek ores containing 1 to 2 ounces of gold per ton. I think, however, that rather more should be taken, and more frequently, especially if duplicate samples are not taken. With richer ores, especially when the values are very unevenly distributed, it would be best to take not less than ½, and take a slice out of the stream not less than once every 1 or 2 seconds.

As to cleaning the sampling-machinery, the boot of the elevator and sometimes the spouts need it. The sampling-machine cleans itself.

When small lots of ore are to be sampled, especially if they are rich, the method of "coning and quartering," sanctified by long usage, is employed. Assuming that the greatest care is taken to keep the apex always vertically above the point of its first beginning, to have the distribution as nearly regular as possible, and to do the quartering by sheet-metal plates, so that, when a quarter is removed, the coarse pieces from the adjoining quarters do not fall upon the ore that is being removed, the result is still not always perfectly satisfactory, If the cutting-down is done by taking every alternate shovel for the sample, reducing the pile formed by these in the same way, a closer sample is the result, with one-third to one-fourth the amount of labor. In this way ore is treated as a stream from which a foot is taken, and the next foot rejected. If the pile contains 4 tons, and a shovelful weighs 10 pounds, as might be the case with heavy ore, 800 cuts are taken. This sample must certainly be closer than when, in quartering, only 4 cuts are made, for the supposed mixing due to coning cannot possibly compensate for the error due to so few cuts. The sampling of small lots, or the cutting-down of the samples from the main automatic sampler, can be done by one man, if he has a small platform-hoist at his disposal. He would hoist the ore in a car, or in suitable cans on wheels, and dump it over a good divider. From this the ore would fall into similar cars or cans, and the operation would be repeated until the required reduction was obtained. There would be no sweeping-up or shoveling. When it became necessary to crush the ore finer, the same hoist would serve to raise it so that it could be dumped into the hopper over the feeding-shoe of the sampling-rolls. The crushed ore from the latter would be received in a pan on wheels or a car. There would be no feeding-arrangement for rolls, consisting of a man shaking a shovel. Thus, one man could do the work of at least eight, and more satisfactorily. The sampling-rolls should be very strong, so as to crush. I recently saw a pair, 20 to 12 inches, that could safely be set for a pressure of 20 to 25 tons between the rolls.

On page 10, Mr. Austin speaks of the water-jackets, whether of cast-iron or wrought-iron, as unsatisfactory. The life of a cast-iron water-jacket, if made of the best iron, cast in dry sand, is three years and upwards. According to the repairs during the past year, the average life of a jacket in one of the smelting-works of Denver is more nearly ten years. The loss of first-class cast jackets is now almost always the consequence of carelessness on the part of the attendant. The cost per pound is 3 cents, making the cost of a jacket, 20 inches wide and weighing 450 ponnds, $13.50. If made of sheet-metal, they weigh about half as much, but cost about three times as much if 20 inches wide, and fully twice as much if each side of the furnace is made of two jackets. I myself know but two works where steel jackets were used. In one of these, each side of the furnace consisted of one jacket. They gave a good deal of trouble in the beginning, due, to some extent, to the lack of skill on the part of the maker. In the other works, each side was formed by two jackets. These were very well made and carefully handled; but within four years some of them had to be patched, increasing very much the liability to burn out or become leaky. In 1881 or 1882 three or four months were considered a good life for a

cast-iron jacket. They were then cast in green sand, and cost about 7 cents a pound in Leadville. Some economical metallurgist beat the fouudry down ¼ cent per pound, and reduced the quality in consequence. Poorer iron was used; and the jackets lasted, at most, six weeks. At certain works in Colorado, as recently as four or five years ago, cast jackets made in green sand by men who evidently didn't know how, broke, when the furnace was blown in, before it was half full; and none of them lasted over a week or two. Hence the growth of feeling in favor of the wrought jacket. The life of a well-made cast jacket, its low cost, and the ease with which it can be replaced, hardly justify Mr. Austin's remarks.

Air-Leaks. (Page 10).—The principal loss is probably through the infinite number of fine holes in the canvas sacks or hose. They can be made air-tight by coating the inside with a thin covering of glycerine glue, which remains pliable like rubber.

Blowers. (Page 10).—I think Mr. Austin will find that the cost of a cylinder-blower is but 20 to 25 per cent. geater than that of a rotary pressure-blower and engine to drive it, the two having the same capacity according to the catalogues. The capacity of the latter is given as the displacement of the impellers without allowance for back-leak or slip. With pressures from 1 to 2 pounds, this slip becomes very great; and it is probable that for the same actual capacity at 2 pounds pressure the cylinder-blower will cost no more, if as much, as the rotary.

Vein-Walls.

(Paper read before the American Institute of Mining Engineers.)

By T. A. Rickard, Denver, Colorado.

From time immemorial the fissure-vein has been held the simplest type of ore-deposit. The prominence given to it by Cotta and his disciples, from their study of the mines of the *Erzgebirge*, is impressed upon technical literature; and, in consequence, the ores which carry the valuable metals have been supposed to occur mainly in fissures, cleaving the rocks in diverse directions, and the noblest type of vein has been deemed that which cut across the country independent of its structure, whether evidenced as bedding, foliation or cleavage, and which was identified with rents produced in the rocky crust of the earth.

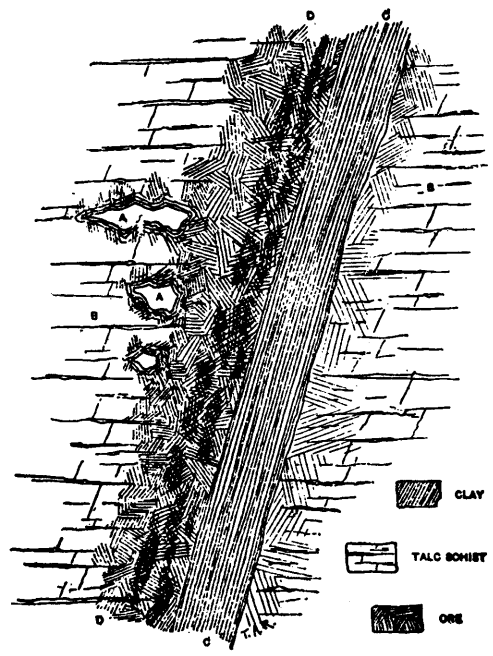
As so conceived, the vein was a fissure filled with ore, extending through the country for a varying distance, and continued downward to a depth more or less proportionate to its longitudinal extent. The vein-material was bounded by an encasement of rock, and those immediate surfaces which limited it on either side were called "walls."

These primary conceptions have become modified by the experience of modern mining in widely separated regions. The study of lode formations has led to the recognition of notable departures from the supposed normal structure of the veins of Saxony and Cornwall, the two classic homes of early economic geology.

Typically the walls of a vein are conceived as parallel rock-planes enclosing the ore; the upper one being called the "hanging," and the lower the "foot-wall."*

Walls are rarely alike. Even where a vein traverses a homogeneous formation, such as a massive crystalline rock, it is usually found that the surface which bounds it underneath differs from that which limits it overhead. This is to be ascribed to the effect of the agencies which brought about the deposition of the ore. The action of underground waters tends at first to affect both equally; but in many cases probably the solutions, as they slowly ascend along the line of fissuring, are prevented from penetrating into the encasing rock by the occurrence of an impermeable covering of clay, due to abrasion, which may line either wall, but, because of gravity, generally accompanies the under one. Similarly we are justified in supposing that the deposition of a mineral deposit may form a coating which would serve to protect the foot-wall from the corroding effects of chemical action. The activity of the mineral-bearing current thus becomes diverted in its greatest intensity toward the upper wall, where the decomposition of the rock-surface may be followed by its disintegration, so as to cause the exposure of fresh faces for further dissolution.

Illustrations of these conditions may be seen in Figs. 1 and 2. The first is reproduced from a sketch made June 25, 1895, in the lower level of the Union and Companion mine at Cornucopia, Union County, Oregon. It represents the breast of the north drift on the west vein. The country, a fine-grained granite, is not visibly altered under the foot-wall; but along the hanging it exhibits an alteration of its more soluble ingredients. There is a slight selvage, D, separating the granite from the pay-ore, C, which is about 10 inches thick, and consists of ribbons of quartz, impregnated with pyrite and alternating with strips of altered country. A distinct parting, unaccompanied by any apparent selvage, divides this streak of ore from one, B, below it, which is twice as thick, but mnch less gold-bearing. This part, B, of the vein, consists of white quartz,carrying occasional patches of pyrite, and marked by large inclusions of slightly altered country, arranged along the foot-wall, where a thin selvage separates them from the outer granite. The evidence of vein-structure embodied in this figure permits diverse interpretations. The upper pay-streak, C, appears to me to be country-rock, in place, decomposed, fractured, and silicified, with accompanying precipitation of gold. The central wall may have been the original hanging-wall. The present foot-wall is sufficiently distinct; but the occurrence of the pieces of enclosed country leads me to believe that at an earlier stage the foot-wall was broken and irregular; the shape and position of the fragments of rock

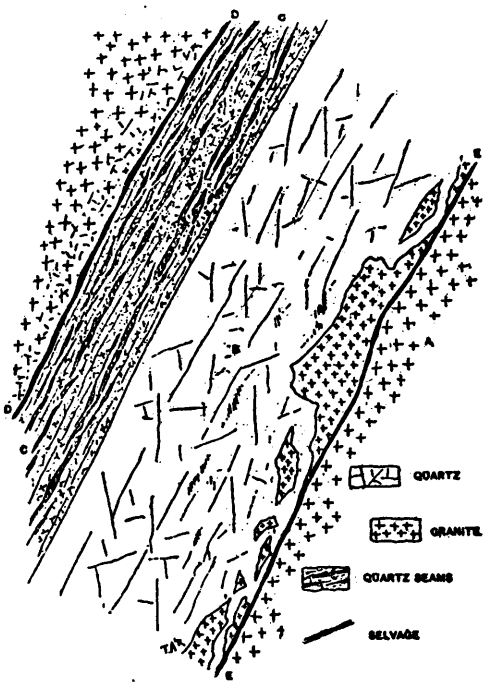


Union and Companion Mine, Oregon.

now lying upon it being such as to render it doubtful that they could have been detached from the hanging.

Fig 2* was drawn May 10, 1893, in the No. 4 level, north, of the Hillside mine, Yavapai County, Arizona. The lode occupies a strong fissure, cutting almost vertically through the nearly horizontal layers of a quartzose talc schist, B B. The original line of fracturing is probably now occupied by the seam, C, 6 inches thick, of white talcose clay, covering the foot-wall. The ore-bearing portion, D, of the lode is formed by an irregular mineralization of the hanging-wall country extending to a distance of from 15 to 18 inches, and presents an intricate medley of quartz, pyrite, zinc-blende, and a little galena, carrying about 1 ounce of gold and 25 ounces of silver per ton.

The most noteworthy feature of the section is the occurrence in the hanging, on the outer confines of the main ore-streak, of several irregular



Hillside Mine, Arizona.

cavities, A A, whose inner surface is covered by a series of siliceous coatings, evidently deposited by mineralizing waters that have circulated through them. Along the outcrop of the lode, at Wikiup Point, there occur hollows in the schists, of a character similar to those above described, and of such a shape as to suggest that their origin was due to the removal, by waters carrying carbonic acid, of certain portions of the country, rendered soluble by the

* The French equivalents are le toit "the roof," and le mur, literally, "the wall." In German, das Hangende and das Liegende.

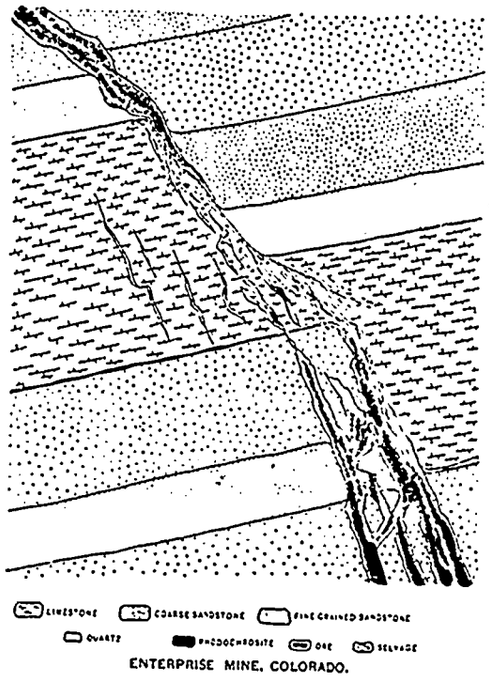
* See also Trans., xxiv, 945.

segregation of lime. As the fourth level nearly follows the water-level of the mine, and the siliceous encrustations were stained with iron oxide, the formation appears to have been due to what Posepny called the Vadose circulation. On the other hand, the impregnation of the hanging-wall country by sulphides cannot be ascribed to oxidizing waters, and must have taken place at an earlier period, when the surface was relatively more distant.

The lode follows a fissure formed along the axis of a synclinal bend in the schists, and often very noticeably reproduces the structure of the country which it has in part replaced; the ore breaking along lines corresponding to the almost horizontal foliation of the schists. The width of the ore is very irregular. That occasionally found under the clay seam is rarely rich enough to mine; the main pay-streak being that portion of the vein bounded underneath by the clay, and extending into the hanging until the mineralization becomes so meager that "ore" becomes "country-rock."

When a vein occurs in a formation composed of several kinds of rock it may cut across the lines of parting and be labelled a "true fissure;" or it may conform to them, and become a "bedded vein," if the two beds happen to be similar, or a "contact-vein," if they are dissimilar. It is evident that, when a vein crosses the bedding of a series of sedimentary rocks, the differences between the enclosing walls at any given place will depend upon the thickness of the beds traversed, and the extent of the faulting of the country along the line of the fissure. When the faulting is slight, the change in the wall-rock will be practically simultaneous for both sides of the vein; while, when the dislocation is equal to, or exceeds, the thickness of the members of a series of dissimilar beds so intersected, the opposing walls may be entirely dissimilar. This is illustrated in Figs. 3 and 4.

Fig. 3 represents the breast on August 14, 1894, of the north drift of the Jumbo No. 2 vein, on the Group tunnel level, in the Enterprise mine, at Rico, Dolores County, Colorado. The vein follows a fault-fissure through a



ENTERPRISE MINE, COLORADO.

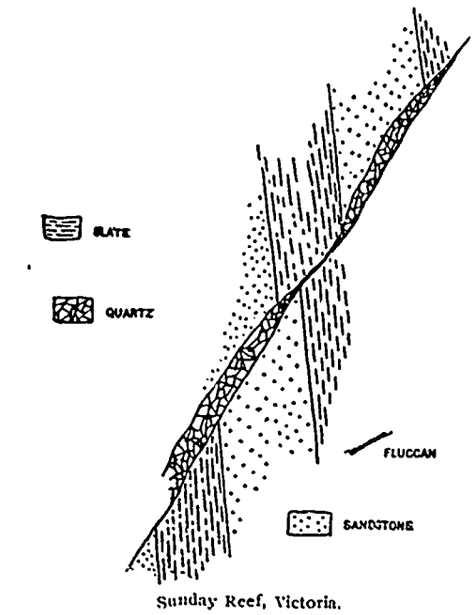
series of lower carboniferous shales, limestones and sandstones. The throw of the fault, along which the ore has been deposited, is about 2 feet; the thickness of the prominent bed of limestone is 3 feet, and the section shown in the figure covers 7 feet by 6. It is characteristic of the veins in this mine that they split up and become impoverished in lime, while in the sandstone, on the contrary, they usually become clean-cut, compact and richly ore-bearing, as is the case at the top of the drift represented in the figure. In traversing the lime, the selvage following the line of fissuring is very noticeable; but in the sandstone, particularly where the vein splits, the ore is "frozen," that is, has no evident parting separating it from the encasing rock.

Fig. 4 is taken from a drawing accompanying a note by Mr. E. J. Dunn, of the Victorian mining department, contributed by him to the Quarterly Report of December 31, 1888. It represents certain features of the Sunday reef, near Beechworth, in Victoria (Australia). The country consists of Silurian slates and sandstones, which have been faulted about 2 feet. Along this line of faulting gold-bearing quartz has been deposited; and it is noticeable that its occurrence is mainly confined to the under side of the sandstone, while under the slate it disappears and gives place to fluccan or clay. I would suggest that the lenticular shape of the quartz-bodies indicates that the spaces occupied by them were produced by the movement of one of the walls of a fissure, following a line whose undulatory form was caused by the unequal texture and hardness of the beds traversed by it.

Of the change observable in the character and value of the mineral ingredients of a vein in its passage from one kind of rock into another it is hardly possible to speak in parenthesis. One of the best known examples is that of the old Dolcoath mine in Cornwall, where the vein, in leaving the clay-slate (killas) and penetrating the granite, changed from a copper-bearing into a tin-bearing lode. I might also mention the silver-lead veins of Pontgibaud,* in France, which are in a gneiss country, diversified by dikes of granulite. The ore-veins have been formed along fractures within the dikes, and on their line of contact with the gneiss. When the dike diminishes in size, the ore decreases in width; when the vein penetrates into the gneiss, the ore disappears. The best ore is associated with the kaolinization of the fieldspar of the granulite; and when the latter becomes hard and unaltered in depth, the ore pinches out.

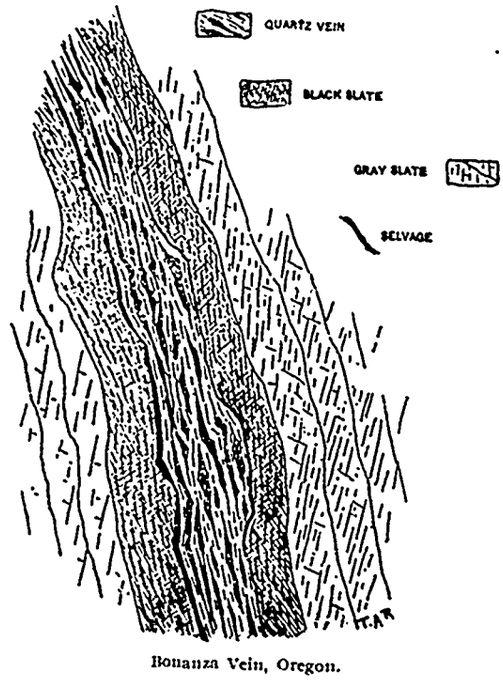
On Newman Hill, Rico, Colorado, the veins of rich gold and silver-bearing ores are noticeably affected by the character of their rock-walls. The particular changes due to penetrating from lime into sandstone have already been mentioned in connection with the veins of the Enterprise mine, but there is also the more general observation, that when the sedimentary beds are black, the veins in them are rich; when they lose that black color, the ore diminishes.

Other instances occur to me, but the above are typical. This interdependence between country and ore has been used as an argument in support of the now crippled lateral-secretion theory. It has been suggested† that this relation, often noticed in vein-mining, points to the derivation of the ore from the enclosing rock, and that some formations have an enriching effect, because they have been the source of the valuable metals now found in the veins penetrating them. But as Gotta long ago suggested, the influence of the physical texture and chemical composition of the country, as facilitating the deposition of the ore, may explain this phenomenon. The former would affect the rate of cooling and the formation of adhesive crusts. The latter would act by direct chemical precipitation.



Sunday Reef, Victoria.

As I suggested in the discussion of the paper just referred to, the local enrichment or impoverishment of veins may be explained by the presence or absence in the enclosing formation of precipitating agents. What the agent has been we can only in rare instances guess. At Rico it was undoubtedly the carbonaceous matter enclosed in the Lower Carboniferous shales, limestones and sandstones. At Pontgibaud it was probably the feld-



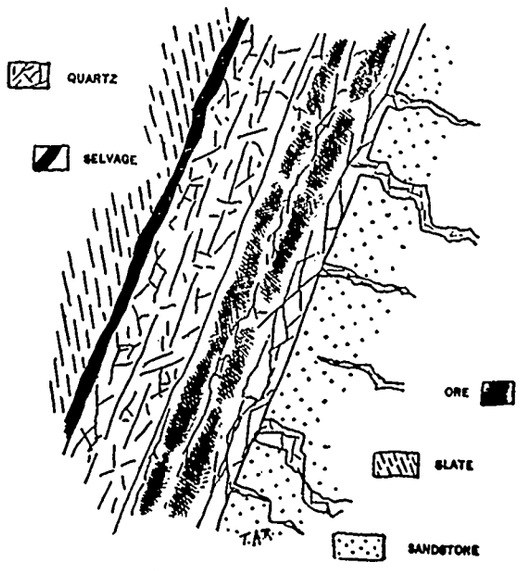
Bonanza Vein, Oregon.

* See "The Lodes of Pontgibaud," by the writer, in the Eng and Min Jour. of August 11 and 18, 1894.

† As, for instance in the paper "On Some Evidences of the Formation of Ore-Deposits by Lateral Secretion in the John Jay mine, at Providence, Boulder country, Colo., by P. H. Van Diest, in the Proceedings of the Colorado Scientific Society, vol. iv., p. 340, and in the discussion of the said paper, Id., p. 340.

spar which made room for the silver-bearing galena, and in Cornwall also the beautiful pseudomorphs of tinstone after feldspar suggest similar chemical interchanges.

In the case of veins which lie along the bedding-planes of sedimentary rocks the dissimilarity between the enclosing walls may not go further than a slight difference in the grain of two beds of sandstone, the color of two



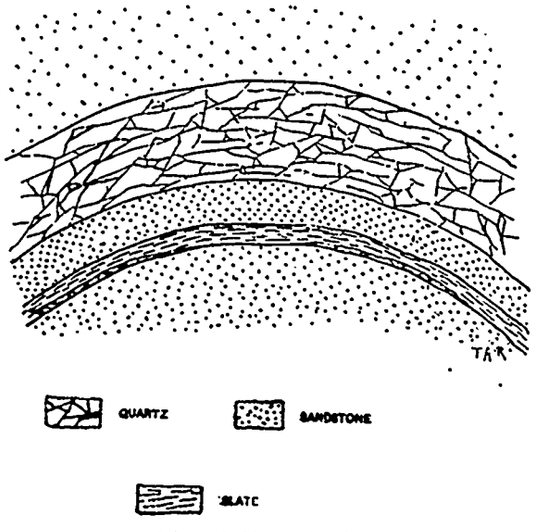
Shenandoah Mine, Victoria.

beds of slate, etc., or it may reach the more marked diversity presented by rocks as entirely unlike as a quartzitic sandstone and a soft slate.

Fig. 5 represents a gold-vein, following the bedding of, and encased by, a band of black slate, which is in turn flanked on either side by light gray slates. The ore consists of ribbons of quartz, mingled with strips of included country, and separated from the outer slates by a selvage, faint on the hanging but strong on the foot-wall. The drawing was made July 3, 1895, in the upper level of the Bonanza mine, Baker county, Oregon.

The comparatively straight walls of ordinary vein-mining occasionally give place in veins of the bedded class to surfaces having a marked curvature. Such walls characterize the saddle-reef, a type of lode-structure common in only two known mining districts, namely, Bendigo in Australia and Waverley in Nova Scotia—unless it be true, as is now stated on good authority, that the Broken Hill lode in New South Wales is also a saddle-reef.

In these regions, gold-bearing quartz is found along the bedding-planes of folded sedimentary rocks. While anticlinal folds (or saddles) alternate with synclines (inverted saddles or troughs), experience has shown that the ore-deposition is mainly confined to the former. Such a formation will offer many striking features, because of the occasionally very regular curvature of the walls. I remember, for instance, standing in the stopes just above the 980-foot level in the Johnson's mine at Bendigo, and seeing the foot-wall curve underneath like the top of a boiler, while the hanging arched overhead like a Roman bridge. This was the apex of a saddle, as illustrated in Fig. 7, reproduced from a sketch made at the time.* The lode is seen to



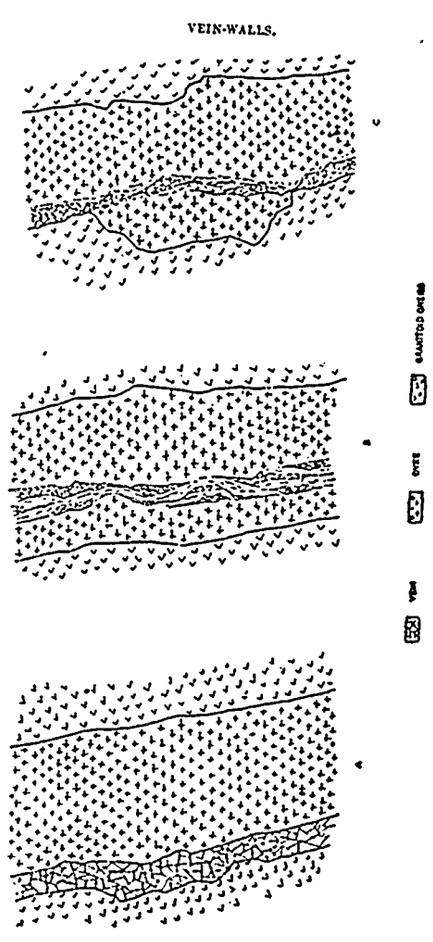
Johnson's Mine, Victoria.

consist of white quartz about 2½ feet thick, separated from the overlying sandstone by a very regular parting of black clay. Underneath is about a foot of sandstone, then a dark seam of slate, from 5 to 6 inches thick, whose parting from the next bed of sandstone is marked by streaks of quartz, thinning out both east and west.

The downward continuation of such a formation (the "legs of the saddle") presents the appearance of an ordinary bedded vein, usually marked, however, by a noteworthy want of persistence of ore in depth. Of the many drawings illustrating such veins already contributed to the *Transactions*† I have reproduced, in Fig. 6, the breast of the north end of the 1990-foot level in the Shenandoah mine at Bendigo. The lode carries 2 feet of closely-laminated quartz, from which spurs or stringers go off into the underlying sandstone. The hanging shows a gouge or selvage, ‡ separating the quartz from the overlying slate.

Many veins follow the contact between eruptive dikes and the metamorphic or sedimentary formations which they have penetrated. The dikes of quartz-andesite porphyry traversing the granitoid gneiss of the earliest mining districts of Colorado (in Boulder, Gilpin and Clear Creek counties) offer many examples of this type of vein-structure. In such cases the mineralization may often be found to have spent itself on the more soluble porphyritic igneous rock, rather than upon the less soluble metamorphic. The wall of such veins will vary, as the ore deposition has followed either fractures along the immediate contact, or those which ramify into the body of the dike, or those again which cut across the latter, where its irregular outline has been an obstacle to the main line of fissuring. These ideas are illustrated in the diagrams A, B and C, Fig. 8.

The California mine, in Gilpin county, offers many examples of such vein-phenomena. Figs. 9 and 10 represent the western ends of the 2000-foot and the 2100-foot levels, as seen on July 13, 1892. In the first the vein is seen to lie between mica-schist, on the foot, and "porphyry," on the hanging. The "porphyry" forms part of a dike, 17 feet thick, of dacite or quartz-andesite, and is both brecciated and much decomposed near the lode, from which it is separated by a dark band of "flint," which consists of small fragments of porphyry, cemented together by a very dark chalcedonic quartz. Underneath this there are 5 inches of white kaolinized porphyry,



Types of Vein Structure in Gilpin County, Colorado.

containing threads of iron and copper pyrites. Next comes an inch and a-half of quartz and feldspar intermingled; then a band of included country, part gneiss and part mica-schist, which is subdivided by a streak of pyrite. Finally there is an irregular foot-wall; the load-filling shading off into the soft mica-schist which underlies the vein.

The lower level, shown in Fig. 10, exhibits a marked difference. The lode has crossed the dike, and the porphyry forms the foot-wall. Next comes a thickness of 6 to 8 inches of white, soft, decomposed porphyry, then a black selvage, with slicken-sides on the lower side. Then comes two bands of mineralized porphyry, separated by thin partings. The main width of ore consists of about 2 feet of lode-filling traversed by patches and streaks of pyrite. Fragments of porphyry can also be recognized in it. This is separated from the overhanging gneiss and mica-schist by a selvage of varying thickness.

* October 5, 1890. See also Trans., xx., 506.

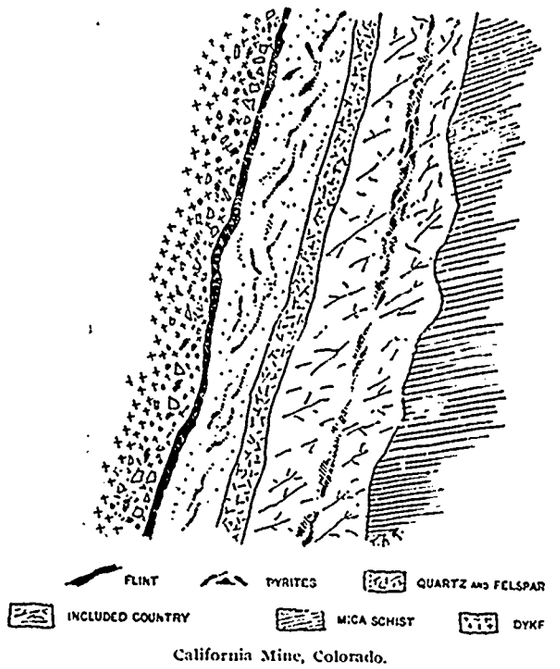
† By the writer in vols. xx. and xxi.

‡ "Selvage," "gouge," "dig," "pug," "flaccan" are all more or less synonymous. "A layer of soft stuff" would cover them all. It is perhaps worthy of notice, however, that our "selvage," used in this sense, is not the exact synonym, as it has often been supposed to be, of the German Saalband. A Saalband is a definite wall, as distinguished from a gradual transition from vein-matter into country-rock. A layer of soft material on the wall is a Besteg.

In the neighboring Indiana claim, the California vein exhibits certain changes, the most evident of which are the absence of selvages, the indistinctness of its limits and the brecciation of the vein-filling. This is suggested in Fig. 11, which represents the breast of a stope above the 800-foot level west, as observed November 13, 1895. The enclosing country, A A, is a granite almost destitute of mica. The part B is bespattered with pyrite. The best ore is a seam, C C, of black zinc-blende lining the hanging-wall. D is evidently brecciated. The larger part of the section consists of slightly altered country (E E) reticulated with seams of blende, following joint-fractures. The foot-wall of the vein is considered to be under the bands of zinc-blende and copper pyrites occuring along F F. The entire width is about 4 feet. The lode has departed from the dike, with which it is so closely associated in the neighboring mine; but the workings show that it meets this dike at intervals, and is benefitted by the intersection.

That the vein follows the line of a fault can be seen by examining the walls of 2000-foot level in the California mine, more particularly at points between 350 and 450 feet west of the shaft, where the lode has left the dike entirely, and is encased in the gneiss and mica-schist. The country-rock on the two sides of the drift is not the same. The extent of the throw of the fault, however, could not be measured.

In the course of the foregoing descriptions of lode-structures, mention has been repeatedly made of the occurrence of clay selvage, following sometimes both, of the walls of a vein. This "clay" may occassionally be material precipitated from solution; ordinarily it is only crushed rock. It frequently encloses exquisite mineral specimens, because its soft consistency has permitted untrammeled crystalline growth. Most examples of well-developed crystals of native gold have been discovered under such conditions. This is the case at Cripple Creek, Colo., where the gouge or clay has been dried and hardened near the surface, and as a crumbly earth, made purple by the presence of fluorite, carries beautiful crystals of gold pseudo-



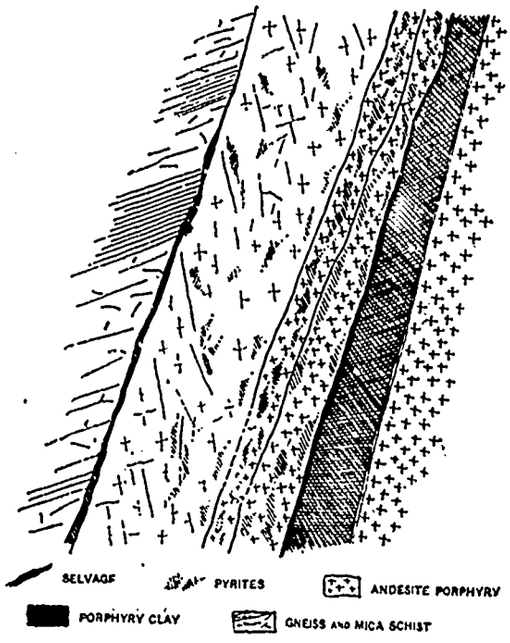
California Mine, Colorado.

morphic after sylvanite and calaverite. The exquisite leaf-gold specimens, for which Farncomb hill (Breckenridge, Summit county, Colo.) is so famous, are found imbedded in talcose clay. Large pieces of pure argentite are often found in such an environment, as at the De Lamar mine, in Owyhee county, Idaho. Wire-silver also has been found in comparatively large amount encased in such a "mud" in many Leadville mines; notably at the Crown Point, in 1886.

By reason of their opposition to the passage of water such seams of clay protect the rock-surface of vein-walls, and underneath them there will occasionally be found comparatively fresh and unaltered rock having beautifully polished faces or slickensides. At Ballarat, in Australia, I have seen many such rock-faces like finished ivory in their smoothness, and streaked with black lines, due to the grinding of specks of pyrite. In the Bonanza mine, Baker county, Ore., there could be seen quite recently an exquisite example of such an occurrence. In an upper drift there was at one place a surface of a few feet square (on one of the walls of a gold-bearing quartz-vein) covered by a thin layer of black clay, under which lay what seemed a white enamel of very remarkable delicacy. It could not be removed without breaking, because it was very friable, consisting essentially of crushed quartz partially recemented, probably by pressure.

"The handwriting on the wall" is not always easy to decipher. The lines or striæ occasionally to be seen upon its surface have been held to indicate the direction of that movement (or succession of movements) of the opposing rock-planes to which the deposit of ore primarily owed the opportunity for its existence. These lines, however, sometimes have opposite directions within a short distance and offer conflicting evidence hard to explain.

Rarely is a story told more clearly than in the ripple-marked foot-wall which was to be seen in October, 1891, in the Johnson's mine, at Bendigo. If had been very difficult to distinguish the bedding of the country, because the development of a strongly-marked cleavage had obliterated the lines of original sedimentation. At the 1065-foot level, however, the matter was made plain For more than 100 feet square the surface of the foot-wall was covered with ripple-markings. The crests of the waves were about 3 inches apart, and presented all the little irregularities to be seen to-day when the wind blows over the shallow waters of an estuary, and imprints the evidence of its action upon the yielding sand. The markings had been protected by layers of Silurian sediment, and the whole series had been indurated into

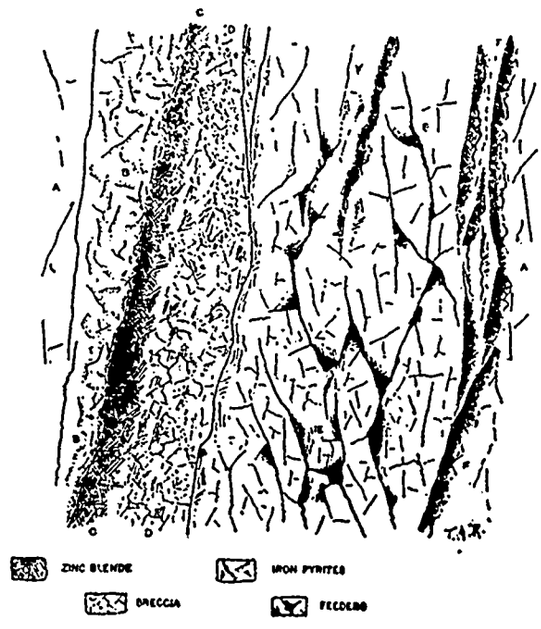


California Mine, Colorado.

rock, the sand which bore the markings becoming quartzitic sandstone, and the overlying mud slate. Between them, as within the pages of a book, was preserved the conclusive evidence of the original position of the beds of rock enclosing the reef, which had been formed in later times, when fissuring had made room for the circulation of underground waters and the deposition of the gold-bearing quartz.

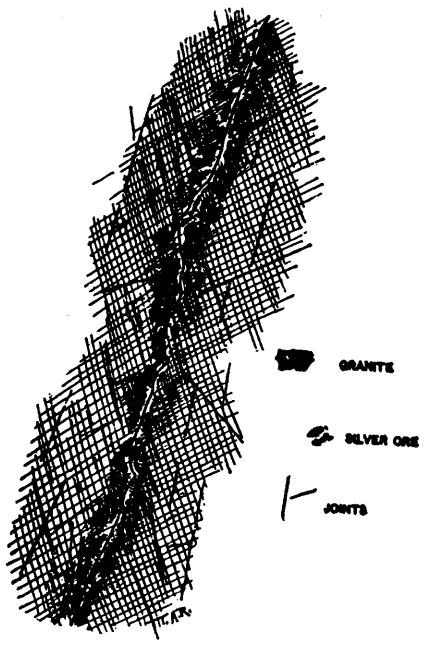
In the above interesting case the corrugation of the foot-wall, due to the ripple-markings, rendered difficult the detachment of the ore. Distinct walls, especially when accompanied by selvage, are very useful in actual mining; but they are not by any means necessarily indicative of a productive vein, or particularly favourable to the continuity of the ore. A "clean" wall and a good "gouge" are welcomed by the miner, because they ease his toil; but the idea that their presence alongside a lode gives it a character better than another unprovided with such adjuncts is a dangerous delusion. In many mines more ore has been lost by the persistent following of a "wall," without exploring beyond it, than was ever compensated for by the greater facility given by such a parting-plane for the breaking of the ore found.

Many veins have no defined walls, but graduate imperceptibly into the enclosing country, and are bounded only by the commercial value of the material mined. Such veins are to be seen, for instance, in the mountains that overlook Silver Plume, Clear Creek County, Colo. Fig. 12 represents a sketch made May 27, 1892, from the 300-foot level of the Seven-Thirty mine. A fracture penetrating the metamorphic granite carries ore on



both sides, which diminishes in richness as it spreads into the encasing country. The joints in the granite are evident.

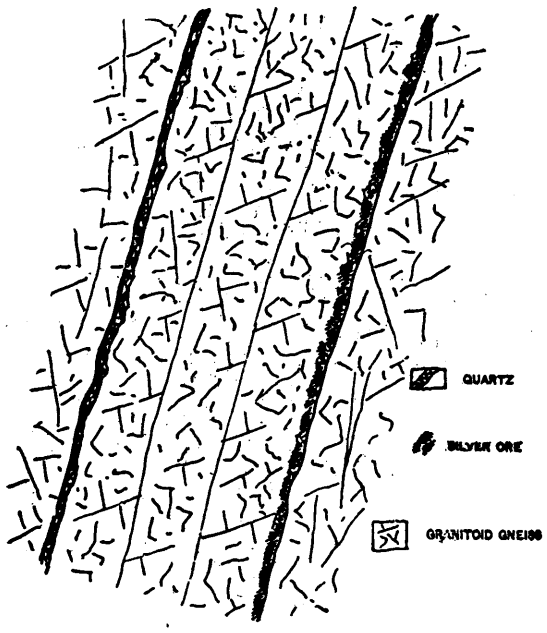
In this mine the so-called "walls" are often simply two parallel veins (rich, but very small), separated by clean, hard country. This is illustrated in Fig. 13, which was obtained from the same level about 1,000 feet further



Seven-Thirty Mine, Colorado.

east. The granitoid gneiss is traversed by two streaks of ore, of which the one to the right is much the richer. Between them there are at least two well-marked parallel fractures devoid of ore. The vein to the left has a thin selvage, under which there is a streak of quartz carrying a little silver-ore; but the companion-vein to the left follows a fracture, unaccompanied by any selvage, whose upper side is impregnated with about three inches of tetrahedrite, galena and polybasite.

Where ore is absent in the Seventy-Thirty mine, the walls are apt to be particularly well-defined; and when there is any thickness of rich silver-bearing mineral present, the walls are scarcely to be distinguished, and the rock is hard to break, because it is destitute of convenient partings. The large veins carrying gouge are found to be uniformly poor, except where



Seven-Thirty Mine, Colorado.

they meet the very narrow rich streaks which constitute the resource of the property. The Seven-Thirty vein proper is only 2½ inches thick, but it is very persistent through the midst of hard crystalline rocks, and it has, for twenty years, proved very productive.

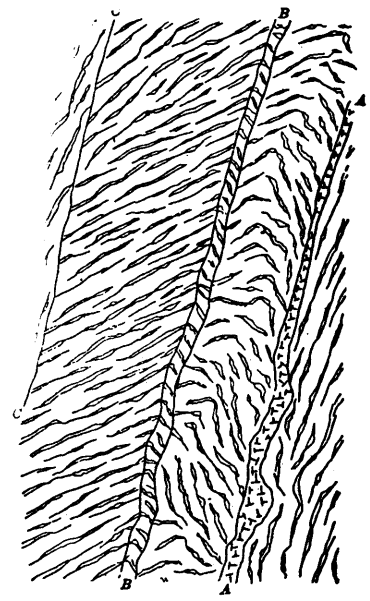
In many mines one vein only is exploited. and cross-cutting the country in search for parallel bodies is entirely neglected. In others, a cross-cut is stopped as soon as it reaches the further wall of the particular vein it was started to reach. Both these unwise practices are founded upon a misconception of lode-structure, due to a narrow interpretation of the early teachings of economic geology, which lays a misleading emphasis upon the definition and clean-cut boundaries of so-called true "fissure-veins." The fact is, as daily observation proves, that there are walls within walls, and walls beyond walls; and that to follow closely any particular hard, smooth rock-surface, with the idea that it is the utmost limit of ore-occurrence in any particular mine, is to be blind to the realities of geological structure.

Fig. 14 represents the face of a drift* in the Canton mine, near Waipori, Otago, New Zealand. A A is the reef, a vein of quartz which is supposed to lie immediately upon the foot-wall. Along B B the quartzose schist is soft,

* On November 15, 1890. See also TRANS., xxi, 415.

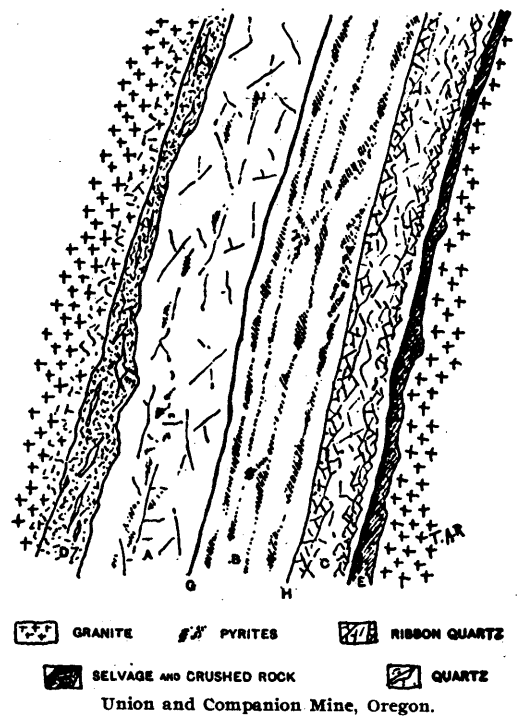
and the included quartz-folia are much twisted. C C is one of the so-called "false hanging-walls." Along A A and C C faulting is evident, along B B distortion only. It was not possible to say where the lode ended, or where it began. The whole width from A to C was known to be gold-bearing, although A A served as a guide in following the gold-bearing channel. Nevertheless those who were working the mine had little comprehension of the formation, particularly of its essential lack of definition, and, while admitting that there were several "false hanging-walls," insisted that there was only one foot-wall (underneath A A) which was stated to be of a different kind of rock, and exceptionally hard. On examination I found that the rock of the supposed foot-wall was similar to that of the rest of the gold-bearing country forming the lode, and on a sample of it being crushed and tested in a prospector's pan, it was discovered to be richer than that which was being actually mined. It was scarcely necessary after that to insist that a cross-cut should be made into the foot-wall.

Fig. 15 represents the north breast* of the lower level on the main lode



CANTON MINE

in the Union and Companion mine, Union County, Oregon. It illustrates the occurrence of "walls within walls," for while the lode may be limited by the main boundaries along E and D, there are at least two partings (G and H) equally well-defined, sub-dividing the enclosed width of ore. The country is a fine-grained granite, which, near the hanging, is decomposed and ore-bearing. D is a streak of granular crushed country, mixed with lenticles of white quartz whose longer axes are parallel to the lode-walls. D is from 3 to 7 inches wide, and carries only traces of gold. A consists of white hackly quartz spotted with iron pyrites. It is from 14 inches to 2 feet wide, and contains about ½ an ounce of gold per ton of ore. Then comes a



Union and Companion Mine, Oregon.

hard, regular "wall," separating A from B, which is the main pay-streak, ribboned with veins of iron and copper pyrites. The width is from 2½ to 3 feet, and the ore averages about 2 ounces in gold and 8 ounces in silver. Then follows a parting marked by a slight selvage, underneath which comes a 10 to 15-inch band (C) of ribboned white quartz, stained by the oxidation of copper pyrites, and carrying about 5 pennyweights of gold per ton. Then comes the main foot-wall with its streak, 1 to 3 inches thick, of granular crushed country, mixed with clay. The underlying rock is but little altered.

(TO BE CONTINUED.)

* On June 26, 1895.

MINING NOTES.

Nova Scotia.

At the Touquoy mine, Caribou district, an extraordinarily nice lead was found by surface prospecting. The quartz vein is about 14 inches thick, and from less than a ton of the first taken out 250 oz. of gold was taken. The shaft is now being timbered for permanent work. Your correspondent had the pleasure of examining some of this rich ore and thinks it belongs to a "pocket," although the workmen and owners claim it is from the cropping of a fabulously rich "chimney" of ore, which at the present stage of development would be somewhat difficult to determine. Nevertheless, the owners have good reason to be pleased with their showing. Last March they bought this property for $24,000, equipped with a 15 stamp water mill. Since the acquirement they have minted 541 oz. of gold, which runs 965 fine, and have paid dividends amounting to 20 per cent. on the capital invested. The officers of the company are E. E. McNutt, Truro; E. C. Bigelow, Truro; Robert Kaulbach, Mid. Musquodoboit.

At the Richardson mine, Isaac's Harbour, the expense of mining has been greatly reduced by the recent introduction of steam drills. Last month's returns were 276 oz., making a valuation of $17,500 for the last 90 days, leaving a good margin of profit, the working expenses being about $2,000 per month. The belt of the ore is large about 16 ft., and low grade, running from 3 to 4 dwt. per ton.

At Caribou, N.S., the Lake Lode gold mine, for several years operated by Mr. W. A. Sanders, has been sold to Pittsburgh people who will operate under title of the Guffey Mining Co. Mr. Getchell, one of the new owners will act as manager. Additional mining plant, including extra stamps, compressor, etc., will be put in at once. It is proposed to sink the present shaft 1000 feet, cross-cutting north and south and driving levels. Work will begin on 1st July.

Never at any time since the inception of gold mining in Nova Scotia has there been so much interest evinced by her own people as at the present time. This province has never had a fair chance to show what her gold mines were capable of producing, while gold mining in the majority of countries where gold is produced has been over-capitalized. Nova Scotia has always suffered for want of sufficient capital.

It is estimated by good authority, that at no time in the history of gold mining in this province has there ever been represented a capital of half a million dollars, and yet the annual gold product has averaged an excess of this amount. Can any other country, state or province make so good a showing?

The class of people heretofore operating the Nova Scotia mines, with few exceptions, were those having practically no capital and little experience. True, there has been some exceptions, where there was both limited capital and experience combined; in such instances success almost invariably followed. Operations of this class have been confined chiefly to Nova Scotians and Americans. English capital seems to have been singularly unfortunate in management. Instances where Englishmen have failed, and the same properties afterwards operated successfully by others, are strongly in evidence.

Nova Scotia gold mines, too, have suffered much from the operations of a class of irresponsible people, having neither capital nor experience. Men who are possessed of nothing but a flippant tongue, with which they worm into the confidence of the industrious middle class, inducing them to put their means into prospects which are grossly misrepresented, so far as their knowledge of them extends; yet, were the monies thus collected by these sharks judiciously expended on the properties represented, success would often follow; but such promoters (if worthy the name) simply squander the capital of their too confiding dupes, and thus a worthy class of people are not only fleeced, but are led to believe gold mining is a delusion and a snare. Then, too, there is the unsuccessful business man. The man who has been set up by his father, his uncles and his old spinster aunts, only to make as many failures, after exhausting the funds and the patience of everyone he has touched. It is remarkable that so large a percentage of this class finally conclude that their fort lies in gold mining. Comment is unnecessary on the results attending the operations of such incapables. We have seen too much of it.

With such existing facts, it is not surprising that this industry has been looked upon with suspicion, and a man's financial standing impaired in both banking and mercantile circles were he known to be interested in gold mining. Gradually, however, for some years past, through the success attending the patient and persistent efforts of some of the best men in the business, the solid business men of the province have began to realize that gold mining as a business, managed on business principles, is not only not "to be despised," but indeed, no other business in the province may be made as profitable as that which they once looked upon with so much doubt. As one gentleman recently remarked to the writer, "Thank heaven it is at least a business which does not keep one on the rack fearing tariff changes, and the fluctuations of market values."

A striking proof of the above remarks is the recent purchase from John E. Hardman, S.B., and Geo. W. Stuart, of the large area of consolidated properties at Goldenville—in the Sherbrooke district—which includes the "Palmerston," "Little Palmerston," "Wellington," "Dominion," "Mayflower," "Bowlder" and other adjoining areas, aggregating over one Hundred in all, by the following syndicate of gentlemen, viz.: Thos. E. Kenney, President Merchants Bank of Halifax; Hon. Wm. Stairs, President Union Bank of Halifax; Hon. David McKeen, Vice-President Dominion Coal Co., and Director Merchants Bank; John F. Stairs, President Nova Scotia Steel Co., etc., etc.; Michel Duire, Director Bank of Nova Scotia; Wiley Smith, Director Merchants Bank; Graham Fraser, Vice-President Nova Scotia Steel Co., and Managing Director Ferrona Iron Works, and Major R. G. Leckie, President Nova Scotia Mining Society, etc. Mr. Hardman and Mr. Stuart remain shareholders in the Company. It is the intention of the Company to thoroughly equip, develop and work these mines in the most thorough and systematic manner known to modern science in this great industry.

The Touquoy mine, at Moose River, Caribou District, was purchased by a syndicate of Truro, Maitland and Musquodoboit gentlemen in March last, for the sum of $24,000, since which it has paid its fortunate owners 25 per cent. on the capital invested. Recently a new vein has been opened by a surface shaft, and in two shots, which turned out about a ton of quartz from the vein, which is 14 inches thick, nuggets of gold to the value of over $5,000 have been mortered out. The shaft is now being timbered up for permanent work. While this is unquestionably a rich pocket, the find is a valuable accession to this very valuable property, and there is little doubt but this new bonanza vein will often gladden the hearts of its owners with such production. During the 12 years this property was worked by its former owner, Mr. Touquoy, it missed but two months in paying a handsome dividend. Mr. Touquoy only parted with this mine on account of his increasing age, which necessitates his retirement from active mining operations.

W. S. G.

A phenomenal find of gold has been made at the old Touquoy mine, in prospecting a new lead has been cut near the mill and a piece of quartz taken out weighing 158 ounces and which yielded 100 ounces of gold; the returns from this property for last month are probably the most curious ever returned at the mines office, they read "ore crushed 25 lbs., gold obtained 172 ounces," we assume that the regular monthly clean-up had not been made when these returns were sworn.

There is to-day a strong conviction by the best mining men in the country, of the permanency of the gold deposits of Nova Scotia, and this conviction has grown upon the observing monied men of the province, until there is a strong belief in the safety of investments under the guidance of experience and integrity.

The clean-up from the Richardson mine last month produced 272 ounces of gold.

The yield from the North Brookfield mine was 309 ounces of gold.

We understand that Mr. W. A. Allen of Ottawa has purchased the Baker-Hardman property at Chester Basin.

We regret to hear that Mr. G. W. Stuart, the well-known mining engineer, has been taken ill and is confined to the house.

The returns from the Thompson-Hill mine at Cow Bay was 56 ounces of gold.

Mr. J. B. Neiley has obtained an option on the Cochrane Hill mine and will start operations at once. This mine, it will probably be remembered, was shut down about three years ago owing to the secretary absconding with the funds of the company. There is a new mill on the property and active operations can be resumed with little delay.

Mr. D. C. McDonald has been suddenly taken seriously ill and is not expected to recover. Mr. McDonald has been associated with mining at Renfrew for a number of years.

We hear from Mr. Puttner that the new mill and concentrators at the Central Rawdon mine are giving complete satisfaction and that a high grade of concentrates is being obtained.

Active prospecting is being resumed at Cheticamp and from specimens we have seen we believe there is every prospect of valuable copper and silver lead deposits being discovered there.

Some very rich ore has recently been discovered at Oldham and West Chezgetcook.

A considerable amount of development work is being done at Cow Bay by various syndicates and some very promising quartz is being obtained.

A collection of economic minerals of Nova Scotia is being made by Mr. F. H. Mason for the coming exhibition in Halifax and he will be glad to receive samples for that purpose at Queen Building, Hollis street, Halifax. This will be a good opportunity of showing people the mineral wealth of our province and we hope everyone will do their best to assist in making a good and representative show.

F. H. M.

Owing to the lateness of the season the quantity of coal shipped by the Dominion Coal Co. to the 1st of June was not as large as last year for the corresponding date, but since the first of June shipping has been very steady and there has been a good demand for the Phalen seam.

At Reserve, Caledonia, and Dominion No. 1 collieries, shaker screens and picking belts have been added this year to their plant, and were in working order for the shipping season.

The following is a general description of their working. The coal on being raised from the mine in self-dumping cages, is dumped into weighing tanks, weighed and then allowed to run into another tank which holds coal, from these tanks the coal is let gently down on to the shaking screen. These screens are six feet three inches wide and have a wire gauge or netting fifteen feet in length with appertures three-quarters of an inch square. The screen has an inclination of 18 degrees and makes from 60 to 80 shakes per minute according to the quantity of coal to be passed over them. They also have a forward motion of six inches at each shake. From the screens the coal is delivered on a picking belt which is an endless band of steel plates, revolving round a drum at each end 45 feet apart. The belt is composed of steel plates five feet long and six inches in width, and travelling at the rate of 40 feet per minute, so that the coal is distributed over the belt area, giving the boys and men every opportunity to pick out the impurities of brass and splint which may be in the coal, before it is delivered into the cars for shipment. These new screens and belts have very materially helped to add both to the appearance and quality of the coal, which is now being shipped perfectly clean, both as regards slack and splint. The slack which is taken from the shaker is elevated again, and put through another screen, and graded into nut, pea, slack and duff coal.

At the Reserve, Caledonia and Dominion No. 1, large outputs can be made and maintained, and they are now very extensive collieries.

On Monday, June 7th, at the Reserve Colliery, 2,002 tons, 7 cwt., were hoisted from the mines, in 9 hours and 37 minutes—the largest output from any one mine in one day in Nova Scotia. Mr. McVey, the manager, and the officials, are justly proud of their record. The following is a comparative statement, showing the maximum output to date of the various collieries of the Dominion Coal Co.:—

Collieries.	For One Day.	For One Week.
Caledonia	1752	8551
Dominion	1481	5783
Gowrie	489	1554
Hub	793	2665
International	1116	5063
Old Bridgeport	1049	4619
Reserve	2002	8686
Victoria	615	3253

Total of all collieries for one week : 38628 tons.

Victoria Colliery is still working away, despite the current reports that the colliery had to be closed down. Gowrie Colliery has had considerable idle time, there not being a large demand at the present time for this coal.

International Colliery has been working steadily, with an average daily output of 1,000 tons.

The report which was printed in some of the local papers, that the Company intended closing up the Hub, was without foundation, and the dull work can be accounted for by the fact that nearly 90 per cent. of the output was shipped to the United States, the increased duty which has been imposed by that country excluding to a great extent the shipments which were being made. But Mr. Whitney, in a telegram to the men, who had put themselves in communication with him on the reported closing up of the mine, assured them that the Company did not intend to close the mine, and that he was personally exerting himself to find a market. Narrow work is being carried on without interruption, and the marine deeps are now over 400 feet beyond high water mark, and showing an excellent quality of coal.

This season the Company are concentrating their shipments to the International and Louisburg piers, and have shipped large quantities of coal, both in point of time and in despatch.

On Saturday, June 12th, the S.S. Turret Cape arrived in at 4 p.m., was loaded, bunkered, and sailed at 11 p.m., having taken on board 2905 tons of coal.

The S.S. Huelea came in on May 28th ; was back again for the second round trip on June 15th, for a 3,700 ton cargo each time. She was discharged in Montreal in the short time of 16 hours.

At the Hub Colliery work has been dull all the early part of May, but better the first part of June.

General Mining Association.—They are shipping steadily, and have a large force employed, both on the surface and in the pit, and are maintaining a large and steady output. They are now calling for tenders for the sinking of a shaft 13 feet in diameter and 500 feet deep, to the No. 3 seam. At the Cape Breton Colliery during the winter the slope was extended to the deep, which has given them a much superior quality of coal.

The General Mining Association, Sydney Mines, C.B., has ordered a 125 horse power Monarch Economic Boiler from the Robb Engineering Co.

J. G. S.

Glace Bay, 17th June, 1897.

British Columbia.

Slocan District.

The statement that the Crow's Nest Pass Railway arrangement has been settled, and that this line will be built at once, is refreshing. If we wait in proportion to the time we wait for much smaller enterprises of the C.P.R. we may wait a very long time. However, promises of transportation stimulate development, and it cannot be expected that costly mountain railways will be built for prospects.

The Slocan River Railway has been about to begin operations every few weeks for the last few months, and latterly the start has became a daily expectation. As this line does not depend entirely upon the tributary mines, we shall probably soon see it under way.

The production in sight of the Southern Slocan is not yet enough to build costly railroads, although great hopes and fears characterize this section during the present time, owing to the development under bond going on just now.

The "Wonderful" is once again hydraulicing its ore, and shipping a good deal saved in this manner ; the plan being to wash out the loose dirt and rock, then divert the stream and gather the exposed boulders of galena.

A wide patch of galena has been laid bare upon the Galena Mines property. It is locally decided that this body of ore is a resultant of "breaking over" of the vein, whatever that may mean. Hence it is not expected to be very thick vertically. Some very rich ores of silver are being found upon 10 Mile Creek, the same creek upon which is the Enterprise, lately taken over from J. A. Finch by D. M. Brunton, of Colorada, for some $300,000. The Enterprise is at present the only shipper upon this creek, though in times past the Kalispell has made a few shipments of ore, carrying ruby silver and other rich combinations. There appears to be a good deal of native silver present in the ores of this creek ; also rich combinations of silver with arsenic and antimony. The veins are more nearly vertical than those found further south, and the gangue is in most cases very compact, and of a lime nature. Some little galena is also present in a scattered condition, but this galena is low grade. These ore bodies are rather unevenly mineralized, otherwise, if the existence of extensive chutes of such rich ore can be demonstrated, there will be some fortunes made out of them.

Most of the representatives of English capital call in on the Slocan nowa-days. They appear to be somewhat supercilious, and over-possessed with the idea that silver is very cheap. A few penetrate the prejudice, but are staggered at the prices asked for the mines. It is somewhat to be regretted that prices should be set so high in the new districts, which are as yet unproved, as this results in several properties being thrown up in the face of heavy payments due, and no fair showing of ore in sight. However, it is extremely hard to get working bonds on properties, without a 5 per cent. payment at least, in cash. The relapse of a few properties in this manner gives a black eye to a section at once, as may be seen by the failure of the "Two Friends" at Springer Creek—although, to those who understand the local conditions, this failure carries very little weight ; yet amongst the outsiders, from whom the money comes to develop, it creates a depreciation at once.

Another townsite is being brought to the front on Slocan Lake. This is Rosebery, the upper port for Slocan Lake, and a point through which passes all the Slocan ore which goes out by way of the C.P.R. The C.P.R. owns one-half of this townsite, and the situation is a very favourable and flat one, with a large creek (Wilson Creek), upon the extensive branches of which stream productive ore bodies will no doubt be found. At present there are no producers tributary to this point.

The syndicate of owners of the Idaho-Alamo group are being called upon to consider the proposition of disposing of their property. Many rumors of a sale have been current for months past. This group is one of the first magnitude in the Slocan.

Mining generally appears to be prospering up Four-Mile Creek this season. The ores are high-grade, and in many cases are clean galena, with some of the richer combinations of silver also present. The chief properties being worked are the "Thompson," "Wakefield," "Fisher-maiden" and "Humboldt."

Upon Lemon Creek there is much assessment work being done. This shows up a great many quartz veins of a coarsely crystallized character, containing iron pyrites and silver sulphide. The values are somewhat greater in gold than in silver in many cases. The nature and origin of these low, dipping and somewhat irregular veins is not yet very clear, although some men place them as segregations. Provided the segregations come often enough and richly enough it does not appear to matter much.

The "Howard Fraction" is at present shipping a carload of this typical ore of Lemon Creek," and active work is being carried on by J. A. Finch, on the "Meteor Group," which adjoins the "Howard Fraction."

A rich discovery is reported from the "Arlington," in the line of steel galena, of much the same character as that of the Enterprise, showing specks of copper pyrites, and also large flakes or leaves of native silver.

At present a great deal of material is being packed up Springer Creek to supply development companies and prospectors. A waggon road is badly needed if the prospects expect to make shipments next winter. The owners of these at present seem disinclined to subscribe $4,000 called, for under existing conditions.

Several parties are hanging round the outskirts of the snow in the vicinity of Kokanee Creek. These expect to discover some fractions in this very highly spoken of section. Perpetual glaciers cover several of the claims there located last year.

The formations west of Slocan Lake and River continue to furnish nothing of value; but many very interesting mineralogical specimens are being brought in from this metamorphic area.

J. C. G.

SLOCAN CITY, 17th June, 1897.

NELSON DISTRICT.

The season has now fairly begun, and prospectors are in all directions examining the hills for minerals, in the hope, of course, of finding a fortune. Never before has the country round been so thoroughly prospected, and most varied are the samples already brought in, not by any means valuable as a rule, but there are some very marked exceptions. It is difficult at this date to say which will prove the newest and liveliest camp this season, but all indications point to Nelson as being one of the busiest and most solid towns in the Kootenay, and the advent of the long promised, but now confidently expected, Crow's Nest Pass Railway, will very materially advance the interests of the city.

Several claims which have been worked on all through the winter are now shipping ore in small quantities; the Hall mines smelter taking quartz propositions gladly, as that mineral is a great help to the successful working of the reverberatory furnace, which has been recently started with the object of improving the pitch of the matte, and converting it into blister copper. Anyone familiar with copper smelting will be aware that the slag produced from the mixture of raw and roasted matte is extremely corrosive, and acts very powerfully indeed on siliceous bricks that form the furnace lining; hence the advisability of supplying extra silica to protect the furnace itself.

The back-bone of the Hall mines, namely, the Silver King on Toad Mt, is still by far the largest producer of ore in the immediate neighborhood, and the Company have been fortunate enough to secure the services of Mr. Kellogg, formerly of the Anaconda, Butte, to assist in the management of the mine, which, as is well known, is not a very easy one to handle, on account of the best ore occurring so much in pockets, with lower grade ore intervening. But other properties on Toad Mt. and the adjoining hills are also turning out mineral, though as yet in amounts comparatively small; the Exchequer, Athabasca and one or two others showing valuable ore.

A few miles west of Nelson, the well known Poorman group, so long worked by Messrs. Davenport, has been made into o Company, with a capital stock of some $250,000, a large portion of which sum will be expended in development. This is a very old established concern, and should prove a thoroughly sound investment; but like all other public companies, will require good management, and the exercise of common sense. One prominent company has recently been strongly criticized, and no one who knows the facts can say that part at least of that adverse criticism was undeserved.

In the neighborhood of Quartz Creek (N. fork of Salmon) there are many properties being opened up, and the surrounding country is crowded with prospectors. This district seems to be extremely promising, and the new towns there are booming, Ymir perhaps being the principal one at present, though doubtless others will arise as the population increases.

It is pleasant to note that the pioneer camp, Ainsworth, is again active. Your correspondent was much surprised on a recent visit there, to find such an excellent town, and so much business being transacted. Free gold is reported to have been found in the ore from the Highland claim, and the same valuable metal is known to exist in the galena from the Black Diamond.

The air is again thick with rumors of new smelters to be erected. Now it is near Nelson, now at Boundary Creek, and again at Northport, or the immediate vicinity. Time alone can tell whether there is any truth in the reports; but if the promoters are wise they will secure *two years supply of ore* before blowing in their smelters, and so far the known supplies have hardly amounted to that quantity. It is no use to blow in a furnace, and then shut down after a week or two on account of shortness of ore; that is a specimen of very bad management wherever it occurs. The proverb, "First catch your hare, &c.," is as true in smelting as in cooking, and may prove an expensive maxim to neglect.

As an illustration of the amount of prospecting that is being carried on in Nelson District, no less than 413 new locations were recorded between May 1 and May 27, and while Toad Mt. is being examined almost inch by inch (and some say it has paid them to do so) yet much interest is taken in the hills which lie just back of the banks of the Kootenay River, and it is certain that there are many deposits of better low grade copper ore along the north bank, though no very extensive work has yet been done on them.

As an indication of the permanence of the renewed activity, hoisting machinery is being, or has been, placed on three properties, namely, the Mamie, Mile Point and Little Donald, which would hardly be done if the owners were not fully satisfied as to the quality and quantity of their deposits One or two more claims have been lately bonded for very considerable sums, all of which is good for this good old camp.

On the south side, Forty-nine, Bird and Rover creeks have all had new locations made on them, and in some instances no doubt old claims have been re-staked On Forty-nine Creek a very fine ledge has been discovered (the "Annie May"), which carries free gold in very visible quantity, and also a 3-foot vein of copper ore, assaying well in silver, copper and gold. Another much larger ledge is reported from the other side of the river, said to be 12 feet wide, and to carry an assay value of $25 in copper and gold. These very wide ledges, in your correspondent's opinion, require the proverbial "pinch of salt," though it is not easy to shake the locator's faith in the size of his vein.

All things considered, Nelson appears to have a remarkably bright future before her, and all good citizens hope that these very flattering promises may be fully realized.

H.

BOUNDARY CREEK.

In anticipation of the early construction of Heinze's Railway, from Penticton to Boundary Creek, a big deal in real estate was made last week. Mr. T. A. Garland, of Portage la Prairie, paid $10,000 for a three-quarter interest in the townsite of Anaconda. This townsite is situated in the Boundary Creek valley, about one mile south of Greenwood.

On the "Mother Lode" a winze is being sunk; the tunnel is in over 200 feet. The ore carries a large amount of copper pyrites, and a good gold value, in a mixed gangue of hornblende, magnetite, calcite, and occasionally quartz.

The tunnel on the Sunset and Crown Silver has not yet reached the ore body.

Leslie Hill is drifting both ways on the Jewel. At the 120 foot level, considerable water is encountered, and so far the pump, a Deane, has not been installed. He has also a working bond on the North Star, and is already at work. There is a 60 foot shaft now on the property.

Assessment work this spring has disclosed some fine ore in Long Lake Camp, notably on the "Lakeview," "Agnes" and "Amanda."

Everyone in the district is pleased to greet W. A. Carlyle, Prov. Mineralogist. A more genial mining expert is seldom met. His extensive experience and wide reading make his reports very valuable. He will remain about a month in the district.

On the Golden Crown a tunnel is being driven. It is to be 300 feet long, and is expected to cut six leads. It is now in 100 feet, and two veins have been reached. Surface cuts have disclosed three other leads, making a total of what is thought to be nine distinct leads, varying in width from one to eight feet. The ore is pyrrhotite and copper pyrites, in a quartz gangue, and carries a high gold and copper value. Mr. G. H. Collins is general manager.

The Boundary Creek Mining and Milling Co. are working ten men on the "D A," "O B," "G A R." The Company has recently acquired 640 acres of land in the Boundary Creek valley, adjoining their mineral claims and the Greenwood townsite on the north. A townsite has been surveyed from this, and is now on the market.

The owners of the "Joe Dandy" group at Fairview are having surveys made and estimates prepared, with a view to milling their ore at the Okanagan River, and bringing electric power from Okanagan Falls, a distance of about ten miles. Since October, '96, these people have been employing from 18 to 25 men, and now have their property fairly well opened up.

The machinery for the Tin Horn at Fairview has arrived. The mill consists of eight of Joshua Hendy's triple discharge two-stamp batteries.

Jay P. Graves starts work immediately on the Knob Hill and Ironsides in Greenwood Camp. A compressor plant, steam hoist and pump are being brought in, and development work will be carried on continuously.

GREENWOOD, B.C., June 17.

H.

Ontario.

An officer of the Foley Mines Company of Ontario, writes under date of 5th June :—The result of the first week's mill run in February was 165.94 ounces, which netted $2,682.37. As per U.S. Mint Certificate No. 5,334, the results of the runs from March 13th to May 3rd, which included many stoppages, were as follows : Certificate No. 5,985 for 91·10 ounces, $1,446.16 ; Certificate No. 6,243 for 370·50 ounces, $5,786.97 net value ; Certificate No. 6,856 for 445·70 ounces, $6,639.31 net value. We think the latter certificate is about $700 out. We to-day shipped 210 more ounces of gold.

"Ever since the beginning of May we have been suffering from strikes among our miners, wanting exhorbitant wages, and from lack of good miners. Most of our men took their wages and went prospecting the beginning of May. As a result of lack of miners, the mill has not been running at more than half its capacity, and during May not more than half the month at that. Our management estimate that only about twelve hundred and fifty tons of ore have been crushed to produce the results given you, including the 210 ounces we shipped to-day."

"We are figuring on putting in a ten to twelve drill compressor plant, which we hope to get in by the beginning of September, and in this way we expect not to be to such a large extent dependent on the caprice of miners. Meanwhile we will have to do the best we can. We are entirely satisfied with the richness of the proposition, and our manager, Mr. J. C. Foley, is most confident of the success of the mine ; but it will take time to get it properly opened out."

Messrs. Æmilius Jarvis & Co, report under date 21st June :—With the disappearance of the ice and snow, and the consequent opening of the interior, a large rush of "prospectors" has taken place, whilst at the same time a great number of developing camps have been equipped, and are now in active operation. Whilst American capital continues to come in freely, we are glad to note that London is also showing a practical interest in the new gold fields, and some of the most progressive and successful combinations either are making or are arranging for careful and systematic investigation of the most developed areas, with a view to investment, and already not a few purchases have been made. There is no doubt that the new goldfield will, during the year, have a thorough and impartial examination of its possibilities made, and the results of this season will either make or mar the region as a rival of the leading goldfields of the world.

With the new and increased local activity in legitimate test and development work, the market for locations has grown distinctly quiet, and the absurd figures to which we have on more than one occasion drawn attention, are ceasing to be conspicuous. This depression is much more marked in mining shares which have, whether good or otherwise, shown substantially lower quotations all round. The heavy losses made by the speculating public, as a consequence of their rash and injudicious purchases of worthless share certificates last year, have caused the usual strong reaction, and it will be probably some time before they will be again prepared to invest freely, thus giving judicious investors an opportunity of purchasing at natural prices. We would again draw attention to the fact that the probable average value of the ore in the various divisions of the new district is still very uncertain, and all purchases should be made upon a conservative basis. Before long we may hope to have a larger number of mills running continuously, and regular returns made in a bona-fide manner, giving to shareholders definite statements as to the quantity and quality of the ore treated, and the amount of development work completed each month, so that the data necessary to inspire confidence in the value of the properties, and the capacity of the management, may be in the hands of the public. When we get these it is very possible that we shall find the average returns higher than expected ; but in the meantime purchasers should be careful not to indulge in fancy prices. In laying stress upon this point, we believe we are consulting the interests of owners equally with investors, for nothing could be more injurious to the future of the district than a repetition of the Trail Creek bubble. The confidence of the investing public is the surest basis of success for a good mining district.

Shares in working companies closed for the month :—Cornucopia and Mikado, $7.50 nominal ; Gold Exploration, $5.00 nominal ; Bannockburn, 15-20c. ; Foley, $2.50-$2.75 ; Princess, 20-25c. ; Saw Bill, $2.70-$2.75 ; Hammond Reef, 35-40c. ; Empress, 10-15c. ; Hawk Bay, 90c.-$1.00.

Locations in prospectors' hands have run from $100.00 and charges np to $5,000.

Locations partly developed, reported sales name high figures, K 257 fetching $20,000. Two locations adjoining the Olive, $50,000 ; E. 177-176, and H.P. 305 and 258, are also reported sold at good figures.

In Hastings and Peterborough the gold bearing area is shown to be much larger than was supposed, and rich specimens from widely separate points have been brought in during the month. Development is now proceeding in many places. The transfer of the Bannockburn, the shaft on which is down over 60 feet, for $30,000 is reported, and other properties have been bonded at various prices, up to $15,000.

Fresh development camps are opened upon the following :—395 X ; Maple Leaf ; 504 X ; 411 D near the Mikado ; M. H. 61 on Shoal Lake ; D 395 and M. H. 76 and 77 ; D 311 and 317 ; H. W. 19 and 41 ; and all are showlng up well.

On K 244 the shaft is down about 60 feet, opening up a 5 foot 7 inch reef, which pans well and shows visible gold. S.V. 17 shows a 9 foot reef at 10 foot depth, looking very well, with assays running high. On the Ruby they have struck a gold reef of free milling quartz at 25 ft. On H. W. 38, shaft No. 1 is down over 50 feet, with 6 feet of ore at bottom, and No. 2 shaft, down 15 feet, shows the reef 3½ between the walls. The Black Fly is opening up well, and several reefs from 2 ft. to 12 ft. in width, assays going from $8 to over $100. One vein which was not very promising on the surface shows in the shaft coarse free gold. The tunnel on the Mascotte is in 90 feet, and has cut the vein, which shows 12 feet between walls, and pans gold freely. The vein was about 4 feet on the surface, and at 50 feet it was 6 feet wide. The first shipment of ore has been sent to the Reduction Works at Rat Portage for treatment. The shaft on the Olive is down 80 feet with a widening vein. On the Hawk Bay work is advancing well, and No. 1 shaft is going down at over 30 feet a month. No. 2 shaft is now down 40 feet, with the reef 4 feet wide, looking better and running richer than at higher levels. The Regina shaft is down over 260 feet, and the reefs run as high as ever. On the "Kablskong" the tunnel is in 60 feet, all in solid ore, yielding good showings in the pan. On the Hammond Folger dyke the mill is in a forward state, and the dyke has been completely crosscut. On the "Saw Bill" the reef is reported as showing better than ever. In No. 1 shaft the first level runs 210 feet, and the second 135, whilst No. 2 shaft is down over 30 feet, with a reef 4 feet wide at that depth, and the assays have run from $16 to $30. The Empress mill has had a seven weeks' run to check assay results, and the directors, finding that they have an immense body of low grade ore, have decided to close down the mine till after a general meeting of the shareholders, which is to be held shortly. The Trojan is reported as sold, subject to examination, to an American syndicate. The Lakeside Gold Mining Company's property on War Eagle Lake is opening up well, having stripped 6 to 60 feet wide, and a crosscut 7 feet deep shows ore giving returns that have determined the Company to commence working. The returns from the Foley show that the clear-up between April 20th and May 3rd gave $7,360. From the latter date a strike of the miners and difficulty in getting good hands, delayed crushing for over 10 days. The Sultana continues steady crushing, and it is expected to put out $1,000 a day when the new mill is up. The Master Jack and the Scramble are putting up their plants.

During the month letters patent have been issued, incorporating the following companies :—The Manitou Gold Mining Company ; capital $1,000,000, in $1.00 shares. Rand Gold Mining Company, of Wabigoon ; capital $1,000,000, in $1.00 shares.

The following have applied for letters patent :—The La Reine Gold Mining Company, of Ontario ; capital $1,000,000, in $1.00 shares. The Ottawa Gold Milling and Mining Company ; capital $1,000,000, in $1,00 shares. The McGowan Gold Mining Company, of Parry Sound ; capital $1,000,000, in $1.00 shares.

Mr. John F. Caldwell is overhauling the mining and milling plant at the Sultana. A new mill of thirty stamps, with power and capacity for fifty, is now being built. The mill will be equipped with challenge feeders, six Frue Vanners, No. 3 Gates Crusher, &c. A battery of three 100 H.P. boilers, a 75 H.P double drum hoist, self-dumping, two ton capacity, skips, Rand duplex 10 drill compressor, Corliss engine for mill, etc., are also being put in, the contract having been given to the Canadian Rand Drill Co. of Sherbrooke. A new shaft house, 50 feet high, is being constructed. The shaft at date is down about 360 feet, and the fifth level, the lowest, is well in and looking all right.

The small milling plant at the Crystal mine, recently put in by the Jenckes Machine Co. on specifications of Mr. John E. Hardman, S.B., the well known specialist in gold milling, is working most satisfactorily. So far none of the rich ore on the dump has been put through the mill.

COMPANIES.

Canadian Pacific Exploration.—The statutory meeting of this company was held at the offices on June 3. Viscount Powerscourt, the Chairman, presided, and dealt with the formation of the company (February, 1897) and its present position and prospects. He explained that the authorized capital was 500,000*l.*, in 1*l.* shares. The properties and options on properties acquired were taken over from the Atlantic-Pacific Syndicate, and comprised in all 2,080 acres. The vendors had received fully-paid shares in full payment for their properties and rights. 50,000*l.* had been privately subscribed by influential English and Continental capitalists. The Chairman dealt with the conditions of mining in both British Columbia and Ontario, and said that the properties, etc., acquired were situated in West Kootenay, B. C.—of which Rossland was the centre—and Lake of the Woods and Seine River Sections of the Rainy River district, Ontario. The company had been formed to carry on operations which included exploration, land, trust, mining, etc. The manager arrived in Canada in April, and is now making a thorough inspection of the properties, and full reports are expected from him shortly regarding the properties purchased or bonded. The Chairman referred to the favorable conditions under which mining operations were conducted in Canada, enumerated the groups of claims and leases acquired, and commented on the favourable assays obtained from the samples taken from the reefs on the different properties. Some of those in the Kootenay district ran as high as 50¾ ozs. of gold to the ton, while an assay taken from the ore on one of their Rainy River leases went as high as 119 ozs. to the ton. Their manager in Canada had formed very high opinions of the properties acquired and bonded, and his reports and impression were strengthened by the latest cable advices. In a recent cable he stated his impression that one particular property "will make one of the richest mines in the country." On the motion of Mr. J. M. Maclean, M.P., seconded by Mr. T. Edwardes, a vote of thanks was passed to the Chairman for presiding, and the meeting then separated.

Mikado Gold Mining.—At the last ordinary meeting of the Shareholders of the South Africa General Development Syndicate, the chairman (Col. Engledue) said :—

"Your directors finding the channels of prospecting and investment in South Africa closed, at all events for some time, decided to strike out a new line, and to promote a gold mine in another part of the world—namely, the Lake of the Woods, Ontario, Canada, within Her Majesty's domains, and only twelve days' easy journey from London. Strictly speaking, the history of this transaction belongs to our next meeting, as the expenditure was not incurred during the period now under review, but it is felt that on account of a very favourable and promising investment may not be out of place on this occasion. I will, therefore, briefly describe our new adventure. In June last I was deputed by your Board to proceed to Canada to inspect a gold mining property called the Mikado, situated on the Lake of the Woods, Ontario, about 32 miles south-west from the town of Rat Portage. I found a well-defined quartz reef, 6 to 8 feet wide, which had been stripped for a length of 100 feet, and opened on by pits for a further distance of 314 feet. I took miners with me, and tested the reef in several places by large blasts, thus enabling me to get fair average samples. These were assayed at Toronto, the general average showing 4½ ozs. per ton. With such a result, and considering the large size of the lode and its favourable geological position, your Directors thought it safe to proceed with the formation of the Mikado Gold Mining Company, with a capital of £45,000 in £1 shares, of which £15,000 was reserved for working capital. Of this capital the South African General Development Syndicate hold 28,000 shares, and have a call at par for 5,000 more. A competent manager was despatched, arriving at the mine on August 19, and by the end of that month—that is in only about ten days—114 tons of ore were quarried, and sent to the Dominion Co's battery to be crushed, producing 417 ozs. of gold, or 3·65 ozs. per ton, exclusive of the gold in the concentrates, which ran 2½ ozs. per ton. A few days later 22 tons of ore were milled, which yielded 110 ozs. of gold, or 5 ozs. per ton, the total value being $7,512. Roughly, that would be about £1,500. Since that time about 700 tons of ore have been quarried, and will be crushed as soon as the ice on the lake breaks up and permits of navigation. The ore has the appearance of being as rich as that previously raised, and should be worth about £5,000. (Applause.) In addition to the lode first discovered, another rich vein of about 4 feet in width has been found, and is now being worked, and the last average assays taken by the manager over a length of about 100 feet, gave 10 ozs., 7½ ozs., and 5 ozs. 16 dwt. of gold per ton. There is every probability of this reef being equally as rich as the first. A very complete mining camp has been erected ; a main shaft 12 feet by 6 feet is being sunk, and at 60 feet deep a crosscut is being driven to cut the lode. A steam hoisting engine and boiler have been ordered, and complete plans have been drawn up for the erection of a battery, and the laying out of suitable dressing machinery. These, however, will not be ordered until the lodes have been further proved in depth. (Hear, hear.) In the meantime, the crushing of about 200 tons of ore, which was conveyed to the public mill before the navigation was closed, is being proceeded with, and we have just heard that of that quantity 144 tons of 2,240 lbs. have been crushed, yielding 442 ozs. of gold, or a little over 3 ozs. per ton. (Applause.) The value of this crushing is about £1,400, and will provide funds for continuing develpments. I may here say that only £500 have been remitted to the mine from London, the expenditure having been met out of the gold raised, and there is every probability that no further money will be raised from this side, and that the mine will pay for its own machinery. (Applause.) The area of the property at first acquired was 123 acres, but about 200 additional acres have since been granted on lease, so that the Company has sufficient area to admit of sub-division, should this prove desirable."

The above is the official report made to the shareholders of the Syndicate. Their investments having proven of so satisfactory a nature, will do much to make prominent the wealth of the Lake of the Woods gold fields. In his report Col. Engledue went on to say :

"As the Lake of the Woods gold mining district is but little known as yet to English investors, a brief description on the locality may interest you. The lake, with its numerous islands and extensive shores, occupies an area of about 80,000 square miles, and only became known to prospectors when the advent of the Canadian Pacific Railway opened up communication. Little progress in gold mining, however, was made until six years ago, when the settlement of the boundary disputes, and the discovery of the successful Sultana mine, and the opening up of the Regina mine, and other rich properties in the Seine and Rainy Rivers, caused a general influx of explorers, with the result that in every part of the lake's shores and in spots widely apart, numerous gold bearing lodes have been discovered. The district generally is served from Rat Portage, a town of about 8,000 inhabitants, on the Canadian Pacific Railway, and every part of the Lake is easily accessible by steamer, rendering the carriage of machinery and supplies easy and cheap. Since the discovery of the Mikado the whole of the immediate neighborhood has been prospected, and a large number of rich properties have been located. Considerable American capital has been attracted, and the coming spring will see widely-spread developments in the rich area. I may here mention that we have been lately approached to take up other properties on the Lake of the Woods, and it is quite possible the directors may appeal to the shareholders to give them a chance of sharing in what are likely to be very valuable concessions. (Applause.) There are very few localities in the world where mining can be carried on under better economic conditions than in the Lake of the Woods. The climate is excellent, supplies are plentiful, labor is cheap, machinery, &c,, can be easily transported, and properties can be effectively supervised from England, as the journey from London only occupies 11 or 12 days. The Board trust that the acquisition of this valuable Mikado property will more than compensate you for the disappointing result in South Africa, and hope in another six months to show good results, producing substantial dividends."

Dominion Coal Co, Ltd.—The annual report submitted to the shareholders, under date of 3rd instant, for the year ended 28th February last, is as follows :—

"As will appear from the Treasurer's statement, the output for 1896 was 1,169,785 tons. This is larger by 284,881 tons than for the previous year.

During the latter part of the year it was found desirable to erect a coal-washing plant. This was proceeded with, and is now in operation. It has proved economical and effective in increasing the market value of the smaller grades of coal.

Since the close of the year the sum of $54,172.65 for the sinking fund has been paid to The New England Trust Company. This, with previous payments and interest, amounting in all to $136,318.19, was in excess of the sum required as special deposit for sinking fund ($125,000) by $11,318.19, which has been used to the extent of $11,275 for the purchase and cancellation of twelve bonds. Hereafter all amounts paid into the sinking fund (five cents per ton on all sales) will be available for purchase and cancellation of the bonds."

The accounts contain the following particulars :—

Proceeds 1,169,785 tons, less mining, transportation, royalty, etc,		$303,037 76
Net income from steamships, railways, barges, real estate, etc.		286,263 45
		$589,301 21
Less—		
General expenses	$46,071 66	
Accounts payable	34,476 42	80,548 08
		$508,753 13
Less—		
Interest on bonds	$180,000 00	
Other interest paid and accrued	33,765 23	
Sinking fund	54,172 65	267,937 88
		$240,815 25
Less—		
Dividend preferred stock paid and accrued	$160,000 00	
Two months' dividend preferred stock, $500,000.00, referred to previous year.	6,666 67	166,666 67
		$74,148 58
Add—		
Surplus from 1895		18,214 73
		$92,363 31

BALANCES FEBRUARY 28, 1897.

Assets :		
Property accounts		$20,180,274 33
Cash assets—		
Cash in banks and offices	$14,794 30	
Accounts and bills receivable	70,059 05	
Balances due from agents and coal at distributing points	203,929 94	
New supplies in warehouse and stores	103,076 45	
Cash in New England Trust Company for outstanding coupons	90,915 00	
Cash in New England Trust Company, sinking fund and special deposit	81,123 30	
Cash in American Loan and Trust Co. for uncalled-for dividends	988 00	564,886 04
		$20,745,160 37
Liabilities :		
Capital stock, common	$15,000,000 00	
" " preferred	2,000,000 00	
First mortgage bonds	3,000,000 00	
Bills payable	282,896 70	
Unpaid coupons	90,915 00	
" dividends	988 00	
Sinking fund, 1896	54,172 65	
Dividend two months	26,666 67	
Royalty	36,977 62	
Interest accrued	704 00	
Accounts payable	34,476 42	
Railway suspense account	125,000 00	
Balance to general surplus	92,363 31	
		20,745,160 37

Cariboo Hydraulic Mining Co.—Advices of the first clean up for this season show a yield of $60,000.

The Strength of Ladders.*

To those who spend a dozen hours a week underground, as well as to the miner with his ten hours a day, the strength of ladders is of great interest, and on occasion may become supreme. To quiet apprehensions on this score, and to furnish a basis of judgment as well, the following tests were made, and if any excuse for them be called for on the ground of crudity and incompleteness, it will be amply given, if others, with better facilities for such tests, be persuaded to take the question up.

The ladders tested were of the common "Bull" pine of the Sierra region, ("black pine" *Pinus Jeffreyi*), the sides of 2 in. x 4 in. rough lumber, fairly clear, and the slats of 1 in. x 4 in., nailed on and not notched in. The width of the ladder and the length of step were 12 in. In such a ladder, when new, the strength of the slats would exceed the resistance of the nails, so that it would fail by the pulling off of the slats. Assuming a vertical position for the ladder, the maximum angle of a man's arm in climbing would

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* By R. GILMAN BROWN, in the Eng. & M. Journal.

be included by 45° out from the vertical, which would also represent the maximum tendency toward pulling off to which the slats would be subjected. In accordance with these premises, the tests were made by placing the ladder at an angle of 45° against a support, with the slats on the lower side, and weighting the slats to the point of rupture or detachment by means of sandbags. The results are shown in the table.

TABLE OF LADDER TESTS.

Ladder	Age—years.	Condition of Wood.	Nails—12-penny.	No. of Tests.	Weight of cubic foot of wood.	Pull. Max lbs.	Pull. Min lbs.	Pull. Av. lbs.	Remarks.
A	New	Green	Wire	3	24·6	886	609	725	Slats all pulled
B	"	"	Cut	3	24·6	1524	1075	1324	" " "
E	½	Very wet	Wire	6	23·2	922	612	759	3 slats broke with warning 1 slat " without " 2 slats pulled with "
C	1	Wet	Cut	5	22·6	1101	811	979	3 slats broke with warning 1 slat " without " 1 slat pulled with slight warning
D	1	Damp	"	7	23·1	1188	356	721	5 slats broke without wrn'g 1 slat pulled with " 1 side broke " "
G	1	Very dry	Wire	6	25·3	464	226	310	All pulled with warning from 2 to 30 seconds
F	5	Dry	Cut	2	21·7	665	403	534	1 slat broke without warn'g 1 " " with slight warning
F	3	"	"	3	21·7	1227	709	987	Made on three-year old slats on same ladder 1 slat pulled without wrn'g 1 " broke " "
G	1	Very dry	Wire	4	25·3	1345	1082	1248	1 " " with " Made on slats pull'd from G All broke without warning

Before proceeding to discuss the general strength of ladders as brought out, it will be found interesting to compare tests A and B, made on ladders of identical condition, save in the kind of nails used. The relative resistances of the two kinds, wire and cut, was found to be practically in the proportion of their respective adhering surfaces. Twelve-penny wire nails, 75 to the pound, present an adhering surface of 0·785 sq. in. each, the point being ignored, and 1 in. being subtracted from the length to allow for the thickness of the slat. Twelve-penny cut nails, 47 to the pound, with the same allowance present 1.394 sq. in. each. Their relative resistances are 725 and 1,324 lbs. for 6 nails, or 121 and 221 lbs. per nail, which reduces to 154 lbs. per sq. in. of adhering surface for wire, and 159 for cut nails.

In studying the table, the column of "Minimum Pull" is the one to which the most interest attaches, and in that the smallest value is 226 lbs., corresponding also to the smallest average of 310 lbs. The descriptive data for this test, G, are "one year in use in very dry place," and "nailed with wire nails." These would seem to be the ear-marks of the poorest ladder. Referring to the last test in the table, it will be seen that the wood was sound, but brittle from its dryness. The failure of this ladder was due to the shrinking or drawing away of the wood from around the nails. Shrinking produces also the same appearance, and to a certain degree the same effect, as if the nails had started from their places; the shrinking of the slat is toward the nail head, which is grasped by the wood, and that of the sides is away from the slat against the resistance of the nail point. And this gives an obvious means of diagnosing this malady of extreme dryness, and one that can be applied instantly to any ladder.

But the case is different for ladder D, probably the most dangerous, if not the weakest one of the lot. A minimum pull of 356 lbs., and five slats breaking with no warning, make a very dangerous combination. Casual scrutiny, such as one would naturally give to his surroundings on ascending an unfamiliar ladder-way, would reveal the weakness of G, but not of D.

From general appearance F would have been classed as the weakest ladder of the lot, so that its record is surprising, and it is quite worth bearing in mind that prolonged dryness is not the worst condition for timber. Returning to a further consideration of D and G, we should also note that taking into account the foot pressure, G is probably as strong as any in the list. In an average man the chord of his arm, bent in climbing, measures 20 in. from centre of shoulder to palm of hand, and 69 in. is the distance from center of shoulder to ball of foot. With the foot placed 72 in. below the hand, the pull of the hand is $\frac{23}{69}$ of his whole weight, and the thrust of his foot $\frac{46}{69}$ of it. With an assumed weight of 200 lbs., the pull and thrust are 55 and 166 lbs., respectively. On this basis G presents, as factors of safety, 4 for pull and 6 for thrust. D, on the other hand, presents 6 for pull and 2 for thrust, with the additional danger of no warning before rupture. When we come to inclined ladders the danger of pulling off becomes less, and G drops from the dangerous list.

The points that stand out from the foregoing are three: The weaker ladder is the very dry one; the most dangerous ladder is the damp one; the strongest ladder is the new one put together with cut nails. As a whole the study is reassuring, and goes to account for the infrequency of accidents from the failure of ladders. As a corollary the following may be suggested: For dry places use dry lumber, and notch the slats in flush; for damp places make heavier slats.

DETONATORS AND DETONATION.—In a recent paper before the Manchester Geological Society, Mr. W. J. Orsman, F.I.C., contributed a paper on this subject, in which he pointed out that gunpowder was a comparatively slow-burning compound, the gases formed taking some time to get up to the maximum pressure, and this circumstance made it a valuable explosive when blowing soft seams of coal, as the slow development of pressure produced a heaving, instead of a rending, effect. The decomposition of certain explosives, however, could be brought about not only by the application of heat, but by exposing them to an intensely rapid explosive wave, causing an effect called detonation. With these compounds the maximum pressure was attained in less than one ten-thousandth part of a second, and it was this circumstance—viz., the time during which given force was exerted—that made the high explosives so much more powerful than gunpowder. Experiments had shown that the best detonating results were obtained by the aid of fulminate of mercury, which was the most powerful explosive per unit of volume, and would exert a pressure of nearly 200 tons per square inch. It had been found that certain mixtures, such as nitrate of ammonia, together with a nitrated organic body—e.g. the nitro compounds of benzole, toluoli, and naphthalene—could easily be exploded by detonation, but were totally non-explosive when exposed to the effects of fire, electric sparks or percussion, and during the last few years a new class of high explosives had been introduced, called the nitrate of ammonia safety explosives, such as roburite, bellite, ammonite, &c. These were remarkably safe to use; their products of combustion were gaseous and non-poisonous, and the temperature of detonation was much less than that of any other class of explosives. The detonators of commerce consisted of metallic capsules, resembling elongated percussion caps, and contained varying weights of pure fulminate of mercury mixed with a small proportion of chlorate of potash. The weight of the chlorate should not exceed 5 per cent. when the detonators were used for firing nitrate of ammonia explosives. For firing the nitro-glycerine compounds a larger amount of chlorate was advantageous. On this account nitrate of ammonia explosives should never be fired with detonators intended for nitro-glycerine compounds, such as dynamite, gelignite, carbonite &c. Detonators were distinguished by numbers, varying with the quantity of explosives they contained, ranging from No. 1, containing 0·3 grammes, to No. 8, containing 2 grammes. Nearly all the detonators used here were made abroad, and last year nearly 10,000,000 were imported into the United Kingdom. For firing the nitrate of ammonia class of explosives, detonators containing at least 1 gramme of fulminate should be used, and for this reason Nos. 6 and 7, containing 1 gramme and 1½ grammes respectively, were in most general use. It had been found that a large number of the cheap foreign detonators imported into England contained from 30 to 40 per cent. of chlorate, and were quite unfit for detonating the above class of explosives. Great care must always be exercised when handling detonators, and the fulminate of mercury was very sensitive to percussion. When used for detonating explosives, the detonators were fired either by tape fuse, or, preferably on account of safety, by electrical methods.

BOUNDARY CREEK MINING AND MILLING CO.

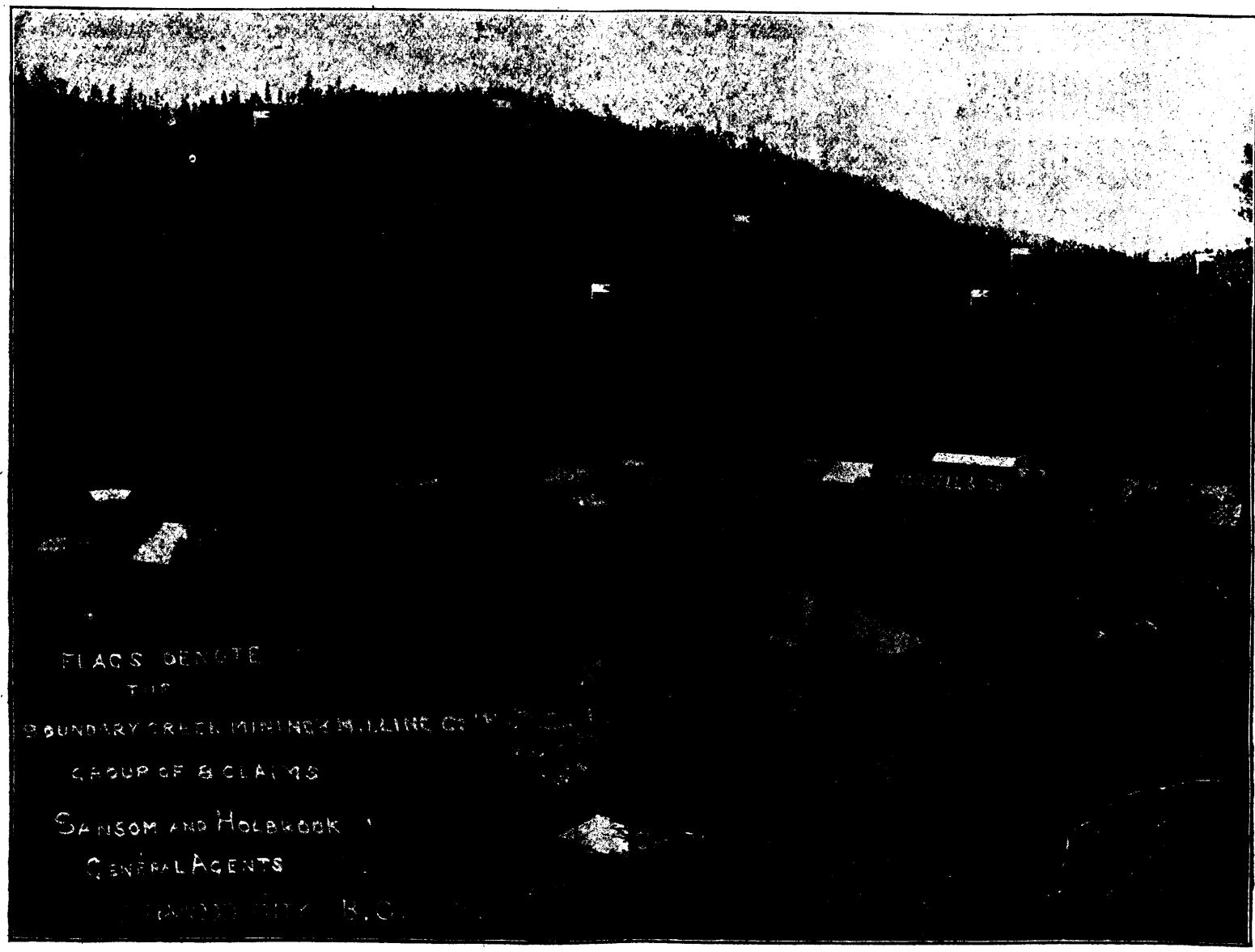
INCORPORATED OCTOBER 21st, 1896.

CAPITAL, $1,500,000. **1,500,000 SHARES AT $1.00 PER SHARE.**

700,000 Shares in the Treasury for Development.

This Company owns and operates a group of the highest grade in Gold, Silver and Copper properties in Boundry Creek.

CLAIMS—The G. A. R., D.A., O. B., S. H. B., J. A. C., FRED D., S. F., C.S. & H., D.H. and BIG LEDGE, constitute the group, which is the most compact and advantageously situated of any under one ownership in Boundary Creek. The proposed Columbia and Western R.R. being surveyed to pass right through Greenwood City and along the base of the hill.



From the above photograph it will be readily seen that, lying as they do on a steep sloping hill, the properties offer unusually good facilities for drainage and rapid and economical development, by main working tunnels driven in from the base of the hill.

The veins lie in the Granite Area—which occupies the upper part of Boundary Creek basin—along the line of contact with the more basic eruptures, and are among the oldest locations in the camp.

A small shipment of 8,653 lbs. was made to the Everett smelter in 1894, yielding per ton, Gold, $103.15; Silver, 74-7-10 ozs.; Lead, two per cent., and a considerable amount of shipping ore is at present on the dumps of the different claims.

Careful investigation is earnestly invited by the Company, as their properties are being developed with a view to making mines and not to booming stock.

Attention is drawn to the large amount of stock (700,000 shares) put into the Treasury, and to the fact that the properties are all fully paid for.

150,000 Treasury shares fully paid up and non-assessable, have been put on the market at 10 cents, and most of the stock so far sold has been taken up locally. A large proportion of the miners now working are also taking stock in payment. For further particulars address

BOUNDARY CREEK MINING AND MILLING CO.

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CANADA;
Province of Quebec,
District of Athabasca.

IN THE SUPERIOR COURT.

No. 125.

IN THE MATTER OF

The American Asbestos Company, Limited,

IN LIQUIDATION.

The undersigned Joint-Liquidator will sell by

PUBLIC AUCTION

at the office of Messrs. ROYER & BURRAGE, 87 Wellington Street, Sherbrooke, Que, at eleven of the clock in the forenoon, on the

EIGHTH DAY OF SEPTEMBER NEXT, 1897

the Asbestos Mining Property and Plant of the said Company, at Black Lake, in the Province of Quebec,

situate upon the parcel of land known and distinguished as the southerly ends or halves of lots number twenty-seven and twenty-eight, in range B of the Township of Coleraine, in the County of Megantic, containing about one hundred and four acres of land.

The property is situated about one mile from Black Lake, on the Quebec Central Railway, on the main road leading from Black Lake to Thetford mines. It is in the midst of the asbestos bearing belt of serpentine from which the greater part of the world's supply of asbestos is mined. The mine has been operated by the American Asbestos Company since 1888, and has been a steady producer of a very fine grade of asbestos, nearly the whole of the output of the mine since that time having been supplied to prominent European manufacturers of asbestos goods. The property is splendidly situated and well adapted for the purposes of asbestos mining, and is thoroughly equipped with the most modern machinery for the economical handling of the rock and manipulating of the fibre. Special machinery was placed last year for fiberizing, the result proving very satisfactory. There are a number of workmen's dwellings on the property, sufficient to accommodate a large number of men.

The machinery consists of four steel boilers (300 h.p.,) 16 x 24 Rand air compressor, 6 Ingersoll & Rand rock drills, 4 duplex Bacon winding engines, Blake rock breaker, special crusher for fiberizing asbestos, Blake and Knowles steam pumps, boom and cable derricks, ropes, pitcars, steel rails, and a miscellaneous lot of tools, the total value of plant and improvements amounting to about $45,000.

Tenders for the property will be received up to the date of sale, the Joint-Liquidator reserving the right to accept any such tender and withdraw the property from sale, and further reserving the right to place an upset price upon the property at such sale, and make such other conditions as they may see fit. The property is open to inspection at any time. Inventory can be seen, and any further information will be furnished on application to the undersigned.

JOHN J. PENHALE,
R. R. BURRAGE,
Joint-Liquidator.

Sherbrooke, Que., May 31st, 1897.

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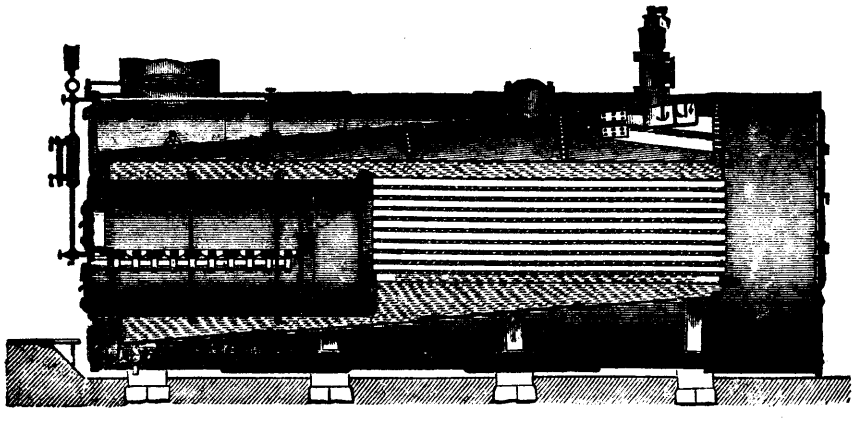

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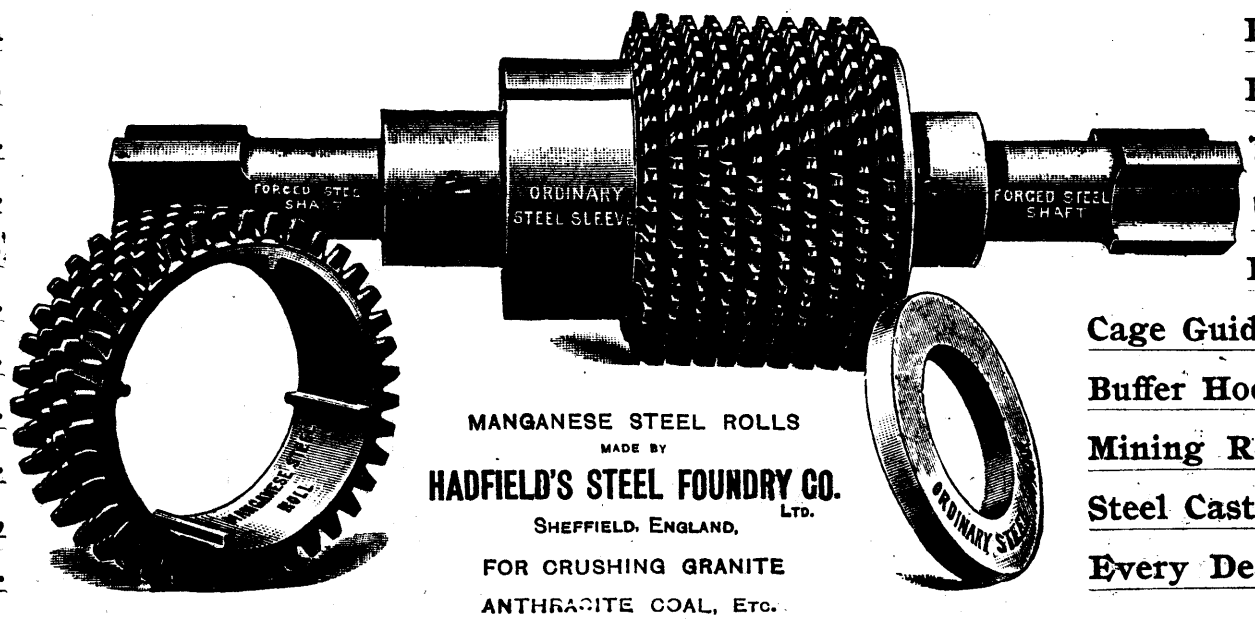

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