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The CANADIAN MINING REVIEW

Established 1882

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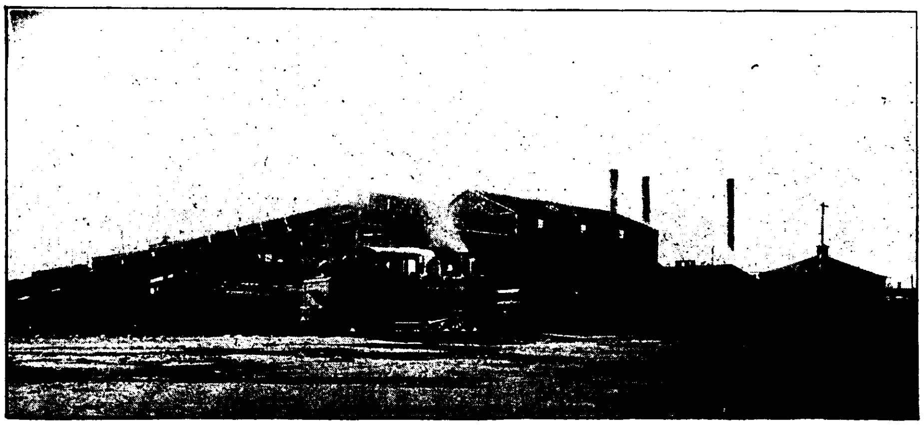

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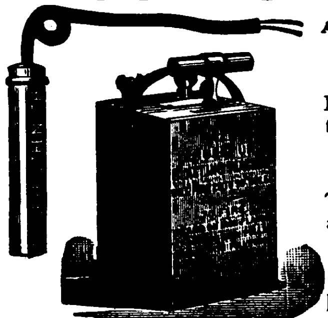

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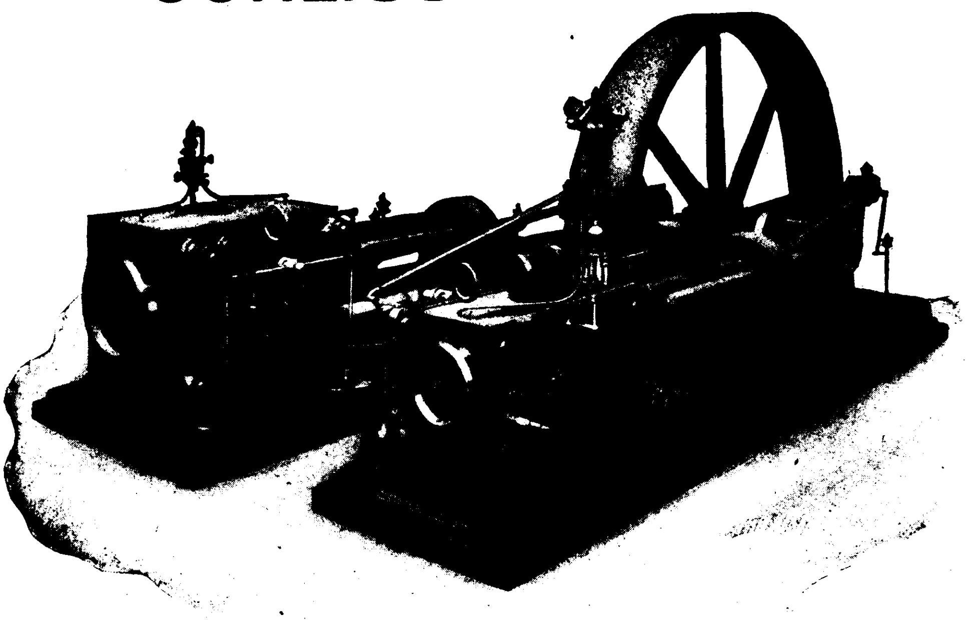

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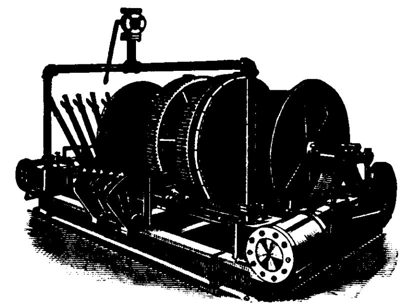

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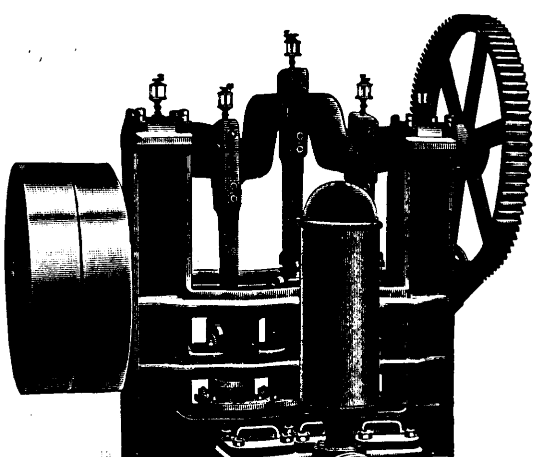

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B. T. A. BELL, Editor and Proprietor. Secretary, Canadian Mining Institute, etc. | Published Monthly. | OFFICES { Orme's Building, Ottawa; Windsor Hotel, Montreal.

VOL. XXII., No. 10. | OCTOBER, 1903. | VOL. XXII., No. 10.

The Passing of Prosperity.

There are onimous signs on the business horizon, at any rate on that of the United States—signs of a coming storm. The prosperity that has been rampant for a number of years seems to be drawing to an end, and the long postponed but inevitable reaction is setting in.

Economists are agreed that the industrial system of to-day rests upon a basis of pig iron. If the iron trade is in good condition, other trades are likely to be prosperous, it is a barometer responding promptly to the rising demand of good times, and promptly showing the recession when the flush of activity is past. In October 1902 No. 2 foundry pig iron sold in Philadelphia at $22 per ton, in October 1903 it is being sold at $15.25 per ton, a reduction of 30 per cent. In the Cincinnati market the fall has been even more pronounced. The cause of the decrease is simply the smaller demand. Consumption has measurably overtaken production, and there is a movement among producers to restrict the output. Those furnaces whose margins over the cost of production has disappeared or is disappearing are being blown out. The demand for iron ore is also lessening. The quantity of ore shipped from the Lake Superior district of the United States will be considerably smaller this year than last, and is not expected to exceed 25.000,000 tons. As yet manufactured steel has not shown a corresponding reduction in value, steel rails being quoted at the same price as in October 1902, viz., $28 per ton, and steel billets, having fallen from $29 to $27 per ton. But there is no mistaking the tendency of the markets, which is decidedly downward, and favorable to a further diminution of the production.

The United States Steel Corporation reduced its quarterly dividend on the common stock, payable in October, from one per cent to one-half of one per cent, the earnings of the company having fallen from $11,930,846 in September 1902 to $9,000,000 in September 1903, for the quarter ending in September from $36,945,489 in 1902 to $32,302,821 in 1903, and for the nine months from $101,142,158 in 1902 to $94,013,836 in 1903. This reduction in the dividend has been followed by a heavy fall in the selling value of the stock, common now being quoted at $12.50 per $100 share. The public has always been nervous about U. S. Steel stock, the general conviction being that it carried a great deal of water.

Coal and coke, bound up as they are with iron, exhibit a sympathetic downward tendency. The demand for bituminous coal has slackened, and prices are going down. The scarcity of coke which has been a marked feature of smelting and manufacturing operations for two or three years is likely to come to an end. The situation in anthracite contrasts strangely with that of a year ago. Then hard coal was not to be had at any price, now dealers everywhere are well stocked, and the collieries are running on short time.

Labor troubles have done much to cause uneasiness and are still disturbing the situation. The high wages which have been the rule for a long time seem destined to suffer a reduction, as in the iron mines of Alabama, where the miners have had to submit to a cut varying from 2½ cents to 5 cents per ton, the cause alleged being the fall in value of pig iron. Railway companies are discharging men, but notwithstanding this there are rumors of strikes among the employees of other lines.

The course of the stock market in New York and elsewhere has been sufficiently alarming. Shares have been tumbling until it seemed as if there were no bottom, and the end is not yet. The great industrial combines whose proportions startled the world when formed are entering upon a period of trial, and already some of them are showing intrinsic weakness, the outcome of inflated valuations. A business which in times of high prices and active demand can easily earn money enough to pay 6 per cent on a capital of $100,000,000 representing say $50,000,000 of real assets, may be hard put to it to do more than defray expenses when prices are cut in two and goods have to be forced to a sale. The next few years will undoubtedly be a time of sifting among these enormous aggregations of business and capital.

While this has been the course of events in the United States, what is the outlook for Canada? In past years we have been vitally affected by conditions south of the line, and good or bad times prevailed here concurrently with there. This state of affairs yet obtains to some extent, but notwithstanding the large increase of Canadian trade with the United States, this country is more independent of her neighbor in matters of commerce than ever before. Canada buys largely in the States, and sells largely to Great Britain. A country's ability to sell does not suffer so much in a time of depression as its ability to purchase, hence Canada may continue to buy to advantage south of the line and sell to advantage across the water despite the coming of hard times to the great republic.

The causes, however, which have produced evil effects in the United States have been at work here. A striking case in point is the Lake Superior Consolidated Company, whose affairs at Sault Ste. Marie have reached a crisis. The preferred stock of this company, amounting to $28,000,000, sold at one time for 80, now it stands at 2½, while common stock of which there is $74,000,000 has fallen from 36 to a quarter of a cent or less. That a company with a nominal capital of $102,000,000, owning its own mines, blast furnaces, railways, steamers, pulp mills, steel works, water-powers, and saw-mills, and huge grants of land, should come to such a pass as to permit its effects to go to the hammer for lack of funds to pay off a mortgage of $5,000,000, seems almost incredible. Yet this is what has taken place, and the law has placed the mortgagee in possession. The Dominion Coal Company and the Dominion Steel Company are additional instances, but perhaps not so pronounced, of heavy losses following upon bad management.

Yet making due allowance for these failures, the situation in Canada comprises elements which may well go to mitigate the severity of a financial depression, should one be in store for this country, if not to avert it altogether. Immigration is adding to the population by leaps and bounds, and during the present year the incoming tide has been fuller than ever. The fertile plains of the Northwest are being rapidly occupied and brought under cultivation. In Ontario the government railway from North Bay to Lake Temiskaming and northward, and in the Dominion the Grand Trunk Pacific will render accessible large tracts of good farming land, great forests of timber, areas of ranching ground, and deposits of minerals. In addition they are causing and will cause the expenditure of large sums of money in the work of railway construction. This year's harvests were abundant in some parts of the Dominion and good in all, and are bringing high prices. All these causes cannot but contribute to a prolongation of good times in Canada, without reference to the turn events may take in the United States.

There is some recompense for the shabby way in which this country has always been treated in trade matters by the United States in the fact that Canada is more self-contained and less dependent upon her great neighbor than if the commercial relations of the two countries were more intimate, and that she is consequently better able to withstand the crisis which appears to be gathering in the south of us.

A Danger Ahead

Notwithstanding that the proposal to re-organize the Dominion Geological Survey has been under consideration for three years or more no particulars are as yet forthcoming concerning the scheme which is to be adopted. The Minister of the Interior has announced his intention of separating what he calls the "econmic" work of the survey from the "scientific" work, and of giving the former much more prominence in the future than it has enjoyed in the past. It seems to be his idea to establish a distinct branch of his department to deal with the industrial side of the mining business, leaving the remnant of the survey to continue the geological mapping of the country, and either to place the two branches under different deputy ministers or assistants, or to subordinate the geological and "scientific" functions of the department to the "economic" placing the management of the survey or whatever the transformed branch may be called, in the hands of the "economic" chief.

In our way of thinking the attempt to divorce the practical from the so-called scientific aspects of the geological survey is doomed to failure. The fact is, the work of the survey is, or should be, wholly and entirely practical, and among the most practical of its duties is the working out and recording in reports and maps the geological formations of the country. Time and again in the history not only of the Canadian Geological Survey, but in that of similar institutions in other countries, investigations carried on and results achieved which had little or no economic value at the time have later on proven most fruitful in dollars and cents. An instance occurs to us of the usefulness of work done primarily for scientific purposes In 1887 an examination was made of the Rainy Lake region of Ontario by Dr. A. C. Lawson, who thoroughly worked out and mapped the geology and topography of the district. A few years later gold was discovered in the territory covered by Dr. Lawson's survey, and the map accompanying his report which had lain in the Survey's archives came suddenly into demand, for prospectors found that they could travel almost anywhere by its guidance with the added advantage of having the rock formations plainly and accurately delineated.

But if we mistake not, Mr. Sifton will encounter other and greater difficulties in the attempt to cover the mining industry of the whole of Canada than those offered by problems of internal administration. In not a few of the Provinces of the Dominion the local governments have established bureaux or departments for the express purpose of promoting the interests of mining within the Provincial boundaries. In British Columbia, Ontario, Nova Scotia and Quebec these organizations have been in existence many years, and have done valuable work, quite as useful and important in its way as any done or likely to be done by the Geological Survey.

The Provinces, or at any rate the older Provinces, own the Crown lands yet unsold within their limits, which in the case of Quebec and Ontario comprise the greater part of their area. Being in the position of proprietors of the land, it is naturally in the interest of the Provinces to explore their unsettled areas, and to systematically make known their mineral and other resources. One end served by such action is to promote settlement in the new districts, and another is to increase receipts from the sale of wild lands.

Again, the duty of making laws for the government of the mining industry is by the constitution of Canada relegated to the Provincial Legislatures, who frame such measures as they deem the circumstances of the Province require. It is quite conceivable that the views entertained by the Government of any one of the Provinces, say British Columbia or Ontario, on any matter connected with mining might be very different from those held by the Dominion Government of the day. In a clash of this kind, the cry of Provincial rights would certainly be raised, and the interests of legitimate mining would suffer, as in the past they often have suffered, in the clash of party politics. In Nova Scotia, coal, and in Ontario, nickel, have been the subjects of special Provincial legislation. Whether the action of the Legislatures in these cases was wise or the reverse, it was the action of competent authority, and was no doubt taken on the advice of the mining departments of the respective Provinces. It is exceedingly doubtful that the Provincial authorities will tamely acquiesce in any abridgment of their rights or curtailment of their jurisdiction.

The proposal to include the whole of the mining industry in Canada in the scope of the revised Geological Survey will almost inevitably lead to the duplication of work and expense. The Dominion and Provincial Governments will be covering the same ground, and public money will be thrown away. Nor will the trouble end here. Independent reports will be issued by the respective governments on identical fields or subjects, and as geologists and mining experts are notoriously apt to disagree, differing or directly contrary views will be given to the world on official authority regarding the objects of investigation. Such a state of things can only have the effect of discrediting one or both of the organizations, and of reducing the usefulness of both to the vanishing point. As the Dominion Government will be the invading party, the blame will naturally and rightly fall upon it.

It is possible some rational division of work might be made as between Provincial and Federal mining or survey departments, which would result in co-operation rather than confusion. The indispensable work of defining the geology of the country might well remain with the Dominion survey, as well as the extenseve field for industrial investigation afforded by the Northwest Territories. Mining statistics for Canada as a whole might also be collected and published by the Dominion authorities. But any scheme of collaboration can only be

TREADGOLD ROYAL COMMISSION

1903.

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THE HON. BYRON MOFFATT BRITTON, Commissioner.
H. H. ROWATT, English Secretary.
B. T. A. BELL, Commissioner.

arrived at after consultation with the Provincial authorities, and so far we have not heard that anything of the kind has taken place. The Dominion Government appears to be bent upon taking over the work of the Provincial mining departments and of putting the latter out of business, notwithstanding the excellent service which they have rendered and are continuing to render. This end will not be gained without much trouble, and it is doubtful whether it would be an improvement on the present condition of affairs.

Since the above was written an appropriation of $10,000 has been made by the Dominion Parliament to cover salaries and expenses for the mining bureau to be established in connection with the Department of the Interior. Sir Wilfrid Laurier, in explaning the item, said it was intended to form a bureau similar to that at Washington, and for the present to confine the staff to two or three experts under the superintendence of Dr. Eugene Haanel. The duties of the bureau would be to collect and publish statistics and information regarding mining operations and the mineral resources of the country, processes employed, and the production, consumption, imports and exports of economic minerals and products. The sum of $5,000 has also been provided for metallurgical assistance to the Geological Survey, Mr. O'Connor having been appointed metallurgist.

The working out of the proposed arrangements will be watched with interest. It is difficult to see how the new bureau can operate to any purpose without infringing on the domain of the Provincial organizations.

Manganese in Nova Scotia.

In view of the constant demand for manganese it may not be out of place to recapitulate briefly the localities in this Province yielding its ores.

The most common ore is wad or bog manganese. This occurs at Jeddore, Ship Harbor, St. Margaret Bay, Chester, Springhill, Londonderry, etc. At Boularderie Island a deposit said to be several feet thick contains from 11.00 to 34. 3 per cent of peroxide.

Pyrolusite is the only ore that has been mined to any extent in Nova Scotia. It occurs in carboniferous and pre-carboniferous strata. In the gold districts it has been noticed in veinlets penetrating granite and slates. In the rear of Wolfville it is found in slates referred to the upper silurian age. The lower carboniferous limestones also contain pyrolusite. So much is this noticeable at a certain horizon that the late Sir William Dawson proposed to subdivide the lowest limestone division by distinguishing a certain manganiferous limestone. This subdivision he recognised at Salmon River, Cape Breton Co., Springville and New Laing, Pictou Co., and at Chester, Fenny Cape, Maitland, Windsor, and Onslow.

These limestones carry in the rock manganese carbonates from traces up to 14.58 per cent.

In the northern part of Hants County the presence of this division is recognised near the mouth of the Shubenacadie river where a dark colored manganiferous limestone is associated with red shales carrying veins of red hematite with manganese oxides and calc spar.

The westward continuation is noticed at Tenny Cape, Walton, and Cheverie. These limestones carrying manganese ores outcrop again about fifteen miles to the south.

The Tenny Cape manganese ores were discovered about the year 1862 and have been worked intermittently since that date. Here it is found in limestone in irregular pockets, and in seams eroded on the beddin planes and cross fractures. Masses up to 180 tons in weight have been found. Usually, however, the pockets are small and connected by stringers. The ore is chiefly a fibrous pyrolusite, lustrous, and bedded on compact pyrolusite, psilomelane, and manganite. After hand dressing these ores have brought $125.00 a ton.

The high grade of these ores and their freedom from iron will appear when it is found that numerous assays show it to yield from 88 to 95 per cent of available oxide, with traces of iron, silica and moisture.

At Walton and Cheverie manganite is more common than at Tenny Cape. An analysis of the Cheverie manganite gave

Manganese oxides	86.81
Iron peroxide, Baryta	2.05
Silica	1.14
Phosphoric acid	—
Water	10.00
Available oxygen	47.73

It is believed that if a system of systematic quarrying and washing were adopted, many of the more highly mineralized belts would yield good returns.

Apparently his locality could be worked by quarry work, crushing and washing. Considerable quantities of psilomelane with manganite occur with limonite ore at the Steel Company's mines at Springville, associated with the manganiferous limestones. Manganese is also present in the iron ores up to 14 per cent.

In Cape Breton County, near the head waters of the Salmon river, a fine-grained pyrolusite occurs at several points. At one point it occurs as a bed, underlying a black manganiferous limestone, the two together varying in thickness from two to twelve inches. At another point it occurs in irregular bedded layers in a coarse reddish shale. The ore runs, according to the analysis of the Canadian Geological Survey, from 70 to 90 per cent of binoxide, and is free from iron or other impurity.

The system of following the irregular courses and stringers of ore hitherto followed, is too expensive to permit of profit. Judging from the extensive district known to contain ore and the abundance of surface indications it is probable that this part of Hants County would repay investigation.

In similar limestones at Minudie, in Cumberland County, soft fine-grained pyrolusite occurs, containing 97.04 per cent of binoxide.

Ores similar to those of Tenny Cape occur at Onslow and on the Salmon river, near Truro. Here red sandstones and shales and beds of dark colored limestone carry narrow veins and irregular nests and layers of ore. Some of the ore runs up to 90 per cent of available oxide. The ore also occurs in nodules in the soil.

On the College grant, Lunenburg County, some prospecting has been done on veins of manganese ore, which show over a large tract of ground. The country rock is reported to be a granite, carrying the ore veins varying in thickness from four to forty inches. Several hundred tons have been mined and exported, but as there is a long haulage to water, operations were suspended. Recent railway construction in this locality will, however, permit of a lessened cost of transportation.

The ores run from 85 to 90 per cent of binoxide, two-tenths to one-half per cent of iron, and from one to two per cent of silica.

This locality is believed to present the most promising field for exploration in the Province. Some of the veins are said to carry about 30 per cent each of iron and manganese, and to be large enough for cheap mining. From these notes it will appear that the ores of manganese are widespread in Nova Scotia, and that at several localities they are met over considerable areas. They have as yet however received little attention. There is good reason to believe that further search may show deposits large, if lower in grade, that can be mined in quantity for the purposes of the steel market.

Gold Milling Costs.

By S. Horsley, Mining Engineer and Inspector of Mines.*

The difficulties in the way of a proper comparison of the total cost of extraction on the various goldfields of the world are:—

1st. The nature of the power used—e.g., water power is much cheaper than the most effectively applied steam power. If steam power is used, the relative cost of fuel must be taken into consideration. Extraction is much less costly where coal is obtained easily and cheaply than where indifferent firewood costs 30s. per cord.

2nd The nature of the material to be crushed. Hard material is not so easily crushed as a soft or friable material. A custom battery putting through 4 tons per stamp per day for one mine finds itself unable to put through more than 2 tons per stamp for another mine. Here the nature of the material causes one mine to pay twice as much for crushing as another mine.

3rd. The number of operations or processes necessary for a complete extraction.

Where coarse gold only occurs in an easily pounded quartz in close proximity to ample water power, the cheapest conditions possible for almost complete extraction are realised. But the case is exactly reversed where gold occurs in minute particles locked up in or combined with other substances which are hard and resisting, and which occur in waterless areas, where inferior fuel costs 30c. per cord.

Under favourable conditions, such as the occurrence of large deposits, requiring an extensive milling plant, the total cost of extraction might be as low as 9d. per ton in the former case. Yet the most efficient machinery combined with the most approved methods of treatment have failed to bring down the total cost of extraction so low as 10s. per ton, or 13 times as much in the latter case.

The way out of the difficulty is now apparent. Since the total cost of extraction necessarily varies so largely, we are unable to derive any useful information from a comparison. A great deal can be learnt, however, if, after the hardness of the material has been defined according to some pre-arranged standard, the cost of fuel per indicated horse power per ton and the cost of each separate operation or process is separately recorded.

It is also natural to expect a battery of 100 heads to crush more cheaply than one of 10 heads. But a company which finds 10 heads a sufficient number to erect on their mine cannot be said to lack economy. Although an examination of the costs of extraction by the various gold milling plants of the world reveals a wide divergence, yet the divergence is not so marked when the cost of each separate process is considered.

At Chiapas, Mexico, the cost of milling the soft ore there is only 9¾d. per ton of 2,000 lbs., with a 10 head battery having 750 lb. stamps. The cost of the power is not taken into account, as water power is used. The Alaska-Treadwell Company, Douglas Island, Alaska, with 540 stamps, crushed and concentrated for 9¾d. per ton in 1900. This company's costs for total extraction—milling, concentration, chlorination, smelting, and office expenses, were:—

Year Ending	Quantity Treated	Value per Ton	Cost of Total Extraction.
	Tons	s. d.	s. d.
31st May, 1899	250,408	10 10	2 1
31st May, 1900	557,960	8 4	1 6¼
31st May, 1901	457,802	8 3	1 5½

* Queensland Mining Journal.

Their total costs for mining and milling for the same periods were 5s. 1½d., 3s. 7½d., and 4s. 4d. per ton respectively.

The Alaska-Mexican Company, at the same place, with 120 stamps, crushed and concentrated for 1s. 2d. per ton in 1899. They put through during 1899, 166,054 tons, valued at 8s 7¼d. per ton, for a total cost for mining and milling of 7s. 1d. per ton. The total extraction costs were 1s. 11½d. per ton of 2,000 lbs.

The Homestake Company, South Dacota, U.S.A., crushed nearly 900,000 tons for the year ending June 30th, 1900. The total milling costs were 3s. 4d. per ton, and the total mining costs 10s. 9d. per ton —a grand total of 14s. 1d. per ton. For the year ending June 30th, 1901, the Homestake Company mined and milled 934,373 tons, valued at about 16s. per ton for a total cost of 14s. 8d. per ton, thus making a profit of nearly £63,000 sterling out of ore of a quality that is practically despised in Queensland. There are large deposits of low grade ore, similar in charactar and value to that mined by the Homestake, and superior to that mined by the Alaskan companies, in parts of Queensland as yet barely touched by the miner.

The milling costs of the De Lamar Mining Company, Idaho, U. S. A., for year ending 31st March, 1899, were 9s. 3¾d. per short ton.

The total cost of mining and milling at the following mines for the period ending with the date given is as follows:—

	s. d.	Year ending.
Montana G. M. Co. Mont., U.S.A	23 6¾	30/6/99
do do do	36 10½	31/12/01
Mill at Ben d'Or, British Columbia	21 4	/99
Morro Velho Mines, Brazil	25 8	31/8/01
New Elkhorn Mining Co., Montana	66 10	31/12/99

The milling costs—or total cost of extraction—of the last named company at the date given was 39s. 7d. per short ton.

There is thus a wide difference between the 9¾d. per ton of the Alaska-Treadwell Company and the 39s. 7d. per ton of the New Elkhorn Gold Mining Company.

In the Western Australia the Lake View Consols crushed and cyanided for 10s. 1¼d. per ton in 1898, and for 6s. 10½d. per ton in 1899, but the extraction was unsatisfactory when sulphides came to be dealt with. For these, other methods were adopted, and on August 31st, 1900, the cost of extraction was 43s. 5d. per ton. This amount was reduced to 32s. 10d. per ton during the last three months of 1900, and was still further reduced in 1901 to 28s. 3d. by the adoption of the Diehl process.

At the Great Boulder Perseverance Mine, the costs of extraction were 34s. 11½d. in 1900, and 24s. 10½d. per ton in 1901.

At the Ivanhoe Mine, Kalgoorlie, during November, 1902, the reduction costs were set down at 10s. 4d. per ton; mining, 14s. 3d.; general, 3s. 5d.; development and capital, 6s. 2d. per ton; total 34s. 2d. per ton. The question here is: What part of the general expenses is connected with the process of extraction?

At the Kagurli Mine, for the same period, the total and mining crushing costs were 38s. 5d. per ton, presumably a short ton in all W. A. instances.

At Mount Morgan, Queensland, the cost of dry crushing for 1900 is given at slightly under 4s. per ton.

At the New Ravenswood. Ltd., Ravenswood, the total cost of mining and milling their refractory ore is (1902) 38s. 10d. per ton (2,240 lbs). The works here, however, are not yet complete.

The Brothers' Mill, Ravenswood, cart and crush hard mineralized quartz for 15s. per ton, and dyke stuff for 8s. 3d. per ton. Carting in the former case costs 1s. 6d., and in the latter, 9d. per ton; concentartion, by Wilfley tables, is included, but not cyanide.

The Commonwealth Mill at Donnybrook for similar treatment charges 16s. per ton, viz., 2s. for carting and 14s. for crushing, etc.

The cost of crushing, concenta[r]tion, grinding, and smelting of concentrates at the Imperial Mine, Charters Towers, for the half year ending November 1901, was 9s. 8¼d. per ton of 2,240 lbs. Their total mine battery, and office costs were 28s. 4¾d. per ton.

The usual charges for carting and crushing at the Charters Towers Mills is as follows:—

5 tons or under £5.	
Over 5 tons and up to 25 tons......	14s. 6d. per ton.
" 25 tons and up to 50 tons......	13s 6d per ton.
" 50 tons and up to 100 tons.....	13s. per ton.
" 100 tons	12s. 6d. per ton.

Carting costs variously up to 2s. 3d. per ton, all of 2,240 lbs. These prices, though apparently high, leave a very small margin of profit. Numerous small crushings for the public cause much loss of time, and require a large number of pits for saving the tailings, also entail considerable extra cost of cleaning up. If a mine, owning its own mill, could keep it fully supplied, the crushing, concentrating, and grinding costs would probably not exceed 7s. 6d. per ton.

The cost of crushing and concentration only at some of the mills is stated to be not much over 3s. per ton. Grinding and the drying and bagging of concentrates increases this amount, and further expense is entailed by cyanide treatment or smelting.

The exact cost per ton at Charters Towers of a 5 ton lot or a 1,000 ton lot does not appear to be known, and in high grade districts like Charters Towers and Ravenswood there will always be numerous small lots raised, and there must be customs batteries to treat them. I enclose a table showing the manner in which I think milling costs should be arranged for the purposes of comparison

As regards the duty per stamp per 24 hours in various parts of the world, nothing can be done in the way of a correct comparison unless the hardness, etc., of the material to be crushed is first compared with some standard. Even within the limits of Charters Towers and Millchester variations in the hardness of the material affect the rate at which it can be crushed. At Ravenswood one party of tributers has to pay the mill owner nearly twice as much as another party has to pay owing to the difference in the character of the material crushed. It may be said that the best mills at Charters Towers and Ravenswood crush rather over two tons per stamp per 24 hours of very hard mineralized quartz; and they will crush four tons per head per diem of softer stuff, and each ton of 2,240 lbs. (not 2,000 lbs.)

Most of the mills at Charters Towers have high pressure steam, compound condensing engines, rock-breakers, self-feeders, etc., and are not behind hand in adopting the latest gold or mineral-saving device if it suits the ore which occurs on the goldfield.

A Dry Process for the Treatment of Complex Sulphide Ores.*

By H. Livingstone Sulman and Hugh Kirkpatrick Picard

The class of ores to which our process is applicable is that in which zinc blende and galena predominate, substantial silver values being also generally present; these, commonly known as "complex sulphide ores," are typified by the Broken Hill deposits. The latter indeed are of unusually refractory character, the metallurgical difficulties attending the separation of the lead and zinc being increased by the intimate intercrystallisation of the minerals as well as by the presence of ferrous sulphides, garnet, rhodonite, etc., in considerable quantity.

It is unnecessary to review at length the many attempts to treat these ores, the more important later efforts being well known to members of this Institution; and much valuable information as to the type and values of the Broken Hill deposits is to be found in Mr. Ashcroft's paper.†

*Paper read before the Institute of Mining and Metallurgy.

†Transactions, vol. vi., p. 282.

COMPARATIVE TABLE OF GOLD MILLING AND MINING COSTS.

Year Ending	Name of Mine or Mill.	Annual Tonnage 2,000 lbs. ton	Cost per Ton of Ore. Power	Crushing and Concentrating	Cyaniding or Chlorination	% of Concentrates	Smelting	Administration	Total Extraction Cost	Total Mining Cost	Grand Total	Average Stamp Duty per ton per 24 hours
				s. d.			s. d.	s. d.	s. d.	s. d.	s. d.	
	At Chiapas, Mexico			0 9¾					0 9¾			
31/5/99	Alaska Treadwell, N. America	250,408		1 1	Chl.		0 3		2 1	3 0½	5 1½	3
31/5/00	ditto	557,960		0 9¾					1 6¼	2 1½	3 7¼	3 to 4
31/5/01	ditto	457,802							1 5½	2 10½	4 4	3 to 4
/99	Alaska Mexican	166,054		1 2	Ch. 1½d				1 11½	5 1½	7 1	3
30/6/00	Homestake Co., U.S.A	891,585							3 4	10 8	14 0	
30/6/01	ditto	934,373									14 8	
31/3/99	De Lamar Co., Idaho, U.S.A.								9 3¾			
30/6/99	Montana G. M. Co										26 6¾	
31/12/01	ditto										36 10½	
/99	Mill at Ben d'Or, B.C.										21 4	
31/8/01	Morro Valho, Brazil										25 8	
31/12/99	New Elkhorn, U.S.A								39 7	27 3	66 10	
/98	Lake View Consols, W. A.								10 1¼			
/99	ditto								6 10½			
/00	ditto								43/5&32/10			
/01	ditto								28 3			
/00	Gt. Boulder Perseverance								34 11½			
/01	ditto								24 10½			
/00	Mt. Morgan, Ltd., Q.			Dry crushing, 4'								
/11/02	Ivanhoe Co., W. A.								10 4		34 2	
/11/02	Kalgurli Co., W. A.										38 5	
/02	New Ravenswood, Ltd., Q	2,240 lbs. ton									38 10	2 to 4
/11/01	Imperial, Charters Towers, Q	2,550 tons half-year	1/11⅛	3 10⅞			3 4¼	1 4	9 8¼	18 8½	28 4¾	2
	Charters Towers Mines	"			6 0 ?							2 to 4¾
	Ravenswood Mines	"										2 to 4

Before entering into the details of our process it is advisable to briefly indicate the methods at present employed for recovering the major values from such ores. They are all comprised under the head of concentration, the usual various types of apparatus, both wet and magnetic, being employed. Concentration, indeed, has here been carried to a state of high perfection, but however ingeniously applied, it cannot, owing to intercrystallisation and the slight differences in gravity between several of the minerals, obtain sharply demarcated products; hence it can never be more than partially successful. Even supposing the bulk of the galena to be capable of close separation, a large proportion of the silver would still follow the blende, and thus be lost in the subsequent treatment of this mineral for the commercial production of spelter.

Present systems consist therefore in the mechanical separation of the largest yield of galena which shall carry only such blends as is incapable of giving rise to serious smelting trouble. These lead (silver) concentrates are smelted in the usual manner, and constitute the only product of commercial value derivable from the ore. The other bye-products are zinc middlings, silicious tails, and slimes; each is more or less contaminated with all the various minerals of the original ore. Thus, whist the galena concentrate carries several per cent. of zinc, the zinc middlings similarly hold large amounts of lead and silver, but are nevertheless of little or no present value; samples which have come before us have averaged 25 to 27 p.c. of zinc, about 12 p.c. of lead, and 10 to 12 oz. of silver. The slimes are more or less representative of the whole ore-bulk, and may even be somewhat enriched in zinc and silver; large parcels dealt with by us have been as high as zinc 25 p.c., lead 24 p.c., silver 26 oz.; but the general run is lower, say, zinc 20 to 22 p.c., lead 17 to 19 p.c., and silver 15 to 18 oz. per ton. Slimes are also at present practically valueless. Chairmen of the various mines are apt to describe these middlings and slimes as a reproach to the metallurgist, and to picture to their shareholders visions of the potential wealth which these huge accumulations represent, realisable when once the process for their successful reduction shall be discovered.

At the various Broken Hill mines reduction work is now limited to concentration, the leady concentrates being shipped to coastal smelting works, where they are reduced to bullion with other purchased ores. Net recoveries do not probably exceed 60 to 75 p.c. of the lead, and 55 to 65 p.c. of the silver; with the exception of small parcels shipped to Europe periodically no zinc is recovered, though on this point it is difficult to obtain figures.

The economics of the problem have not greatly altered from those outlined by Mr. Ashcroft in 1898, when he showed that, with the then metal prices, a profit of 15s. was all that was realisable from an ore value of some £9 per ton. Since that date it is true that considerable fluctuations in prices have occurred; zinc rose to £28, but though this was a useless boon to Broken Hill, lead appreciated to £16, and for a while permitted of good dividends. This period was shortly succeeded by a still more serious fall, lead receding to a lower level in 1901 than had been known for many years, whilst silver has recently touched its lowest recorded price. Indeed in 1901 all the Broken Hill mines with the exception of the Proprietary and Central Companies were for a while shut down. Although both lead and zinc have exhibited a slow rise of late months, the general outlook cannot be considered much brighter than Mr. Ashcroft had to face in 1898. Nor do the ore supplies show any tendency to increase in value. An average of 17 p.c. lead, 24 p.c. zinc, and 13 oz. of silver per ton may now be regarded as a general type of available material.

The greatest advances of late have been in the direction of magnetic separation; various types of magnetic concentraters are now under trial and in use at the different mines, by which a closer saving is possible, and the further concentration of the middlings into what may be regarded as a very inferior type of zinc blende ore can be effected. The inferiority of these zinc concentrates lies in the continued presence of considerable percentages of lead, and frequently of as much as one-third the silver originally held by the ore.

By one type of magnetic concentrator known to us the galena and quartz are obtained together, a more or less impure blende as the second product, and the bulk of the rhodonite in a third; the lead product then undergoes wet dressing to separate the silica. Starting with 100 tons of ore, about 40 tons of blende product are obtainable, assaying 40 to 45 p.c. of zinc (about 70 to 75 p.c. of the total in the ore), about 7 p.c. of lead, and from 10 to 12 oz. of silver. This product is bought in limited quantities by continental smelters, but we are unable to say whether they pay for the silver or exact a fine for the lead. In this country nothing would be paid for the silver, and it is doubtful if the English zinc smelter would treat an ore containing 7 p.c. of lead, except by mixing with blende ores in order to reduce the lead to a possible smelting charge. Sixteen to twenty tons of galena concentrates are produced after water dressing, the first product containing about 75 p.c. of the original lead and 45 to 50 p.c. of the silver. The lead product is of course subject to the usual smelting losses, which may vary from 7 to 10 p.c.

A second system, investigated rather with the idea of obtaining the richest mixed galena-blende product for our own use than with the object of effecting the sharpest possible separation of each mineral, was able to produce from zinc middlings (assaying 30 p.c. zinc, 8½ p.c. lead and 12 oz. silver) a mixed concentrate amounting to 65 p.c. of the original ore weight, and carrying 39 p.c. of zinc, 11½ p.c. of lead and 14½ oz. of silver; equal to total recoveries of 85½, 87 and 91 p.c. respectively. This was obtained by the mixing of a more with a less leady concentrate.

The foregoing is a brief sketch of the recoveries now obtainable in Australia, and is given to indicate the possible scope of inventions for remedying the unsatisfactory results realised even by the best systems of concentration.

In the cases of the many huge deposits of complex ore known to exist in other localities, but hitherto unworked, present Australian methods would not necessarily be followed as preliminary steps in our own or perhaps other processes. The Broken Hill products and accumulations are the outcome of evolutionary concentration methods, but in many instances complex ores are capable of direct reduction without the need of mechanical separation, or at most but that of barren silicious gangue if desirable

In our search for a suitable reduction scheme we desired to confine our attention to dry processes, in order to avoid the apparently insuperable difficulties attendant upon all wet methods. When it is remembered that the weekly production of ore from Broken Hill mines amounts to some 20,000 tons, and that the maximum density of zinc sulphate liquors practically allowable cannot reach much over 20 p.c. the task of dealing with the huge necessary bulks of solution, and of leaching, filtration, concentration and precipitation, operations on such becomes appalling. Even then (electrolysis being as yet unsuccessful with aqueous zinc solutions) the result is only a product requiring dry distillation. Indeed, it becomes evident that the difficulties of wet recovery processes only really commence when the solution of zinc or other metal has been effected.

Dry processes are of course no novelty, as witness the efforts of the Smelting Corporation, of Ellershausen, Armstrong, Angel, Claus, and many others in this direction. But we believe we are correct in saying that hitherto all dry processes have started with the intention of recovering the lead and silver in the first instance, whilst obtaining the zinc as a volatilization, or as a slag, or other residual product, for subsequent re-treatment. We cannot, however, include in this category the recently introduced Phoenix process, which, if alone from the daring ingenuity displayed, is worthy of a class to itself.

In fact zinc has always been considered as the objectionable element in the ore, and the efforts of inventors have almost invariably been towards its early elimination, with the hope, never yet realised, of a subsequent economic recovery. The reasons for this attitude are easy to discern; these ores have always been considered primarily as lead ores, whilst those interested in the zinc industry, who may have directed attention towards such, have condemned them at once as unsuitable for treatment in zinc retort furnaces, owing to the fatal presence of lead in any product obtainable by dressing.

In justice to other metallurgists we wish to mention that during the latter period covered by our investigations other workers were independently carrying out researches in the same direction, and had practically reached the same conclusions as ourselves. In this connection we would mention the names of Messrs. Sims and Christopher James as having arrived at the same results upon almost identical lines, although until we were working at the Emu works we were mutually unaware of the facts. It is therefore due to these gentlemen that they should receive full credit for their independent discovery, and we are happy to say that we have secured their co-operation in the future working of the process.

The difficulties in distilling leady zinc ores are shortly these. Foremost comes the destruction of the retorts by the reduced lead; this occurring mainly during the stirring out of the seconds from the pots, whereby the metallic lead is oxidised to litharge, with the inevitable result of the rapid slagging up and holing of the retorts. Even could this be overcome, it is found in ordinary practice that lead tends to volatilise with the metallic zinc vapours in such quantities as to materially damage the spelter produced. Finally, if lead were capable of complete elimination from the ore, we should still have the question of the silver to deal with, which, as we have shown, largely follows the blende, and would, in the usual routine, be lost both in the seconds and (similar to the lead) by partial volatilisation in the zinc vapours.

We may point out that gold also escapes under such conditions, and it was in regard to the recovery of this metal from zinc precipitates obtained from the cyanide process that we were lead to devise a method for obviating such losses.* Indeed, the success of this method induced us to further apply the same principle to the treatment of complex sulphide ores. Our idea was therefore to treat these primarily as zinc rather than lead ores; and to obviate the difficulties encountered when the material is so considered.

It is necessary to draw particular attention to the rule invariably adhered to in zinc smelting, viz.: to employ nothing except anthracite as mixing coal; it being supposed that the gases resulting from the carbonisation of other classes of fuel cause losses in spelter. Moreover, other fuels are (reasonably) considered likely to lead to the slagging of retorts during distillation,† a danger to be avoided as far as possible; even good (roasted) blende ores always contain much slag material (Fe_2O_3, FeS, SiO_2, etc.), whose baneful influence it is sought to reduce to a minimum by the addition of a very large excess of coal over and above that required for reduction purposes; such excess acting as a mechanical diluent. As the amount of mixing coal used in general practice varies from 50 to 100 p.c. (on the roasted ore), it is essential that this should contain the least possible ash. Further, slagging troubles would be far more pronounced if an ordinary zinc distillation of roasted Broken Hill ore were attempted; as, apart from the lead and ferrous sulphides, we have also the manganous oxide (which yields a very fluid slag with silica) and much garnet. As the result, however, of our experience in the distillation of zinc-gold material, we formed the opinion that the use of a strongly-coking coal would, by holding dangerous materials suspended in its pores, overcome the objections to the presence of lead and other slag formers, and permit of the distillation of complex blende-galena ores as ordinary spelter-yielding material. In this factor alone has lain our main departure from previous methods, and extended practical trials have proved our anticipations correct. It is unnecessary here to further trace our progressive trials, and we may now consider the completed process.

It commences with the usual preliminary roast of the crushed ore, slimes, or zinc-lead concentrate, in a reverberatory furnace, to a product which shall contain, preferably, not more than 3 p.c. of total residual sulphur.

Although this is the usual sulphur limit for blendes, we have frequently obtained good zinc recoveries with a higher sulphur residue; calcination is only necessary to such an extent that any residual sulphur should be capable of combining with the iron present in the product. In the case of Broken Hill ores, this usually amounts to about 10 p.c.

The roasted ore is next mixed with only about 20 p.c. of crushed coking coal, and the mixture is briquetted in any suitable type of machine. As a binding agent pitch, or other carbonaceous material, is added; lime or other chemical binders are undesirable as they tend to permeate the whole briquette with slagging material, and also, from some unexplained reason, to cause lead losses. Other carbonaceous binding materials have been the subject of later experiment, one of which it is probable will shortly supersede our use of pitch for this purpose. Further, the admixture of a carbonaceous bond aids the bituminous coal in forming the coherent coke which not only the distillation but the subsequent lead smelting operations demand. The briquetting plant is of a standard type consisting of a disintegrator, into which the roasted ore, coking coal, and pitch, are introduced, a pug-mill, press and table, together with the usual intermediate elevators and a conveyor belt for delivering the finished briquettes to the retort house.

The briquettes are then submitted to distillation in an ordinary zinc retort-furnace. Those used by us at the Emu works in South Wales are of the old-fashioned hand-fired Welsh-Belgian pattern, without regenerators, and using hand-made pots. Each contains 144 retorts in six rows, the lowest being cannon pots; a retort takes about 15 briquettes, the total capacity of a furnace being seven tons.

This type of furnace is, nevertheless, not the most suitable for our requirements, as six rows of retorts one above the other cannot be uniformly heated by bottom firing. The lower row of cannons is apt to be damaged by excessive heat if the uppermost rows are to receive an adequate temperature; too sharp a heat is also detrimental to the best extraction. In most spelter works employing this type of furnace the difficulty is avoided by using the lower rows for the distillation of "hard" material (roasted blende), whilst the upper are employed for "soft" (calamine) ores. A third class, of even softer material, viz., calamine ores mixed with sweeps, may at times be used in the upper rows. On uniform material such as we treat a compromise must be effected; we therefore work to obtain the best results from the three intermediate rows. These give us a 70 p.c. zinc recovery on 26 p.c. briquetted ore, whilst the lower and upper rows yield a few per cent. less.

For these reasons the gas-fired 2-row type of furnace has been

*See Journ. Soc. Chem., Ind. xvi, p. 967, also Trans. Inst. Min. Eng., March 20th, 1898.

†Louis and Schanel, II, 89.

adopted for our process at Cockle Creek, as it permits of absolute uniformity of heating, and, therefore, of the maximum recovery. Hydraulic-pressed retorts, so universally used on the Continent and in America, are also employed in Australia. In ordinary zinc-smelting practice the roasted ore and anthracite duff are hand-mixed in front of each furnace, the damped powder being then charged into the retort; by our method the mixing is more efficiently performed in the briquetting plant, and the charging of the briquettes is more easily effected by means of a shaped iron paddle. In usual practice 4 to 4½ minutes is consumed in charging powdered material into the retorts by means of a scoop, as against 2 minutes with briquettes: this means a saving of some 4 hours' labour per furnace.

Once charged, the procedure for the recovery of the zinc is identical with ordinary practice, although the action within the retort is of a different character. The briquettes, as they reach the temperature of distillation of coal, coke into coherent masses, with evolution of volatile hydro-carbons. Reduction of the lead simultaneously occurs, the minute metallic particles entirely permeating and being held up in the pores of the coke; whilst, at the higher temperature shortly afterwards reached, zinc oxide is reduced, and yields metallic zinc vapours, which are condensed in pipes; these are tapped at intervals in the ordinary way. The distillation occupies the normal time.

We draw attention to the remarkable fact, first noticed at the outset of our experiments, now confirmed by some years, experience, that, whereas in ordinary practice lead distils to a marked extent in zinc vapour, in our process the whole of the lead, as also the silver and gold, is retained by the coke. The latter thus appears to exert an actual physical retardation of the volatility of lead in a slow current of zinc vapour. So definite is this advantage, that we find the smelter thus produced from Broken Hill ores to be of exceptional purity, averaging 99 p.c. of metallic zinc, and commanding prices equal to that of the best brands produced from lead-free ores. This spelter is already in considerable demand, owing to its low lead tenour, which does not often exceed ½ p.c.; it can thus be employed for the manufacture of the finer kinds of brass, for which the ordinary brands, containing from 1 to 2½ p.c. of lead, are useless.

The zinc having been recovered, the seconds are withdrawn from the pots (pipes and luting clay having been removed, and sweeps collected) and discharged into the caves, whence in usual practice they would be dumped. But the seconds resulting from the treatment of such complex sulphide ores still retain the major values, in the shape of all the lead and silver originally present. These are obtained in the coked briquettes in a form eminently adapted for recovery in the subsequent lead smelt. The zinc retained in the seconds does not exceed the amount allowable in ordinary practice, and presents no difficulty in obtaining the usual bullion recoveries. The residual carbon in the seconds is, of course, a considerable source of heat in the after-smelt, and is therefore not lost, as it is in the case of ordinary zinc seconds.

By this simple operation we are enabled to convert a complex ore into a simple silver-lead product, amenable to normal reduction methods, having already recovered the bulk of the hitherto objectionable zinc as high-quality spelter. The final operation for the recovery of lead and silver as base bullion being the ordinary one, conducted in the usual types of plant, both in South Wales and Australia, does not call for further description here.

Indeed, we may remark that the few operations which constitute our process are all affected in well-known and standard types of plant; and that no fresh item of apparatus, concerning which there might be doubt as to costs or method of working, has been found necessary. Roasting, briquetting, zinc-distilling and lead-smelting methods and costs are fully known. Throughout the operations, nothing beyond coal and binding agent and the usual lead-smelting fluxes is emoloyed. It is somewhat surprising that so simple a method of treatment has been so long overlooked. The system is compact, and permits of economies, when zinc and lead-smelting processes are thus linked together, not realisable by either separately.

In general, blende ores containing less than 40 p.c. of zinc are not profitable to treat. Such if mixed with 80 p.c. of anthracite duff would yield pot material containing little more than 22 p.c. of zinc; whereas a zinc-lead concentrate, containing say 35 p.c. of zinc, requires, by our process, the addition of only 25 p.c. of mixing coal and binding material, and produces a briquette carrying 28 p.c. of zinc; with the additional advantage of yielding a residue containing profitable material. It is possible to treat a 35 p.c. concentrate for its zinc alone, the lead and silver remaining in the residues as profits subject only to recovery costs; whilst the fuel values remaining aid in reducing these.

Recoveries.—Lead, silver, and gold, as before stated, are recovered in the seconds in full; the lead of course is subject to the normal smelting losses, just as in the treatment of ordinary lead concentrates; though the Huntingdon and Heberlein and the Carmichael processes claim to reduce such losses to about 2 p.c. and we believe these claims to be well founded.

Bearing in mind the fact that the seconds hold all the lead in the metallic condition the question naturally arose as to whether smelting was the most economical method of recovering this metal and the silver. We devoted considerable attention to the mechanical separation of the reduced lead, but unsuccessfully. The metallic particles and prills are so exceedingly finely divided throughout the carbonaceous sponge that any method of water dressing or concentration results in heavy loss; nor did oil concentration give any better results, owing to the excessive amount of carbon also taken up. On the whole, smelting was adopted as the simplest, safest, and most usual method.

With regard to zinc recovery, the spelter yields are practically the same as those obtained in the ordinary treatment of blende ores. To reckon in percentages is somewhat illusory, as these depend naturally upon the original zinc contents of the ores treated. With a zinc-lead product carrying 40 p.c. of zinc no difficulty is experienced in obtaining a recovery of 80 p.c. of that amount, whilst, with a 25 p.c. material, 70 p.c. may safely be reckoned upon in modern furnaces. Late advices from Cockle Creek inform us that the recoveries of both lead and silver in the seconds are complete, and that the zinc production already exceeds 70 p.c. slimes averaging 25 p.c. of zinc being the raw material used These results have naturally been progressive, and represent our later practice. Some six months ago our average recovery from Broken Hill slimes was about 60 p.c. of zinc, but by more careful location of the varying retort row yields the increased zinc recoveries have been attained to. With 35 p.c. material we have every reason to anticipate an 80 p.c. recovery. The pot consumption is quite normal there; mixing coal is obtainable at lower rates than are available to us in South Wales. Fireclay of good quality for the manufacture of hydraulic-pressed retorts is also available on the spot; and we have used trial lots of this material for some of our retorts in South Wales, with excellent results. The works at Cockle Creek are the first producers of spelter yet installed in Australia.

In ordinary zinc practice, it is not found economical to force the extraction below a certain point, as the increased time required not only reduces the output of the furnace, but, with the higher temperature necessary, the pot consumption becomes unduly great. The zinc usually left in the seconds varies from about 5 p.c. to 8 p.c. Our working costs are also normal; no difficulty is experienced in calcining the complex ores to the sulphur standard usually required for blende; the zinc furnaces do not demand any greater attention or further hands, whilst labour in retort charging and discharging is materially lightened by the use of briquetted material. Briquetting charges are, of course, additional; but are to some extent balanced by the far smaller consumption of mixing coal, and by the economical handling of material during the final lead smelt.

A point to which attention will doubtless be directed is that of pot and pipe consumption. The average life of our pots, even though used for distilling such highly refractory material, is fully equal to that of the retorts used for good blende and calamine ores according to usual methods, being from five to six weeks each. Our present consumption per day is 3.7 pots per furnace. The cost of our hand-made pots is about 6s. apiece. This is admittedly high, even for England, and hydraulic-pressed retorts, having a longer life, requiring less clay and demanding a lower distillation temperature can be produced for 3s. each.

A certain proportion of "fines" is inevitably produced in raking the briquette seconds from the pots into the caves beneath the furnace house. These are separated, damped with water, and re-briquetted for lead-smelting purposes from time to time at a cost of about 2s. per ton of fines.

We append a schedule of costs incurred during the late treatment of a parcel of Broken Hill slimes, averaging 25 p.c. of zinc, 24 p.c. of lead and 26 oz. of silver per ton.

Calcining.—Hand roasting of such material to 3 p.c. of total sulphur or slightly under, in South Wales, costs about 9s. per ton, whilst mechanical roasting in the Godfrey furnace amounts to about 6s. 6d. Other forms of mechanical calciners, such as the Brown Straight Line, will roast complex sulphide ores to this limit at even lower cost: but at present the hand-calciner and the Godfrey appear to yield the denser product and also to be preferable in other respects. The question of the best form of calciner is not fully settled, but we select the Godfrey costs as those most lately obtained.

COSTS PER TON OF ORE TREATED.

	s. d.	s. d.	s. d.
Ore Drying—Screening and crushing of lumps, and wheeling			2 6
Calcining—Fuel, labour, maintenance			7 0
Briquetting—(30 tons of roasted ore per day)—			
Labour—1 pressman at	5 0		
3 belt men at	5 0		
2 labourers at	3 9		
Boilerman	4 9		
		32 3	
Coal—			
1 ton for boiler		8 6	
6 tons for mixing, at 8s. 6		51 0	
Pitch—1½ tons at 48s. 4d		72 6	
Stores—Oil, etc.		1 3	
Cost of briquetting 30 tons		165 6	
per ton ore			5 6¼
Retorting—(Costs per furnace per 24 hours)—			
Labour—2 foremen at 6s. 8d	13 4		
2 second hands at 5s. 6d	11 0		
2 helpers at 4s. 3d	8 6		
4 cave men at 4s. 3d	17 0		
1 pipe chipper (boy)	1 4		
General labour	5 9		
		56 11	
Pottery.—3. 7 pots at 6s		22 3	
9 pipes at 2d		1 6	
Coal, for firing 3¼ tons at 9s. 6d		30 10½	
Stores, luting clay and repairs		4 6	
		116 0½	
Contingencies, unoccupied pots, dead-fires, etc., add 5%		5 9½	
		121 10	
For charge of 7 tons briquettes 5.6 tons of ore per ton			21 9
Yard and general labour			1 6
Re-briquetting of "fines," at 2s. per ton.—			
Seconds contains 30% fines; on 80% of seconds			5¼
(Seconds amount to about 80% on the orinal ore.)			
Smelting per ton seconds	12 6		
Refining, sales, brokerage, insurance, etc., at £2. per ton of bullion produced, at 26% bullion	10 5		
Per ton of seconds		22 11	
per ton ore			18 4
Lead smelting losses—			
2 8 units of lead (10% on residues) at 2s. 3d			6 4
5% silver 1¼ oz. at 2s. 1d.			2 8
Office management and assays dependent on size of installation, say			5 0
Total cost of treating 1 ton of ore			71 1
Recoveries—			
Zinc, 70% (of 25%)=17.5 units at 3.65s			63 10¼
Lead, 90% (of 24 p.c.) 21.6 units at 2s. 3d			48 7¼
Silver, 95 p.c. (of 26 oz.) 24.7 oz. at 2s. 1d			51 5½
			163 11¼
Less costs			71 1
Realisations			£4 12 10¼

From which must be deducted cost of transport of slimes or cost per ton of ore.

In regard to the first four items the above costs are certainly capable of reduction.

In South Wales we have at present no lead-smelting plant for spot recovery of the seconds values, but dispose of these to local reduction works according to their assay values upon the usual scale of returning charges. The erection of lead-smelting plant at our own works is under consideration, in order to save these extraneous profits and to obviate freight to the smelters. In Australia, the smelting plant is that in ordinary use for reduction of the lead concentrates, etc.

The work outlined has occupied our attention for some years past, during which we have carried through a large number of experiments in the laboratory, in small works specially erected in Surrey, and finally at the Emu works in South Wales, where large-scale furnaces have been running for the past year as a commercial undertaking. We have there treated over four thousand tons of Broken Hill slimes, besides many other parcels of complex sulphide ores. The recoveries of lead and silver have been practically complete in all cases, whilst the spelter yields have varied from 60 p.c. to 80 p.c., according to the original zinc contents.

Complex ores containing copper present no further difficulties as to retort treatment; the copper, of course, remains with the lead and silver in the seconds, and is thence obtainable by modern copper-lead smelting methods.

Summarising our process, it may be said to consist in the holding up of the minute particles and prills of reduced silver-lead in a coherent but still highly porous coke or carbonaceous sponge during zinc distillation; thus preserving the retorts from contact with lead or other slag material, and ensuring the all but complete non-volatility of the lead and silver in the liberated vapours of metallic zinc.

We do not claim to have invented a new metallurgy of either metal-zinc or lead: practically all spelter now produced is retort spelter, and except as to certain advantages, our process is subject to the same economic conditions as is the ordinary zinc smelter. Nor do we claim to be freer from lead-smelting methods and costs than the lead smelter: whilst zinc, lead, and silver recovery methods remain what they are, we are content to have reduced these hitherto refractory mixed ores to ordinary simple zinc and lead reduction operations. Local metallurgists can therefore insert the figures and costs obtaining in their own districts for those we have given here; until new processes for the reduction of either metal are discovered, and the electrolysis of zinc, even from the fused chloride, has yet to prove its commercial utility, we may fairly consider that complex sulphide ores are at length amenable to ordinary methods.

In spite of its apparent simplicity, our process has been found capable of complete patent protection in the principal countries and colonies of the world; whilst the grant of the United States, German and Scandinavian patents, may be taken as evidence of novelty.

Dredging and Valuing Dredging-ground in Oroville, California.*

By Newton Booth Knox.

The gravelly bottom land below Oroville, California, is being extensively mined for gold by means of dredgers. Upon a strip of land nine miles long by two miles in width, bordering on and adjacent to the Feather River, 21 dredges are at present working. These dredgers are the property of about twelve companies, who own dredging land varying from 80 to 800 acres. The companies are all close corporations, and though the official figures of working costs and profits are difficult to obtain, it is well known that they yield their stockholders excellent dividends. For instance, one company's working expenses, including labour, repairs, power, interest on capital invested, depreciation of plant, sinking fund, etc., amounted to but 32 p.c. of the bullion output, leaving the remaining 68 p.c. clear profit.

The total general average of the drillings of several of the largest companies' holdings, covering a period of several years, gives the value of the gravel between 17 and 19 c. per cubic yd., and an average depth of 11 yd. As a dredge handles from 1,200 to 2,000 cub. yd. per day, at a cost of from 5 to 8 c., average 6 c., per cub. yd., it is evident that the returns in this work are considerable.

History.—In the early days of California history, Oroville district was extensively mined by first the white man and later by the Chinese. It is claimed that 82 millions of dollars has been taken out within a radius of eight miles of the town of Oroville. The gravels were worked to water level, and washed mostly in hand rockers. Pits and small shafts were sunk until a rich pay streak was encountered, which was followed, drifted out, hoisted to the surface and rocked. Water interfered greatly with this style of mining, and only the richest streaks could be worked. The gravels left, made excellent dredging ground.

The Gravels.—The gravel deposit about Oroville evidently represents the flood plain of an ancient stream of the Sierra Nevada, near the point where it débouched into the gulf which then occupied the present Great Valley of California. As stated, the gravels average about 33 ft., varying from 28 ft. to 60 ft. in depth. A false bed-rock of lava-ash, or volcanic tufa, varying from the consistency of chalk to that of firm sandstone, is encountered at this depth. Below this false bed-rock are gravels and sand. In one place a hole was drilled 80 ft. below, and showed sharp white sand. In some places the gravel is topped by a red soil overburden, varying from 10 ft. to 25 ft. in thickness. This over-burden, and the material below the false bed-rock, contain little or no gold. The gravel is fairly coarse, large boulders, weighing 300 lb. or 400 lb., being very exceptional. One-half of the gravel will pass through a ½-in. screen. As a rule the gravel is not cemented, though some dredgers have encountered pieces of ground which had to be loosened with powder.

The gold is distributed more or less equally throughout the gravels. Rich concentrated streaks of from an inch to a foot in thickness occur, followed by barren sandy areas, which seem to represent varying conditions of flow in the depositing stream. The gold is in a very finely divided state, and easily caught by the riffles, cocoa-matting and quicksilver of the dredge. Nuggets are a rare occurrence. The gold found in the bore-holes is 922 fine, and worth $19 an oz. The dredge bullion is somewhat lower grade, the base being the surprisingly large amounts of lead in the form of quail, rabbit and duck shot, which the dredge digs up.

This fact is interesting and would be hard to believe if it were not very well authenticated. This region has been a great small-game country, and during the last fifty years doubtless thousands of pounds of shot have been scattered over the gravels which the dredge is now recovering. Nor does it require such reckless shooting on the part of these old hunters to reduce the bullion grade as would at first appear. Take an 11-yd. bank of gravel; this contains 50,000 cu. yd. to the acre—a dredger could treat an acre of this a month, producing a bar per month of say $10,000, or, roughly, 500 oz. of bullion.

Now if the bullion from drillings went $19 - 950 fine all gold
and " " dredger " $17 - 850 "
or 50 oz. gained in lead in the 500 oz. bar, fifty ordinary shot gun shells, 12 gauge, would furnish this much shot. The baseness of the bullion however does not truthfully represent the amount of shot, as on most of the dredgers the lead is separated by panning, and carefully picked before the bullion is melted. On the Butte Dredger they have collected about 50 lb of shot from about two acres of gravel.

Occasionally a pistol ball is found, recalling the golden glorious, old days of California history, when some festive "man behind the gun," filled with enthusiasm and "barb-wire" whisky, would sally forth in search of trouble, and—generally find it.

The Oroville district is peculiarly favourable for dredging, for the following reasons:—

(1) Bed-rock (so-called) is soft and easily cut by the dredge.
(2) Boulders are small.
(3) Water is available.
(4) Power (electric) is cheap.
(5) Gold is fairly evenly distributed.
(6) Climate is such that work can be carried on twelve months of the year.
(7) Labour is cheap and efficient; and finally
(8) The gravels contain enough gold.

Testing the Ground.—In order to assertain whether a piece of ground is worthy of consideration, the following system is adopted:

The land is first divided, according to its area, into blocks of from 5 to 10 acres, and a hole is drilled in the centre of each of these blocks.

The Keystone driller has been generally adopted in Oroville as having proven itself fully equal to this work. The driller consists of a "walking beam" operated by steam power producing the required motion for raising and dropping the drill. In addition to this is a reel, on which is wound the rope of the sand-pump used in pumping out the holes. The drill is suspended by a 2-in. in diam. Manila rope, which passes under one sheave on the walking beam over another to the main drum. As the walking beam moves, the rope is alternately tightened and loosened, which raises and drops the drill. The drill itself consists of:—

1. Rope socket.
2. Drill stem—a piece of soft steel about 4 in. diam., and from 12 to 15 ft. long.
3. The bit, with a single cutting face about 5¾ in. long.

When ground containing coarse boulders is being drilled, there is a liability of the drill becoming wedged in the hole, and in order to prevent this, a tool called the jars is inserted between the rope socket and the stem. It is like two links of a chain, and when the bit is caught these two links coming together with a shock jar the drill loose.

The whole string of tools, socket, jars, stem and bit weigh about 1200 lb.

Speed.—The driller makes about sixty 30 to 40-in. strokes per minute.

Fuel.—About a half cord of oak wood is burned per day of ten-hour shift.

Water.—For drilling and washing the drillings about 1000 gal. of water is used per day.

The Operation.—The land is surveyed, and the location of the drill holes staked out and marked by flags. The drill is set up over flag No. 1 A hole is shovelled out to a depth of about 2 ft., and the first length of casing is made ready. This section of casing or drive-pipe is 5¾ in. inside diam., ⅜ in. thick, and about 5 ft. long. It is fitted with a wrought steel drive shoe to protect the lower end from injury. This drive shoe is made 7⅜ in. in diam. at the cutting edge and is slightly bevelled inward. On the other end of the casing is screwed a steel driving head to prevent the threads from being battered during driving. This casing, so mounted, is set up in the hole directly under the suspended drill and tamped around with excavated dirt.

*Paper read before the Institute of Mining and Metallurgy.

Drilling is now commenced. Water is poured in from time to time to thin out the material. After the ground below the foot of the shoe is loosened for a distance of, say, 1 ft., the casing is driven down and the loosened and thinned material removed by means of the sand pump, a hollow pipe supplied with plunger and foot valve.

The driving is accomplished by striking the driving head with a couple of iron blocks clamped to the stem by means of two 1¼ in. bolts, the weight of the string of tools acting as a hammer. After driving, the driving blocks are removed. When the first length of casing is driven down to head, the driving cap is removed, a second section of casing is screwed on the first, the driving cap replaced, and drilling resumed. When the required depth is reached, determined either by striking "bed-rock" or passing through the pay stratum, the hole may be considered finished, and the next step is to pull up the casing. This is accomplished by removing the bit, stem and jars, and replacing them by what is known as the pulling or pipe jars. These consist of an iron boss fixed to the end of a rod 4½ ft. long Above the boss is a 1 in. thick plate—the "knocking head"—provided with threads which are screwed into the sleeve of the top section of casing The stem of boss passes through a square hole in the plate. The walking beam is set into motion, and the string of casings is raised by the boss striking against the knocking head. As each section of casing is raised, it is unscrewed, and the knocking plate screwed on the next. If care is used in keeping the threads of the casing clean, the casings can be used for a long time. It is rarely that a casing is lost.

TREATMENT OF DRILLINGS.—The drillings extracted from the drill-hole by means of the sand pump are discharged into a wooden trough, 12 ft. by 1 ft. by 1 ft., set on a slight grade. From the trough they are run into the riddle of a rocker, and rocked in the ordinary method adopted for washing gravel. Great care is taken to save all the extremely fine particles of gold, as upon this work depends the accuracy of the test made. It is customary to clean up results of each pumping, and to carefully note the number of countable colours obtained, and the character of the ground drilled through.

For instance, a page of the driller's note book taken from actual practice is as follows :—

HOLE No. 14.

PUMPING.	COLOURS.	REMARKS.
Surface—10 ft.	1 speck	Red soil, clay, sand, and fine gravel.
10 ft. 11 ft.	22 fine colours	Gravel starts at 10 ft.
11 ft.—12½ ft.	52 colours and fine gold	Fine gravel.
12½ ft.—13¾ ft.	14 colours and fine gold	Coarse gravel.
13¾ ft.—15½ ft.	4 fine colours	Gravel softer.
15½ ft.—16½ ft.	4 fine colours	Gravel softer,
16½ ft.—17½ ft.	8 fine colours (1 fat one)	Gravel coarse.
17½ ft.—18 ft.	7 colours and fine gold	Gravel coarse.
18 ft.—19½ ft	6 fine colours	Gravel coarse.
19½ ft.—20½ ft.	8 colours, some large	Gravel coarse.
20½ ft.—23 ft.	16 colours, some large	Gravel coarse.
23 ft—23½ ft.	16 fine colours	Finer gravel.
23½ ft.—24½ ft.	21 colours and fine gold	Finer gravel.
24½ ft—25½ ft.	8 colours, fine gold	Finer gravel.
25½ ft.—26½ ft.	13 colours, some large	Finer gravel
26½ ft.—28 ft.	6 colours and fine gold	Finer gravel.
28 ft.—28½ ft.	5 colours, fine gold	Fine gravel
28½ ft.—29½ ft.	8 very fine colours	Stopped in fine gravel.

WATER LEVEL 21 FT.

The term "fine gold" is applied to such specks as are too small to be counted, but which play an important part in making up the total value of the hole. The gold from each clean-up is put in a small dish.

This practice of cleaning up after each pumping (approximately after each foot of hole drilled) instead of one final clean up is all-important in furnishing data for a cross-section map, showing occurrence of rich streaks—sandy or clay patches, fine gravel, depth of over-burden, of false bed-rock, and of water level.

After the last clean-up all the gold from the hole is collected by means of quicksilver forming an amalgam. This amalgam is dissolved in nitric acid and throughly washed in hot water. A few drops of alcohol added to the wash water will prevent the spattering and loss of gold when the last drop of water is evaporated. The gold is annealed and carefully weighed. From this weighing the value of the ground at this particular spot is calculated, and the result given in cents per cubic yard.

CALCULATING THE VALUES is best shown by an example. The gold from say, hole No. 14 weighed 2·22 gr. : this at 3·95 c. per gr. equals 8·76 c. ; the value of gold from hole No. 14. The cubic contents of the whole is next calculated. To do this, a factor called the "pipe constant or pipe factor" is applied. The inside diam. of casing is 5⅝ in. ; the outside diam. is 6½ in. It is the practice of the district to use the outside diam. of the pipe as a basis for calculating its contents, the local engineers holding that it is the *displacement* of the pipe and not the cubical contents that should be used. Figuring the cubic contents per ft. of pipe, with a diam. of 6½ in., would give ·23 cub. ft. In practice it is found that ·23 is much too small, giving values too high, values not borne out by subsequent dredging.

Some engineers use ·25 as factor. "Radford's Factor" is ·27—a factor obtained by Mr. W. H. Radford, a mining engineer of wide experience in this class of work, by the following method ; Mr. Radford sunk a shaft 3 in. in diam., using a drill-hole as the centre, to a depth of 34 ft. The gold obtained from the shaft corresponded almost exactly with the gold obtained from the drill-hole when using ·27 as the factor in the calculation. This factor is very important, as on it depends the value of the holes and consequently the final value of the ground. The difference in the results obtained by using eithe the factor ·25 or ·27 is sufficient to change the value per cub. yd. from net to gross, *i.e*, a difference in some cases of 6 to 8 c. per cub. yd.

Continuing the calculation : Hole No. 14 was 29½ ft. when drilling was stopped ; 29½ · ·27 gives 7·965 (cub. ft in the hole drilled). Now we have the simple proportion, 7·965 (cub. ft of gravel drilled : 27 (the number of cub. ft. in a cub. yd.) : . 8·79 (the value of gold obtained) is to X = the value per cub. yd., whence, X = 29·69 c. per cub. yd.

CALCULATING THE AVERAGE VALUE PER CUB. YD.

The value of each hole in cents per cub yd. is multiplied by its depth in feet, and the sum of the products divided by the sum of the depth ; the quotient is the average value in cents per cub. yd. Thus we have a block of dredging ground drilled with one hole to every 10 acres.

The sum of the products obtained by multiplying each depth by its corresponding value = 14·045. The sum of the depths is 660 ft. Dividing the first by the second gives 21 28 c. per cub. yd. average value of this ground. The average depth is 33 ft., or 11 yd.

FINAL CALCULATIONS.—At an average of 11 yd. deep this ground will contain 53,240 cub. yd. to the acre, and allowing 3240 cub. yd. for ridges and "corners" left in dredging, we have 50,000 cub. yd. per acre, or 10,000,000 cub. yd. in the 200 acre tract under consideration. This at 21·28 c. per cub. yd. gives a total contents of $2,218,000

Assuming the price is	$150,000
Cost of a 5-ft. bucket dredge....	65,000
Working Capital.......	10,000
Total Cost..	$225,000

A 5-ft. bucket dredge is rated at treating 65,000 to 70,000 cub. yd. per month, but up to the present time, the best these dredges have been able to do has been about 70 p.c. of the possible running time. It may be added that the new dredges now building hope to better this, and will doubtless bring up the running time to 80 p.c. In fact a new dredge, the "Butte," which has been running but three months, has, during that time, averaged 75 p.c and the last month of their run they have averaged 86 p.c. of the time. Assuming 70 p.c. running time, a 5-ft. dredge will work out this ground at the rate of an acre per month, or in all, about 17 years for the tract. Assuming a working expense of the dredge as high as $3500* a month, or $42,000 per year, and that 1 c. per cub. yd. is left in the tailings,† then we have—

Total value in ground...............	$2,218,000
Total value in tailings	100,000
To be recovered.................	$2,028,000
Total cost of treatment	714,000
Net gain in ground...............	$1,314,000
Net annual gain for 17 years.......	77,300
Net annual gain per cent, 34·3 p.c.	
Or allowing a sinking fund—17 year's life, annual contribution to sinking fund—to be at 3 p.c.............	10,300
To be applied to dividends......	$67,000
Gain per cent per year on investment with sinking fund........................	30 p.c.

*$3000 per month is closer to a fair average of the month's expenses even when allowing a sum of $500 for possible repairs.

†A test has lately been made by Mr. W. H. Radford in the "Butte" tailings which were found at the end of the sluices and which represent say 50 p.c. of the bank gravel. From 100 buckets of this material six-tenths of a cent in gold and a little quicksilver, about the size of a peppercorn, were obtained.

COST OF DRILLINGS.—The running expenses of a driller per day is.

Labour,	1 Driller	$3 50
	1 Fireman	2.50
	1 Teamster and team	3.50
	Chinese rockerman	1.50
		$11.00
	Wood, half cord, at $6.00	3.00
	Repairs, say	5 00
	Drill hire	5.00
	Total Expenses per day	$24.00

Drilling about 10 ft a day gives a cost of $2.40 a ft. Drilling contracts at Oroville are let for $2 50 per ft, and considering delays, breakdowns, repairs, road cutting and moving from hole to hole, this figure is reasonable enough. The number of feet drilled per day varies greatly—and depends on the character of ground and the season In soft ground 20 to 30 ft. a day can be drilled with a corresponding reduction in cost per foot. In winter and spring, when the top soil is wet and soft, the problem of moving the machine from hole to hole, and of bringing in wood and water becomes a serious one. Just to show the extra difficulties, delays and stoppages a driller must contend with, I quote in full the log of Mr. Radford for the month of December, 1902:—

"1st—Started hole No. 12, but did not do much owing to lack of good driving cap and scarcity of water. Made 11 ft.

2nd.—Drilling on hole No 12 all day. Made 7 ft.

3rd.—Started about 7.30 a.m Broke sand pump about 8.15. Had to take it to town to get it repaired. Finished hole No. 12 at noon Commenced pulling casing 12.30. Finished and moved to hole No. 18—1320 ft. Set up and started drilling.

4th—Worked all day on hole No. 18. Made 20 ft.

5th.—Wet, did not work.

6th.—Started work on No. 18 after lunch. Made 7 ft.

7th.—Wet, did not work.

8th.—Worked on hole No. 18. Made 11 ft. Started pulling up casing.

9th.—Finished pulling up casing from hole No. 18, moved to hole No. 20 about 900 ft, ground very soft, had to raise drilling machine with jack-screws, and to keep it up by means of wood placed under the wheels. Made 14 ft. in hole No 20.

10th—Wet, did not work.

11th.—Wet, did not work.

12th.—Worked on hole No. 20.

13th.—Finished hole No. 20, 34 ft deep; pulled up casing and started moving to hole No. 14—ground very soft.

14th.—Moved to hole No. 14, and set up machine, ground very bad in places; distance from No. 20 to No. 14, 1,320 ft.

15th.—Working on hole No. 14, made 17½ ft.

16th—Working on hole No. 14; reached depth of 28 ft., broke bolt in driving blocks, got new one from machine shop in town. Lost two hours.

17th.—Finished hole No. 14, 29½ ft. deep. Pulled up casing and moved machine a short distance towards hole No. 16.

18th.—Moved machine about 100 yd. Got into soft mud and stayed there all day.

19th.—Raised machine out of the mud. Took off gear-ring on account of broken teeth, and took it into town and got it repaired

20th.—Got gear-ring about noon, put it back on machine, and started, ran short distance towards hole No. 16.

21st.—Moving machine to hole No. 16, road very bad in places.

22nd.—Moving to hole No 16, 1,320 ft. from hole No. 14. Set up machine, and started drilling. Struck old drifted ground. Made 21 ft.

23rd.—Finished hole No. 16, 29 ft. deep. Pulled up casing and moved toward hole No. 10.

24th.—Finished moving to hole No. 10, 1,320 ft. Set up machine and drilled 4 ft.

25th.—Working on hole No. 10, reached depth of 19½ ft.

26th.—Wet, did not work.

27th.—Ground too soft to haul wood and water.

28th.—Working on hole No. 10; reached depth of 31 ft.

29th.—Working on hole No. 10; reached depth of 41 ft.—stopped.

30th.—Finished pulling casing from hole No. 10 soon after lunch; started moving to hole No. 8.

31st.—Finished moving to hole No. 8, 1,320 ft. Set up machine and started drilling. Broke walking-beam arm, had to send to town for a new one—lost three hours. Made 13 ft.

Although the crew worked a ten-hour shift during this month, only 7 holes were finished, giving a total depth of 212·5 ft., or an average of 6·8 ft. a day."

I quote this, not as an example of average work, but merely, as I have said, to show the difficulties—particularly in winter.

VALUE OF THESE TESTS.—Three years' drilling followed by subsequent dredging of the drilled tract, has proven that these tests are but fairly indicative of the values in the tract. For instance, one company, in order to prove the efficiency of these tests, drilled an acre of ground with 23 drill holes, which afterwards dredged within 95 p.c. of the calculated value. On the other hand, I have heard that a company with a recently finished modern dredge has already dredged out about six acres, which produced 35 p c of the drilled values (two holes to the acre). It is unfortunate that more exact data regarding the values of these tests are not at hand. Engineers will recognize the ever-present liability of error and consequent dissatisfaction arising from all work where the value of the large is calculated up from the value of the small. So the chief value of this method of testing ground lies not so much in proving the total possible yield of a piece of ground, or its values in sight, but in indicating the presence and occurrence of the pay channels, depth of bed rock, water level, etc, etc. It is now the custom to keep a driller well in advance of the dredge, the results of the drilled holes serving as a guide for its future movements.

NEW COMPANIES.

ONTARIO.

The Ontario Mining and Smelting Company.—Incorporated under the laws of the State of Maine and licensed under the Statutes of Ontario, 2nd September, 1903. Authorized capital for use in Ontario $20,000. H. F. Gann, M.E., Bannockburn, Ont., attorney. Formed to acquire the properties known as "The Ontario Mining and Smelting Company."

The Star of the East Gold Mining and Milling Company, Limited.—Incorporated under the Statutes of Ontario 23rd September, 1903. Authorized capital, $1,500,000, in 1,500,000 shares of $1 each. Directors: S. Sager, E. J. Cowain, A. O. Kidd, J. M. Fletcher, J. W. Sager Head office, Peterborough, Ont Formed to acquire the properties known as "The Star of the East Gold Mining and Milling Company, Limited."

The King Edward Oil Company., Limited.—Incorporated under the Statutes of Ontario, 18th September, 1903. Authorized capital, $100,000, in 100,000 shares of $1 each. Directors: J. R. McDowall, D. S. Robb, J. Houlden, J. Hutcheon, S. Howard. Head office, London, Ont. Formed to acquire the properties known as "The King Edward Oil Co., Limited.

The Eagle Lake Gold Mining Company.—Incorporated under the laws of the Territory of Arizona, and licensed under the Statutes of Ontario, 23rd September, 1903. Authorized capital for use in Ontario, $50,000. J. B. O'Brian, Toronto, Ont., attorney. Formed to acquire the properties known as "The Eagle Lake Gold Mining Company."

Toronto Peat Fuel Company, Limited—Incorporated under the Statutes of Ontario, 23rd September, 1903 Authorized capital, $40,000, in 800 shares of $50 each. Directors: A. A. Dickson, J. Brebner, W. S Jackson Head office, Toronto, Ont Formed to acquire the properties known as the "Toronto Peat Fuel Company, Limited"

The Kipp Oil Company, Limited.—Incorporated under the Statutes of Ontario, 7th October, 1903. Authorized capital, $150,000, in 1,500 shares of $100 each. Directors: G W. Kipp, E. F. Kizer, W. R. Hall, J. T. O'Keefe, J F O'Keefe. Head office, Chatham, Ont. Formed to acquire the properties known as "The Kipp Oil Company, Limited."

BRITISH COLUMBIA

Perry Creek Hydraulic Mining Company, Limited.—Incorporated under the Statutes of British Columbia, 11th September, 1903. Authorized capital, $1,000,000, in 1,000,000 shares of $1, each. Formed to acquire the properties known as the "Perry Creek Hydraulic Mining Company, Limited."

Fisher Maiden Mining Company, Limited.—Re-incorporated under the Statutes of British Columbia, 15th September, 1903. Authorized capital, $150,000, in 1,500,000 shares of ten (10) cents each. Formed to control the properties known as the "Fisher Maiden-Troy Mines, Limited."

MINING NOTES

A special correspondent at Trail, B.C., writes as follows:—"On Wednesday, October 7th, a shipment of 85,000 ounces of silver 999 fine was made to the United States Government at San Francisco for shipment to the Phillipines, which is the result of smelting British Columbia lead ores at Trail, and refining the resulting bullion by the electrolytic lead process, which has for many months past been supplying Eastern Canada with commercial pig lead.

When the electrolytic lead refinery was first operated, the "silver slimes" (composed of the precious metals and all the impurities, such as copper, antimony, arsenic, etc.) were sold to the United States refineries, where the actual separation of the precious metals from the impurities was made. As there were no plants in operation prepared to economically handle this particular product, which differs somewhat from the slimes produced from electrolytic copper refining, it was decided to build a special plant at Trail for the purpose of making a complete separation of the precious metals and impurities, which will make, in connection with the electrolytic lead process and the smelting works, a complete works for the treatment of all lead-silver ores and the production therefrom of pure lead, fine silver, fine gold, copper sulphate, and probably later, metallic antimony.

The first shipment of about 300 ounces of gold which was over 995 fine was made to the United States Assay Office at Seattle, and a second shipment of about 700 ounces of gold was made on Friday to the same place.

As Canada is now in a position to produce steadily fine gold, the Canadian Government should certainly take steps immediately towards purchasing this gold at whatever point it may be produced and so save the Canadian producers the cost of shipping and selling it to the United States Assay Offices

It is believed that the above shipments of fine gold, or refined gold to the United States Assay Office, and silver brick to the Phillipines, are the first which have ever been made as the result of smelting and refining ores in Canada.

The Canadian Smelting Works, Trail, are therefore in a position to supply Eastern Canada with whatever pig lead they may require, fine gold ready for minting purposes, fine silver, copper sulphate for use in Manitoba and the North West Territories, and will in a few months be turning out metallic antimony which will be used in making various babbitt metals"

Arlington Mine (Erie) Trail Dristrict, B.C. -During the month of September there were shipped five carloads of ore to the Hall Mines Smelter, Nelson. The net smelter returns were $5341.95 being an average of over $1000, a carload The expenses in Canada for the month were $4322.03, leaving a profit of $1003.64

Tilt Cove Copper Co., Limited. -The Fifteenth Ordinary General meeting of this company was held in London, England, at No 9 Queen Street Place, on the 22nd inst., for the purpose of receiving the Report and Accounts to December 31st 1902, and for transacting the ordinary business of the company. Two members of the Committee of Management whose term of office had expired under the Articles of Association, but who were eligible were re-elected, viz.. Mr. E A. Berthoud and Mr. E. C. Leaver. Messrs. Deloitte, Dever, Griffiths & Co., were re-elected as auditors for the current year.

Zenith Zinc Mine.—This mine situated on mining location 30-T, in the District of Thunder Bay, Ont., and formerly the property of the Grand Calumet Mining Co, was sold on the 6th inst. by public auction to Mr. Nelson D. Porter, of Ottawa, in the office of Wm L Scott, local master and deputy registrar, Court House. Bidding was principally between Mr. Poupore, Montreal, and Mr. Porter, and started at about $7,000 and stopped at a little over $20,000, and as the reserve bid had not been reached Mr. Scott declared the sale off. A little later Mr. Porter submitted a written tender of $21,000, which was accepted. The mine is situated about twelve miles from Rockland on the C.P.R. The sale included besides the mine a considerable quantity of mining machinery.

Rossland Ore Shipments.—The details of the shipping operations from Rossland Camp for the week ending October 17th, 1903, are as follows:—

Le Roi	5,160
Centre Star	1,501
War Eagle	1,050
Le Roi, No. 2	480
Jumbo	125
Spitzee	60
I. X. L. (milled)	200

Total week 8,576. Year to date 313,354 tons

Western Fuel Company.—A western exchange states that this company which is operating the coal mines at Nanaimo, Vancouver Island, gives unmistakable evidence that the new workings at Departure Bay are proving satisfactory, and that operations are to be carried on steadily there. The company has made a proposition to the City Council to extend the water mains to the new works, and provide sufficient water for four boilers. The company agrees to enter into a contract for a supply of water for five years. There is no doubt that the Coal Company intends to ship from Departure Bay, as an arrangement is sought by which water may be supplied to vessels coming to the Northfield wharf.

Granby Consolidated.—A Montreal despatch of the 8th inst. says:—At the annual meeting of the Granby Consolidated Mining, Smelting & Power Company, Ltd., held at the company's office, Canada Life Building, in this city, the old Board of Directors were elected as follows: S. H C. Miner, Jay P Graves, John Stanton, William H Nicholls, A C. Flumerfelt, A L. White, W. A. Robinson, Jacob Langeloth, J. H. McKechnie, George Martin Luther, Fayette Brown and C. S. Houghton.

When the financial statement was presented it showed the company to be free from debt with the exception of the ordinary monthly bills. The production for the year ending June 30th, 1903, amounted to 12,511,000 pounds of fine copper, 277,000 ounces of silver, and 35,121 ounces of gold, for which was received the sum of $2,232,741, while the rents and real estate sales brought in $38,511, making a total of $2,371,232.

Snowshoe Gold and Copper.—Rumors are current in London that the amalgamation of the Snowshoe Gold and Copper Mines, Limited, and the B. C. Copper Company is being arranged. The former company is a subsidiary company of the B. C (Rossland-Slocan) Syndicate operating the Snowshoe property in the Boundary District of British Columbia, and is now shipping an average of 2,000 tons a week. The B.C. Copper Company owns the Mother Lode Mine, and also an extensive smelting plant at Greenwood, which at present is running two blast furnaces, and will shortly install a copper converter.

The Winnipeg Mine.—The annual general meeting of the Winnipeg Mines, Ltd., was held at the mine, near Phœnix, on the 6th inst., when the following officers were elected: President, John Dean, of Rossland; vice-president, C. D. Hunter, of Phœnix; secretary-treasurer, Richard Plewman, of Phœnix; also W. W. Gibbs, of Portland, R. E. Plewman and F. W. Bauer, of Rossland, and J. A. Morrin, of Phœnix.

CONCENTRATES.

SLATE AND MARBLE INDUSTRIES IN VERMONT —For a number of years past the United States Geological Survey has carried on work in the slate and marble districts of Vermont. Prof. T. Nelson Dale, who is in charge of this work for the Survey, prepared a very complete report on the slate beds of Vermont and New York a few years ago. This report was published in the annual report of the Director of the Survey, and proved to be of such value and interest to quarrymen and others that the edition was soon exhausted. It is probable that a portion of this report will be republished early in 1904 as part of a report on the slate industry of the United States Investigations of the marble deposits of Vermont have also been carried on by the Survey, and Professor Dale is preparing a report on this subject.

Gold Commissioners in British Columbia give notice that placer mining claims are held over as follows: Cariboo, from November 1st to June 1st, 1904. Kamloops, Ashcroft, Yale and Similkameen, from November 1st to May 1st.

The B.C. *Review*, published in London, England, publishes the following in its issue of the 17th inst.:—"During the progress of the Commission which has been recently sitting at Dawson to investigate the question of hydraulic concessions in general, and that granted to Mr. A. N. C. Treadgold in particular, he is reported to have stated that if a clear title is given to him under the terms of his concession, over £800,000 will be expended in a waterworks scheme for supplying the mines. There appears to be an impression in the Yukon that this money will be found in London, but we may state that there is not the least possibility that any such sum could be raised here for such an object. We have hitherto been under the impression that any financial backing Mr. Treadgold may have obtained came from Chicago. The results which have so far attended the investment of British capital in the Klondike have not been such as would enable even one issuing house of repute to find one quarter of the sum mentioned for any concession in that country."

Speaking of concessions of water rights the following is taken from *South African Mines*, a leading mining paper published in Johannesburg, S.A, in its issue of September 26th:—"In his speech on Saturday last His Excellency the Lieut-Governor hinted at the policy of the Government in regard to water-rights He announced that the Government propose to introduce an ordinance vesting the water of the principal streams of the colony in the Government. Reference to the letter of the Registrar of Mining Rights, printed hereafter, will further elucidate the remarks of His Excellency. Water-rights under the present mining law are most unsatisfactory. The fees exacted for power rights are prohibitive and iniquitous, and are to be abolished. Cancellation of water-rights is virtually impossible under the existing law if the holder chooses to pose as a dog in the manger A salutary change proposed is the removal of the restriction of the grant of a water right to the holder of a properly developed digger's claim. This provision has operated toward the creation of monopoly, and the grant of water for development purposes will be a relief. Water-rights are, therefore, to be granted for a period in connection with mining rights subject to proper uses."

The Mount Morgan mine, said to be Australia's oldest and greatest gold mine, paid last year $750,000 in dividends. The annual report for the fiscal year shows the following figures regarding production: Ore treated, 262,819 tons; gold produced, 143,584 ounces, which was 4,024 ounces less than the gold production of the previous twelve months, when 79 866 less tonnage was milled. The mundic ore treated during the year was fifty-two per cent. The average return from all of the ore dealt with during the year was nearly 11¾ dwt., of the value of 45s. 6d, while the cost of mining and treating averaged 21s.

Stream tin was discovered in Alaska last year, and now it is reported that great ledges of tin ore have been found at Cape York, on Behring Sea. Numerous individual placer mines are reported to have made small fortunes during the part summer; two men, for example, having taken twenty-two tons of stream tin from claims along one of the creeks in the Cape York region, using the crudest hand methods. Hydraulic machinery will be taken into the district next season, when the extent and value of the tin deposits will be ascertained.

The history of the cyanide process is as follows: In 1806 it was known that gold was soluble in potassium cyanide In 1884 Eloner published the results of his investigations and gave his well-known equation. Faraday used the solvent effect of cyanide to reduce the thickness of gold films. About 1885 Messrs. McArthur and the Forrests of Glasgow commenced their investigations, and in 1888 the cyanide process was tried in New Zealand and proved to be a success. The year following the process was introduced into South Africa for the purpose of treatment of tailings. It was a great success, and the process has spread into every gold mining district. Between 1844 and 1888 many experiments were made to use potassium cyanide as a commercial solvent for gold but without success. The Messrs. McArthur and Forrest are entitled to the credit of the greatest improvements in metallurgy made during the last twenty-five years.

The announcement comes from Germany that a Frenchman, Edward Mollard, has reported to the state department the discovery of another metal. This new metal is called selium and is both lighter and stronger than aluminum. Its hardness is not quite equal to iron, but is greater than zinc, and its power of resistance ranks between iron and steel. The greatest advantage of the new metal is its cost of production, which is only about one-twentieth that of aluminum. Selium does not corrode and is capable of a very high polish. The former quality is an important requisite in ship-building, while the latter makes the new metal exceptionally suited for cooking utensils.

Rich gold field have been discovered about 160 miles west of the city of Oaxaca, Mexico, and 122 miles from the town of Ejutla. The ore found is said to assay up to $50,000 a ton, and so great is the excitement that cavalry has gone to guard the claims. The ledge is said to be a fifteen feet wide.

A monster nugget of silver weighing more than a ton, the largest single piece of silver ore ever taken from the ground, will be one of the features that the state of Idaho will display at the St. Louis Exposition This is interesting to British Columbians, in as much as the nugget comes from a mine just across the border from the richest silver district in Canada

Efforts are being made to still further develop the manganese ore mining industry in the Caucasian district of Russia To this end two large banks, with the authority of the Government, are about to establish offices near the mines, for the purpose of making advances on ore and undertaking the sale of the same through their agents abroad.

Estimates of the iron ore area of the United States—made for the Wall Street Journal by the United States Geological Survey—place the total at 18,000 square miles. Of the aggregate it is estimated that the Lake Superior area, comprising at least 95 per cent. of the Bessemer iron ore supply, includes not less than 9,000 square miles, and the total may be a little more The total shipment of Lake Superior ores in 1902 was 27,571,121 tons, of which the United States Steel Corporation produced 16,174,473 tons or 58.6 per cent. of the whole.

There have been found on the west arm of Quatsino Sound, Vancouver Island, B.C., immense deposits of limonite and bog iron, by two prospectors Messrs. Hick and Frank These deposits were found late last year, and for various reasons the find was kept secret. Considerable development having recently been done on the property, therefore assuring the owners that it is in reality a rich deposit of hematite.

The Comstock lode has produced $320,000,000 ; the Calumet has paid $80,800,000 in dividends ; the Anaconda, sold for $40,000,000 to the Rothschilds, paid that amount in dividends before the sale ; the Ontario has paid $14,000,000 in dividends ; the Homestake has paid $3,333 in dividends every working day in the last ten years ; the Granite rose in two years from 10 cents a share to $75 and pays 50 per cent in dividends every month Mining is indeed a fine business when you hit it rich —New York Press

During the shutdown at the Broken Hill mines, in N. S W. Australia on account of the want of sufficient water caused by the long continued drought, a bibulous miner drank so much cocculus, indicus, and sugar at the local beer houses as to get delirium tremens He had a mate to whom he went daily for sympathy and threepences. Finally this mate got tired of the drunkard's woes "Oh, go and drown yourself!" he said, hotly "Great Scott !" was the reply ; "I never thought of that" ; and the alcoholic miner rushed away to find a suitable spot. Needless to say, he was miserably unsuccessful ; and at last advices he was still unbosoming and borrowing

Lead Shipments of B.C.

Lead shipments in British Columbia from 1887 to 1902 inclusive are reported by Mr. Macpherson, M.P., for Burrard to have been as follows :—

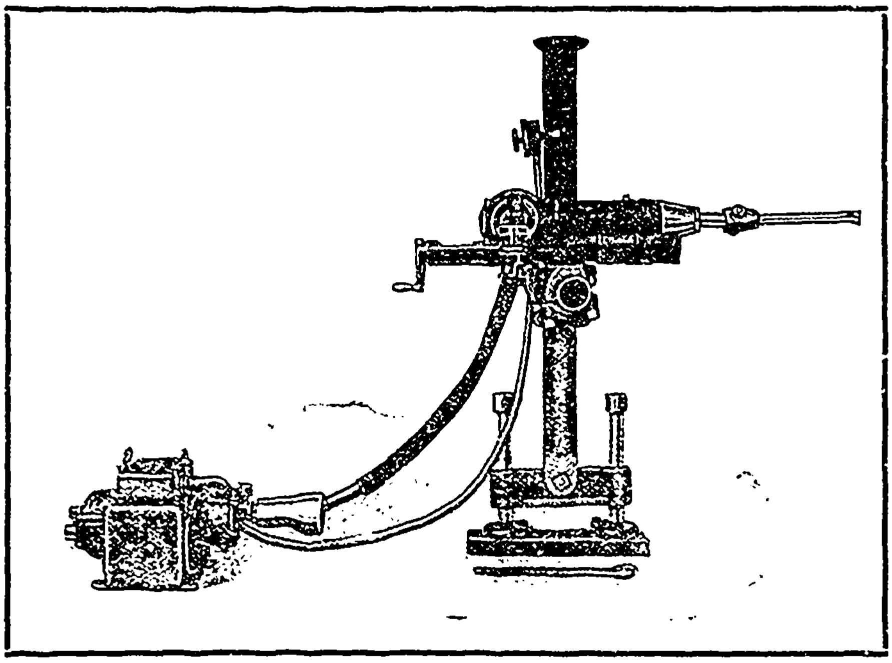
1887	204,800	1895	16,475 464
1888	674,500	1896	24 199,977
1889	165,100	1897	38,841,135
1890	nil.	1898	31,693,559
1891	nil.	1899	21,862 436
1892	808,420	1900	63,358,621
1893	2,135,023	1901	51 582,906
1894	5 662,523	1902	22,536,381

The consumption of lead in Canada during the last year mentioned (1902) was about 24,000,000 pounds.

A New Gold Dredge.

From a western exchange comes the information that a new style of gold dredge is being built in Seattle by the Washington Iron Works and the Puget Sound Machinery Depot for the use of the Bachman Gold Dredging Co. of Pasadena, Cal., on streams in the Mount Baker District, State of Washington. It is claimed for the proposed dredger that its construction and operation is to be on lines entirely new in subaqueous gold mining. The following particulars may be of interest to those of our readers engaged in this branch of the Canadian mining industry.

The mechanism of this dredge is unique, a combination of the well-known chain bucket system and a powerful direct-action plunger pump. The pump is especially designed for pumping granular matter, and is the invention of James Bewsher, of this city. The chain buckets will be operated to bring the boulders and coarser gravel to the surface, where they are disposed of, while the fine sand, gravel and gold are all taken in through the suction pipes and delivered to the sluice boxes on board the dredge. It is claimed for this pump that it will lift and carry gold in any form in suspension as easily as it pumps fine sand, and that it will save all of the bed-rock gold, practically all of which is now lost under the old method of bucket dredging. The most interesting feature in this new departure in mechanics is the fact that the granular matter is passed through the chambers of the pump without injury to the plungers or other wearing parts. As a dredging pump for all purposes great efficiency is claimed for it over the centrifugal pattern now in general use.



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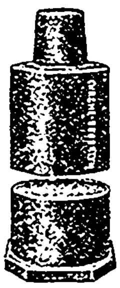

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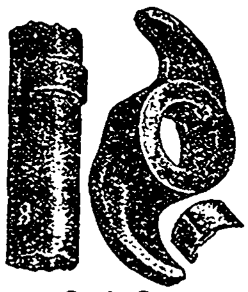

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(A) To promote the Arts and Sciences connected with the economical production of valuable minerals and metals, by means of meetings for the reading and discussion of technical papers, and the subsequent distribution of such information as may be gained through the medium of publications.

(B) The establishment of a central reference library and a headquarters for the purpose of this organisation.

(C) To take concerted action upon such matters as effect the mining and metallurgical industries of the Dominion of Canada.

(D) To encourage and promote these industries by all lawful and honourable means.

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Vol. III, 1900, 270 pp., " "
Vol. IV, 1901, 333 pp., " "
Vol. V, 1902, 700 pp., " "
Vol. VI, 1903, 600 pp., now in press.

Membership in the Canadian Mining Institute is open to everyone interested in promoting the profession and industry of mining without qualification or restrictions.

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DOMINION OF CANADA

SYNOPSIS OF REGULATIONS

For Disposal of Minerals on Dominion Lands in Manitoba, the North-West Territories, and the Yukon Territory.

COAL.

Coal lands may be purchased at $10.00 per acre for soft coal, and $20.00 for anthracite. Not more than 320 acres can be acquired by one individual or company. Royalty at such rate as may from time to time be specified by Order-in-Council shall be collected on the gross output.

QUARTZ.

Persons of eighteen years and over and joint stock companies holding Free Miner's certificates may obtain entry for a mining location.

A Free Miner's Certificate is granted for one or more years, not exceeding five, upon payment in advance of $10.00 per annum for an individual, and from $50.00 to $100.00 per annum for a company, according to capital.

A Free Miner having discovered mineral in place may locate a claim 1500 x 1500 feet by marking out the same with two legal posts, bearing location notices, one at each end of the line of the lode or vein.

The claim shall be recorded within fifteen days if located within ten miles of a Mining Recorder's Office, one additional day allowed for every additional ten miles or fraction. The fee for recording a claim is $5.00.

At least $100.00 must be expended on the claim each year or paid to the Mining Recorder in lieu thereof. When $500.00 has been expended or paid the locator may, upon having a survey made and upon complying with other requirements, purchase the land at $1.00 per acre.

Permission may be granted by the Minister of the Interior to locate claims containing iron and mica, also copper in the Yukon Territory, of an area not exceeding 160 acres.

The patent for a mining location shall provide for the payment of royalty on the sales not exceeding five per cent.

PLACER MINING, MANITOBA AND THE N.W.T., EXCEPTING THE YUKON TERRITORY.

Placer mining claims generally are 100 feet square; entry fee, $5.00, renewable yearly. On the North Saskatchewan River claims are either bar or bench, the former being 100 feet long and extending between high and low water mark. The latter includes bar diggings, but extends back to the base of the hill or bank, but not exceeding 1,000 feet. Where steam power is used, claims 200 feet wide may be obtained.

DREDGING IN THE RIVERS OF MANITOBA AND THE N.W.T., EXCEPTING THE YUKON TERRITORY.

A Free Miner may obtain only two leases of five miles each for a term of twenty years, renewable in the discretion of the Minister of the Interior.

The lessee's right is confined to the submerged bed or bars of the river below low water mark, and subject to the rights of all persons who have, or who may receive entries for bar diggings or bench claims, except on the Saskatchewan River, where the lessee may dredge to high water mark on each alternate leasehold.

The lessee shall have a dredge in operation within one season from the date of the lease for each five miles, but where a person or company has obtained more than one lease one dredge for each fifteen miles or fraction is sufficient. Rental $10.00 per annum for each mile of river leased. Royalty at the rate of two and a half per cent., collected on the output after it exceeds $10,000.00.

DREDGING IN THE YUKON TERRITORY.

Six leases of five miles each may be granted to a free miner for a term of twenty years, also renewable.

The lessee's right is confined to the submerged bed or bars in the rivers below low water mark, that boundary to be fixed by its position on the 1st day of August in the year of the date of the lease.

The lessee shall have one dredge in operation within two years from the date of the lease, and one dredge for each five miles within six years from such date. Rental, $100.00 per mile for first year, and $10.00 per mile for each subsequent year. Royalty ten per cent on the output in excess of $15,000.00.

PLACER MINING IN THE YUKON TERRITORY.

Creek, Gulch, River, and Hill claims shall not exceed 250 feet in length, measured on the base line or general direction of the creek or gulch, the width being from 1,000 to 2,000 feet. All other Placer claims shall be 250 feet square.

Claims are marked by two legal posts, one at each end bearing notices. Entry must be obtained within ten days if the claim is within ten miles of Mining Recorder's office. One extra day allowed for each additional ten miles or fraction.

The person or company staking a claim must hold a Free Miner's certificate.

The discoverer of a new mine is entitled to a claim 1,000 feet in length, and if the party consists of two, 1,500 feet altogether, on the output of which no royalty shall be charged, the rest of the party ordinary claims only.

Entry fee $15.00. Royalty at the rate of 2½ per cent. on the value of the gold shipped from the Territory to be paid to the Comptroller.

No Free Miner shall receive a grant of more than one mining claim on each separate river, creek, or gulch, but the same miner may hold any number of claims by purchase, and Free Miners may work their claims in partnership, by filing notice and paying fee of $2.00. A claim may be abandoned and another obtained on the same creek, gulch, or river, by giving notice, and paying a fee.

Work must be done on a claim each year to the value of at least $200.00, or in lieu of work payment may be made to the Mining Recorder each year for the first three years of $200.00, and after that $400.00 for each year.

A certificate that work has been done or fee paid must be obtained each year; if not, the claim shall be deemed to be abandoned, and open to occupation and entry by a Free Miner.

The boundaries of a claim may be defined absolutely by having a survey made, and publishing notices in the *Yukon Official Gazette*.

HYDRAULIC MINING, YUKON TERRITORY.

Locations suitable for hydraulic mining, having a frontage of from one to five miles, and a depth of one mile or more, may be leased for twenty years, provided the ground has been prospected by the applicant or his agent; is found to be unsuitable for placer mining; and does not include within its boundaries any mining claims already granted. A rental of $150.00 for each mile of frontage, at the rate of 2½ per cent. on the value of the gold shipped from the Territory. Operations must be commenced within one year from the date of the lease, and not less than $5,000.00 must be expended annually. The lease excludes all base metals, quartz, and coal, and provides for the withdrawal of unoperated land for agricultural or building purposes.

PETROLEUM.

All unappropriated Dominion Lands shall, after the first of July, 1901, be open to prospecting for petroleum. Should the prospector discover oil in paying quantities he may acquire 640 acres of available land, including and surrounding his discovery, at the rate of $1.00 an acre, subject to royalty at such rate as may be specified by Order in Council

JAMES A. SMART,
Deputy of the Minister of the Interior.

OTTAWA, 9th Dec., 1901.