The Mining Magazine

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EDITORIAL

AT the International Geological Congress, which is taking place at Washington from July 22 to July 29, the British Government delegates are Sir John Flett, Professors C. G. Cullis and O. T. Jones, Mr. W. Campbell Smith, and Dr. K. S. Sandford.

TWO new areas in the Kavirondo goldfields (Nos. 3 and 4 of Sir Albert Kitson's report) have been declared open. They have been divided into 57 parts and applications are invited for exclusive prospecting licences covering a period of one year. A provisional geological map of the Kakamega field has recently been issued by the Mining and Geological Department, Nairobi.

THE centenary celebrations of the Royal Cornwall Polytechnic Society are being held in Falmouth, Camborne, and Penzance from July 18 to July 21. The arrangements include visits to St. Michael's Mount and the works of Messrs. Holman Brothers and Messrs. Bickford Smith and Co. and lectures by Sir Richard Gregory, Sir John Cadman, Sir Napier Shaw, and Professor S. J. Truscott.

SPEAKING last month in the House of Commons Mr. R. K. Law, explaining the position of his father in connexion with the American Debt settlement, said: "Mr. Bonar Law held that this was not an ordinary contract in the spirit, whatever it was in the letter. He held, in his own words, that you could not measure blood against money." This, it will be remembered, was the view expressed in the MAGAZINE in January last.

ACCORDING to one authority the iron age, in which it is generally conceded we are now living, is shortly to be succeeded by the plastic age. However extravagant this statement may sound—and it was delivered in all seriousness to the Society of Chemical Industry last month—there is no denying the fact that the synthetic resins are finding increased uses in every-day life, to the displacement of such ornamental metals as copper, bronze, nickel, and others of their kind. The plastic materials have properties which render them serious rivals to the common metals and alloys. They have high tensile and compressive strength, are light in weight, have low heat and electrical conductivity, and are fire-proof, while they can be readily moulded into any shape and in almost any colour or mixture of colours. Their life, however, still remains to be proved.

MINING men must of necessity be interested in the activities of concerns such as the British Non-Ferrous Metals Research Association, since their work results in extended uses being found for base metals. The association's report—the thirteenth—just published records the continuation of valuable work done in the solution of problems presented to it by the consuming industries, which form the bulk of its membership. A well-deserved tribute is paid to Dr. R. S. Hutton, the association's director almost since its inception, who resigned in September last on his appointment to the first Goldsmith's Professorship of Metallurgy at Cambridge University. He was succeeded by Dr. H. Moore, who was formerly Director of Metallurgical Research at Woolwich Arsenal. Thus the bond between this essentially commercial and industrial organization and Government-sponsored research is still further strengthened. Another point of interest is that the International Tin Research and Development Council has concluded negotiations for co-operation with the association.

Rand Taxation

In the MAGAZINE for February last the position of the Rand gold-producing industry with respect to the situation created by the departure of the Union from the gold standard was reviewed in the light of a speech made by Mr. John Martin, president of the Transvaal Chamber of Mines. Mr. Martin was then confident that under the different conditions something in the nature of a new mining policy would be evolved, in pursuit of which full advantage would be taken to lower pay limits, to increase ore reserves, and to accelerate the development of both old and new areas. In April—after three months' work under premium conditions—the progress made in the direction of forwarding this new policy was examined and it was pointed out that three major elements of uncertainty must be carefully considered before any prophecy as to the future of the Rand gold mines could be made. These elements were : The wages question, uncertainty as to the nature of subsequent taxation, and doubts as to the future of gold. As to the third of these factors, the position, broadly speaking, remains the same, the general concensus of opinion being that there is nothing to replace gold as a satisfactory standard for international exchange purposes. Of the first—the wages question—this is still rather obscure and is referred to later. The taxation question, however, has to a certain extent been cleared up by the provisions made in the South African budget submitted to the newly-elected Union Parliament last month and it is this which justifies a return to the subject.

Before the introduction of the Union budget there had been many surmises as to the proportion of the gold premium that would be taken by the new administration, certain sections of the local Press prophesying that 50% would be the amount claimed, a conjecture that most people thought to be exaggerated. As it happened, this figure was very near the mark, for Mr. Havenga, the Finance Minister, announced his intention of raising an additional £6,000,000 from the industry, an intention that was resented by the mining industry and the Reef population. The storm of criticism aroused by the new measure has resulted in certain amendments being made to the original proposal, which was set out as a scheme for imposing an excess-profits duty on the additional revenue derived by the mines from the premium. The exact wording of the measure has been generally admitted to be obscure, but the intention of the Union Government is perfectly plain. They desire to separate the premium benefit from ordinary taxation, the maximum duty to be levied now being fixed at 70% of the excess, not 80% as at first proposed. Mr. Havenga himself was obliged to leave South Africa for London, to attend the World Economic Conference, and the handling of the measure in the Union Parliament was left to Mr. Patrick Duncan, Minister for Mines. Mr. Duncan emphasized Mr. Havenga's determination to take 50% of the premium and guaranteed that the additional taxation in 1934–35 would not exceed £7,400,000, which would be about 57% of the gold premium. The matter is now settled, having been passed by the Union Parliament, and it only remains to examine its effect on the gold industry of the Union.

It is interesting to note that the South African Mine-Workers' Union has declared itself to be entirely satisfied that the new revised taxation is fair and reasonable, so that some good may have arisen from it here, since if the Government is taking a large lump of the premium the workers are not likely to claim it. In other words, the wages question can hardly become as acute as at one time appeared probable. The Government's contention that the premium is " an increment due solely to State action " must be admitted, as also its view that " the continued existence of the premium is uncertain," and it is impossible not to recognize that there is still a premium even if it is only half what was at first thought to be coming to the industry. Thus there are still the means available for the working of ore below the previously accepted limits of payability, although it appears to be here that the critic may with some fairness charge the Union Government with short-sightedness. It might have recognized that a certain length of time must necessarily elapse before low-grade reserves can be sufficiently developed to mine—that is, before the full effects of the industry's declared " new policy " could become apparent—and that the limit of payability cannot be lowered as much as it would have been had the new taxation not been so heavy. It is, perhaps, too early to judge of the final effects of the new measure, especially as the official examples of calculated taxes are so obscurely set out as to make it appear that lower-grade mines may feel the tax more than those working high-grade material. Whether the Union Government will benefit in the long run by its action remains to be seen, while it seems to some inequitable that the mining industry should be taxed to help the farming community, since the agriculturist must benefit as much as anyone from the depreciation of the South African pound. There is, too, the fact that the gold industry in Southern Rhodesia and other parts of the Empire has not been penalized so severely. One certain effect may be recorded and that is that various schemes for the resuscitation of old areas and the development of new ones have, temporarily at any rate, been shelved and, although there is a temptation to suspect that both the Government and the industry have been striving after 60% of the premium, such an effect is much to be deplored. Once again we might say that the extension of the life of the industry should be the main end in view, not increased taxation and dividends, and it seems likely that the Government may find it wise to accord—in Mr. Havenga's own words—"special treatment to new development on the lines of legislation already in force in respect of Government leased areas."

Geophysics in the Oilfield

The fact that, as recorded elsewhere in this issue, the World Petroleum Congress is meeting in London during the present month makes it singularly appropriate to refer to a review of recent progress in geophysical exploration as applied to oilfield work that has been made by Mr. Oscar Weiss.[1] It is, perhaps, not generally realized that a modern oilfield organization will include specially-trained men capable of exploring buried structures by geophysical methods or that their methods have become so firmly established that the future is likely to witness considerable expansion. In many fields almost all the surface geology has been roughly explored and the well records correlated and in such cases any additional information that may become available as the result of surveys by geophysical methods will be eagerly seized upon by the geologists in charge. As the author of this review points out, much experience was wasted in the days of early geophysical work by the failure of the geophysicist to realize or at any rate admit the great extent to which he is indebted to the geologist for his information. Nowadays, however, geophysical exploration, like aerial reconnaissance, is recognized to be a new and useful tool in helping in the unravelment of a geological structure and, although the final mathematical considerations involved in the study of anomalous observations must remain in the hands of the trained specialist, sufficient has been made available in the way of graphical checks to enable the geologist concerned to be able to confirm or control the work of his colleague.

As far as geophysical instruments are concerned, the developments of recent years have been confined mainly to the modification of types already well known. Mr. Weiss admits that no new methods have been put in practice, although the cost of deep drilling and the urgent need for more precise data relating to deeper horizons has made more and more exacting demands on those methods already firmly established. These new requirements have been met in the main by increasing the sensitivity of instruments concurrently with an increase in mechanical robustness to enable them to withstand the rigour of field work, while the accuracy of measurements and their reliable interpretation have been greatly enhanced by combining results obtained by different methods. It is recorded that certain areas in the Gulf Coast of Texas and Louisiana have been twice surveyed by the torsion balance and four times by seismograph, in each case improvements in the instruments and methods of calculation having disclosed the limitations of the work previously done. This then is the nature of the progress in recent years—the development of higher accuracy and the combination of different methods.

Turning to the advances recorded in the use of the various methods, the author states that under favourable conditions the torsion balance is almost indispensable for obtaining reliable data about hidden underground structure, the precise theory on which the method is based and the mass of accumulated data that has been checked by drilling rendering it extremely valuable under certain conditions. In seismic work a great advance was made when seismic reflection was introduced into oil prospecting, although the method can only be used when a reflecting surface exists and has been reliably identified. Under these conditions the amount of explosive required can be considerably reduced and very accurate depth determinations made with either electrical or mechanical seismographs set up on the surface or buried in holes. For oil work recent developments in earth magnetic methods are not considered to have opened up any new possibilities, the depth and shape being generally indeterminable by magnetic prospecting, and the author is of the opinion that this method is more likely to lose than gain importance in course of time. The application of electrical methods to the solution of oil problems is a comparatively recent development. Theory for this type of work has always been based on the assumption that the media studied would be isotropic, but the discovery of the anistropy of stratified deposits has done much to

[1] *Journal* of the Institution of Petroleum Technologists. June, 1933.

clarify the position, particularly since the complications aroused by the discovery have been overcome by the use of low-frequency currents. So much for surface work, but an interesting development has been the advance made in measuring the resistivities of different beds by lowering electrodes in wells, a method that has been frequently used for obtaining correlation data. Radioactive methods have not developed well and the author still awaits the process which will be capable definitely of locating oil directly. It is noteworthy that he does not think that such an advance is an impossibility. A development of this kind, of course, would not be confined to the direct location of oil alone and, although its discovery is not likely to be made in the immediate future, it is possible to agree with the author that, in any case, geophysical exploration methods are likely to find increasing application.

The Royal School of Mines Dinner

The 56th annual dinner of the Royal School of Mines held last month under the auspices of the Old Students' Association continued a series of functions well calculated to preserve an interest in the School for its alumni. As usual the atmosphere was that of a family gathering, the guests having been chosen from men known to be sympathetic to the aspirations of Mines men and the traditions of the School rather than from those well known in public life, who can only be indirectly interested in its fortunes. Among these friends of the School—as they were very appropriately termed later in the evening by Professor J. G. Lawn—might be mentioned Sir Albert Kitson, Mr. Justice Howes (from the Gold Coast), Mr. Leonard Holman, and Mr. S. L. Bensusan, while the chair was occupied by Mr. Arthur J. Bensusan, who was at the School from 1889 to 1894.

The toast of "The Royal School of Mines" was in the able hands of Sir Albert Kitson, who, speaking as an Australian, expressed an envy of the position that R.S.M. men held in all parts of the world. He thought of them as pioneers in the true sense, men who had gone to the ends of the earth in times of peace and yet who had not hesitated to offer their services in times of war. He felt that such men must have had unparalleled experiences and he only wished more of them would follow the example of Mr. E. T. McCarthy and pass on their knowledge to others by more frequent publication. This, as our readers know, is a matter on which the MAGAZINE has often had occasion to speak feelingly. It has always felt that men should write more ; there is always someone to whom their endeavours will prove of use. In reply Mr. A. J. Bensusan spoke of the trepidation he had felt in taking office for the year and expressed his appreciation of the efficient way in which the affairs of the Association were managed by their able secretary, Professor Truscott. He spoke of the difficulties likely to confront a graduate leaving the School at the present time, going on to discuss the organization at South Kensington and the facilities that were available there, in spite of its not being situated, as, apparently, certain people would like it to be, in the centre of a mining field. Referring to the correspondence that appeared a year or so ago in these columns concerning the education of the mining engineer, Mr. Bensusan felt that he could do little better than quote another old Mines man, at present in America, who once said that perhaps not so much depended on the wisdom of the teacher as on the virility of the taught, and considered that the best possible material should be available for the profession, as competition was likely to become increasingly great. Mr. Bensusan concluded by announcing that Professor Henry Louis, who had recently been made a Fellow of the Imperial College, would be the next occupant of the presidential chair.

The toast of the guests was proposed by Professor Lawn, who, in the course of an entertaining dissertation on the etymological derivation of the words "host" and "guest," arrived at the happy conclusion that the latter word could, quite legitimately, be interpreted as "friend" and thereafter consistently referred to the official guests as friends. Professor Lawn subsequently mentioned the individual services done to mining by the guests, not only those present, but those who had been unable to attend. Mr. Justice Howes, in response, spoke of his comparative ignorance of mining terms and customs, but showed his knowledge of the important matter of concession titles and of the manner in which these might have been obtained on the West Coast of Africa.

The formal business of the evening was terminated by the toast of the Chairman, pleasantly proposed by Professor Truscott, who gracefully alluded to Mr. Bensusan's close family connexion with the School.

REVIEW OF MINING

Introduction.—The lack of progress made at the World Economic Conference, due principally to the desire of the United States administration to place its policy of price-raising before that of the gold-standard countries for monetary stabilization, appears to have had but little effect on business generally, the position of gold as a standard of value not having been assailed. Although the hoped-for revival is not yet at hand, therefore, there appears to be a growing confidence in the future and metal prices, at any rate, have continued steadily to advance, while there has been a further marked improvement in the employment figures.

Transvaal.—The output of gold on the Rand for June was 868,834 oz. and in outside districts 49,799 oz., making a total of 918,633 oz., as compared with 944,604 oz. in May. The number of natives employed in the gold mines at the end of June totalled 229,751, as compared with 227,178 at the end of May.

The accompanying table gives the dividends declared by the Rand gold-mining companies on account of the past half-year. Figures for the preceding three half-years are given for comparison, but it has to be remembered that with the exception of the Van Ryn payment those for the second half of 1932 were paid in South African currency at the rate ruling on January 27 last, while the latest distributions show the effect of the gold premium. It will be seen that Daggafontein Mines has joined the list, while Witwatersrand Deep returns. A statement has been issued by the Luipaards Vlei company stating its intention to follow the practice adopted last year and to declare a final dividend in respect of its financial year, which ended on June 30.

	2nd half, 1931.	1st half, 1932.	2nd half, 1932.	1st half, 1933.
	s. d.	s. d.	s. d.	s. d.
Brakpan	4 0	3 0	4 0	4 6
Consolidated Main Reef	1 3	1 3	1 3	1 6
Crown	3 6	3 6	4 3	6 3
Daggafontein	—	—	—	1 6
Durban Roodepoort Deep	0 9	0 9	0 9	1 9
East Geduld	—	1 0	1 9	3 3
East Rand	0 6	0 3	0 3	0 9
Geduld	3 6	3 6	4 0	5 3
Geldenhuis Deep	1 0	1 0	1 0	2 6
Government Areas	2 3	2 3	2 3	3 0
Langlaagte Estate	2 0	2 0	2 0	2 6
Luipaards Vlei	—	—	0 3	—
Modderfontein B	1 6	1 3	1 3	1 3
Modderfontein Deep	3 0	2 9	2 9	3 0
Modderfontein East	2 0	2 0	2 0	2 6
New Modderfontein	5 6	5 3	5 0	5 3
New State Areas	2 0	2 0	2 3	2 6
Nourse Mines	0 9	0 9	0 9	2 0
Randfontein	0 6	0 9	1 0	1 0
Robinson Deep (A 1s.)	1 6	1 6	1 6	1 6
Robinson Deep (B)	0 6	0 6	0 7½	1 6
Rose Deep	0 6	—	—	0 6
Simmer and Jack	0 2	—	0 1½	0 5
Springs Mines	4 0	3 9	3 9	4 6
Sub Nigel	3 6	4 0	4 0	6 6
Van Ryn	0 9	1 0*	1 0*	2 0*
Van Ryn Deep	2 6	2 0	2 0	2 0
West Rand	—	0 3	0 4½	0 6
West Springs	0 9	0 9	0 9	1 0
Witwatersrand Deep	—	—	—	2 0
Witwatersrand Gold	0 6	0 3	0 3	2 0

* Free of tax.

Latest advice with respect to the boring being undertaken on the West Witwatersrand Areas properties is to the effect that a reef has been intersected in the Venterspost bore-hole No. 11, which was down 3,381 ft. on June 23 last.

The Potchefstroom town council has accepted the tender of the Anglo American Corporation for gold prospecting rights in Potchefstroom town lands, which cover about 10,000 morgen adjacent to the town.

Shareholders of Potgietersrust Platinums have been informed that operations are to be restarted at an early date by Rustenburg Platinum Mines, Ltd.

The accounts of Henderson's Transvaal Estates for the year to March 31 last show a profit of £35,100, increasing the sum brought in to £65,703. A dividend paid during the year absorbed £10,564, equal to 2½%, and after making other allowances there was an available total of £52,752. A final dividend of 2½% for the year leaves £42,188 to be carried forward, from which an interim payment of a similar amount has been declared for the current year.

During the period from its incorporation in December, 1931, to the end of 1932 the H.E. Proprietary, Ltd., made a profit of £29,752, from which a dividend equal to 7½% has been paid, absorbing £22,500 and leaving £7,252 to be carried forward.

Southern Rhodesia.—The output of gold from Southern Rhodesia during May was 53,358 oz., as compared with 53,559 oz. for the previous month and 46,854 oz. for May, 1932. Other outputs for May were: Silver, 8,721 oz.; coal, 45,806 tons; chrome ore, 3,868 tons; asbestos, 3,700 tons; iron pyrites, 815 tons.

The contract recording the purchase of the mineral rights of Southern Rhodesia by the Government was signed last month and the purchase price of £2,000,000 paid over. The Chartered company has decided to pay an interim dividend of 6d. per share in respect of the current year.

Northern Rhodesia.—A report of the Rhokana Corporation covering the half-year to June 30 states that blister production totalled 26,038 tons, the total cost per long ton being £21·584, including debenture interest. It has been decided to erect an electrolytic refinery at N'Kana, having a capacity of 36,500 short tons per annum, and it is hoped to start production about the middle of 1934. Arrangements have been made for the production of both cobalt alloy and electrolytic cobalt.

The accounts of the Rhodesia Broken Hill Development Company for 1932 show a credit balance of £23,169, as compared with a debit of £41,627 for the previous year. After deducting the debit of £17,927 brought in and making other allowances there was a credit of £7,668 to be carried forward. It is stated that the outputs of zinc for 1933 and 1934, estimated at 18,500 tons and 20,000 tons respectively, have been sold.

A circular to shareholders of the North Charterland Exploration Company issued this month states that an agreement has been concluded with Loangwa Concessions, Ltd., granting that company exclusive prospecting rights over the concession in the Sasare district.

Gold Coast.—At an extraordinary meeting of the Kwahu Mining Co. (1925), Ltd., held this month, an increase of capital to £40,000, by the creation of 100,000 new 2s. shares, was approved and these shares are to be offered to existing holders at a price of 5s. per share. The company has an offer for floating the Tuappin and Bondaye properties under consideration.

The registration of Konongo Gold Mines was announced in the MAGAZINE last month. This company has acquired the property held by Lyndhurst Deep Level (Gold and Silver) and preparations for opening up are in hand.

Nigeria.—Ex-Lands Nigeria, Ltd., proposes to capitalize £19,986 4s. of its reserve fund and to issue the 199,862 new 2s. shares as a bonus to existing holders in the proportion of one share to every nine held.

Kenya.—Shareholders of the Tanami Gold Mining Syndicate have been informed that after an examination by Messrs. Bewick, Moreing, and Co. an option has been acquired on the claims of the Rosterman Mining Syndicate, at Kakamega.

It was announced last month that a concession in the Kakamega field had been acquired by Lyndhurst Deep Level (Gold and Silver), Ltd.

Belgian Congo.—The accounts of the Union Minière du Haut-Katanga for 1932 show a gross profit of 39,309,713 francs. After adding the balance brought in and making other allowances there was an available total of 156,672,696 francs, which has been applied to the redemption of immobilized capital and other purposes.

Australia.—During 1932 the operations of the Zinc Corporation resulted in a profit of £94,838. After adding £56,887 appropriated for new plant (unexpended) and the sum brought in, there was an available total of £188,088. Of this amount dividends absorbed £71,609 and development and new plant £70,000, leaving £46,479 to be carried forward. The ore treated during the year amounted to 350,000 tons, but development has been such that no reduction is shown in the ore reserves, which at the end of the year amounted to 2,800,000 tons on the lead lode and 249,000 tons on the zinc lode.

At extraordinary meetings of the debenture holders of Mount Isa Mines, Ltd., and of Mining Trust, Ltd., held this month, the sale of Mount Isa Mines, Ltd., to an operating company of the same title in Queensland was approved. The Mining Trust, Ltd., and the American Smelting and Refining Co. have expressed their willingness to defer redemption of their debenture holding for five years and, while the redemption of the remaining debentures will be carried out according to the original plan, holders would be given the opportunity of deferring repayment for five years.

At the general meeting of Great Boulder Proprietary, held last month, a resolution increasing the capital to £250,000 by the creation of 750,000 new 2s. shares was approved. These shares are to be offered to shareholders at 5s. per share and the proceeds will be utilized for the erection of a new plant for the treatment of sulphide ores.

An extraordinary meeting of South Kalgurli will be held following the general meeting this month, when it will be proposed that the capital be reduced by the repayment of 2s. 6d. on each 7s. 6d. share. If this is approved it will be proposed that 200,000 new 5s. shares will be created to increase the capital once again to £150,000.

New Zealand.—The accounts of Consolidated Gold Fields of New Zealand for 1932 show a profit of £16,833, increasing the sum brought in to £30,217, of which £15,625 has been distributed as dividends, equal to 1s. 3d. per share, leaving £14,592 to be carried forward. The report for 1932 of Blackwater Mines, Ltd., in which the company is largely interested, shows a profit of £35,756, giving, with the sum brought in, an available total of £45,749. Of this amount £31,249 has been paid as dividends, equal to 2s. 6d. per share, leaving £14,500 to be carried forward. Blackwater Mines treated 41,402 tons of ore, recovering gold worth £133,852. The ore reserves at the end of the year were estimated to be 75,435 tons, averaging 9·64 dwt.

India.—During 1932 the Indian Copper Corporation made a profit of £14,517, after placing £22,500 to depreciation reserve, £1,100 to debenture redemption reserve, and allowing for expenses on the issue of debentures. With the sum brought in there was an available profit of £20,527, which was carried forward. The company treated 185,894 tons of ore during the year, the refinery output totalling 4,443 tons of refined copper, while 5,440 tons of yellow metal sheet was produced at the rolling mill. At the end of the year the ore reserves were estimated to be 700,466 short tons, averaging 3·05% copper.

Burma.—At an extraordinary meeting of Mawchi Mines, Ltd., held this month, an arrangement with option holders to subscribe in cash for 240,000 shares at 4s. per share and to cancel the option on the remaining 200,000 shares in return for a bonus of 50,000 shares was approved. This arrangement will provide £48,000 working capital for development work.

Korea.—It was announced last month that control of the Chosen Corporation had been acquired by a French Syndicate.

Newfoundland.—Shareholders in the Anglo-Newfoundland Development Company have been informed of arrangements concluded with the Buchans Mining Company for prospecting 1,280 square miles of the country owned by Terra Nova Properties.

Venezuela.—A circular to shareholders of New Goldfields of Venezuela, Ltd., states that with the tramway between the Union mine and the mill at El Peru in operation development at the Peru group will be accelerated. Mr. C. O. Lindberg, who has recently returned from a visit to the mines, reports that deeper exploration promises the discovery of ores similar in tenor to those now developed below datum level.

Panama.—A development report issued by the Panama Corporation (Canada) states that the erection of a treatment plant of a capacity of 30–50 tons a day is proceeding rapidly at the Margaja mine and that production is expected to start in November.

Yugoslavia.—An interest in Kapaonik Mines, Novo Brdo Mines, and Zletovo Mines, controlled by the Canadian Selection Company, has been acquired by the Central Mining and Union Corporation groups.

Spain.—The report of the Esperanza Copper and Sulphur Co. for 1932 shows a profit of £4,860. After allowing for income tax and adding the amount brought in, £29,412 was carried forward. In Spain production was on a reduced scale, while operations in Cyprus were stopped early in the year.

Cornwall.—The report of South Crofty for 1932 records a loss of £7,405, increasing the debit balance to £22,969. Operations were on a reduced scale, 55,338 tons being milled, producing 645 tons of black tin and 133 tons of arsenic.

At an extraordinary meeting of Wheal Reeth Tin, held this month, a proposal to write down the value of the shares from 5s. to 1s. and to restore the capital of the company to £90,000 by the creation of 1,040,000 new 1s. shares was approved. This arrangement has in view the re-opening of the mine.

Derbyshire.—For the year to March 31 last the accounts of Mill Close Mines show a profit of £66,436. After making allowance for depreciation, a dividend distribution equal to 2s. 6d. per share, absorbing £40,230, and adding the sum brought in, there was an available sum of £64,375. A final dividend of 1s. per share has been paid. The mine has been working at full capacity and arrangements have been made for the re-equipment of the Warren Carr shaft with electrical winding gear and ore bins. The production of pig-lead from the works at Lea constituted a record, but difficulties with the furnaces have made it advisable to erect new smelting plant.

Anglo-Persian Oil.—The accounts of the Anglo-Persian Oil Company for 1932 show a profit of £2,379,677, after making full provision for all royalties and taxation due to the Persian Government under the recent settlement. The dividend has been increased by 2½% to 7%.

Tin.—The figures available at the end of June show a reduction of the "visible supplies" amounting to 2,070 tons, while the carry-over in the East declined by 190 tons, making a total reduction of 2,260 tons, following the decrease of over 1,000 tons in May.

THE ROAN ANTELOPE CONCENTRATOR

By J. W. LITTLEFORD

A description of concentrating methods employed by Roan Antelope Copper Mines, Ltd., and an account of the results obtained.

Several articles have appeared from time to time in the mining press concerning the various phases of the development of the Roan Antelope mine and the general design of the surface plant, that by A. G. McGregor, appearing in the MAGAZINE for November, 1930, will be recalled by your readers. The concentrator has now been in operation for nearly two years and the following description of the mill itself and the operating results obtained will doubtless be of general interest.

The ground plan (Fig. 1) indicates the location of the several milling units in relation to the Beatty shaft, which is the main hoisting shaft at present. It will be noted that the coarse and fine crushing departments are very closely connected to the mill proper, making for very close co-operation between these units. The skips from the Beatty shaft discharge directly into the coarse ore bins at the primary crushing plant. The concentrate filtering plant, tailings thickening plant, and tailings dam are located 1,700 ft., 2,500 ft., and 3,500 ft. respectively in a south-easterly direction from the mill. In order to take advantage of cheap transport of concentrates by pumping, the filter plant is located close to the smelter storage bins for flux and charge and reverts. The tailings thickener was so placed as to obtain a gravity flow from the mill and still be adjacent to the dam, thereby making use of only one pumping operation to complete the disposal of tailings.

The ore-bearing series of the Roan Antelope consist of dark grey-green, grey, and sometimes brownish metamorphosed argillaceous shales and sandstones. Sandy partings, stringers of quartz, orthoclase, pegmatite, and seams of calcite are often present. Shale is the principal mineral-bearing rock, while chalcocite, bornite, and chalcopyrite are the chief copper minerals present. The distribution of these is variable. In the eastern zone (that which is now being mined) chalcocite is dominant, whereas in the western area chalcopyrite and bornite predominate. The chalcocite is finely disseminated throughout the rock mass and is rarely discernible with the naked eye.

Outcrop oxidation continues down to the water table (100 ft. to 200 ft.). Below this level it still persists, but in diminishing quantities. The oxides are usually chrysacolla, malachite, cuprite, and melaconite, while native copper and sooty-black manganese oxides (named in order of importance) are also present. The average mill feed assays for the first year of operation are shown in Table 1. The high oxide

TABLE 1.

Total Cu.	Oxide Cu.	SiO_2	Al_2O_3	Fe	S	CaO	MgO	Res.
3·65	0·48	55·82	17·27	2·94	0·86	0·81	4·33	14·32

content of the present mill feed is the result of the mining programme, which calls for stoping the upper (and hence more highly oxidized) levels first.

From the standpoint of crushing and grinding the ore presents few problems. It may be considered as medium-soft, is easily crushed, and causes very little wear on the crusher parts, owing to the preponderance of shale, which is not abrasive. Classification is also simple with present practice and no difficulty is experienced in obtaining a 90% minus 200 mesh product with 28% solids. A complete general flow-sheet giving all pertinent data is shown in Fig. 2. It will be observed from the plan and flow-sheet that, while following generally accepted practice, there are a number of noteworthy features.

Starting with the coarse-crushing plant the ore as received from the mine has all passed 22-in. grizzlies, but, owing to the slabby nature of the rock, individual pieces will at times weigh 500 to 600 lbs. The two 6-chain Ross feeders furnish a very uniform feed and it is seldom necessary to resort to blasting to loosen the rock that has arched over in the bins. Very fine ore, high in moisture, causes some trouble, but is easily loosened with a very small stream of high-pressure water.

These feeders are followed by two 60-in. belt conveyors, which discharge on to two 10 ft. 4 in. by 5 ft. 8 in. 4½-in. grizzlies. The load here reaches a peak of 900 to 1,000 tons per hour per belt, depending on the size of the feed. All rock that has passed the underground grizzlies is handled without further reduction. The life of these belts is short, due to large pieces of rock falling directly on to the belt rather than to ordinary wear. In spite of this, however, it is estimated that good quality belts will carry over 600,000 tons each. The cost of maintenance, which includes the cost of new belts, is less than 0·002d. per ton.

The original grizzlies have been altered to take care of wet ore, which is encountered periodically and formerly caused considerable delay. The changes included spreading the bars at the lower end, to leave a tapered opening between bars toward this end, and mounting the upper end of the grizzly frame on heavy coil springs. The lower end of the frame is hinged. The impact of heavy pieces of rock falling directly over these springs sets up sufficient vibration to clear the grizzly in addition to reducing the terrific shock on the grizzly bars. It is seldom necessary to shut off the feed to clean the grizzlies, whereas with the rigid type with parallel bars this was done several times per hour.

The two 30-in. McCully gyratories, set to crush to $4\frac{1}{2}$ in., have an hourly capacity of 500 to 750 net tons each with an initial feed of 750 to 1,000 tons per hour, depending, of course, on the size and character of the ore. Only one crusher is in operation at a time, the other being held in reserve. Large thin slabs of rock often escape the action of the crushers and are passed on to the Symons plant.

A 42-in. inclined conveyor, 380-ft. centres, takes the combined crusher product and grizzly undersize to the distributing conveyor over the Symons bins. This latter conveyor is equipped with a semi-automatic tripper for the distribution of ore to the different sections of the bin.

The cost of maintenance in the coarse crushing department has been practically nil, apart from No. 1 belt renewals and changes that were made immediately after starting operations.

The plant as a whole operates very efficiently. Two Europeans and three native helpers constitute the operating crew and account for approximately 6,000 tons crushed per 8-hour shift, with ample time for cleaning up, oiling, etc. Cost per ton coarse crushed averages 0·03 shillings, distributed as shown in Table 2.

The flow-sheet of the fine crushing plant is very simple. Ore is delivered from the coarse ore bins to the five Type 60 Hum-mer screens and five $5\frac{1}{2}$-ft. Symons crushers by roll feeders and 24-in. conveyors equipped with magnetic head pulleys. The rate of feed is regulated from the Symons operating floor by remote control to the roll feeders. The Hum-mer screens are set at an angle of 37° and are equipped with $\frac{1}{2}$-in. by $1\frac{1}{4}$-in. mesh wire cloth, which removes approximately 15% of the original feed as undersize. Screens and crushers are in open circuit.

TABLE 2

European labour . .	0·007 shillings per ton.
Native labour . .	0·003 ,, ,, ,,
Power . . .	0·015 ,, ,, ,,
Stores, etc. . . .	0·005 ,, ,, ,,
Total . . .	0·030 shillings per ton.

The Hum-mer screen undersize is of a very clayey nature and carries a large portion of the moisture in the ore. It was necessary to instal an auxiliary conveyor to transfer this material to the cross conveyor under the Symons crushers, as it was found that it would not run in a chute placed at an angle. The moisture contained in the undersize is largely absorbed by the Symons product, making it easy to handle and yet practically free of dust.

The dust created in fine crushing is well handled by the dust control system designed by Mr. Geo. E. Lynch and ably described by him in the December, 1932, number of the *Engineering and Mining Journal*. No further comment will be added here, apart from the fact that no difficulties whatever have originated in the system.

As in the coarse crushing plant, the wear on the crusher wearing parts has been very light and no replacements have been required. The indications are that cone and bowl liners will be good for over 800,000 tons of initial feed to each of the Hum-mer screens, or 680,000 tons net.

All cast-iron chute-liners have been replaced with locally made grid-type liners, in which the ore forms its own wearing surface by filling in the spaces between the grid bars.

TABLE 3

% *Weight Accumulative on each Mesh*

1·5 in.	*0·371 in.*	*10 Mesh.*	*48 Mesh.*	*100 Mesh*	*200 Mesh.*
1·8	57·9	84·0	89·1	90·2	8·7

Table 3 shows a typical screen analysis of mill feed. Sizing tests on this ore are liable to be misleading in that the amount of oversize while appearing excessive is due

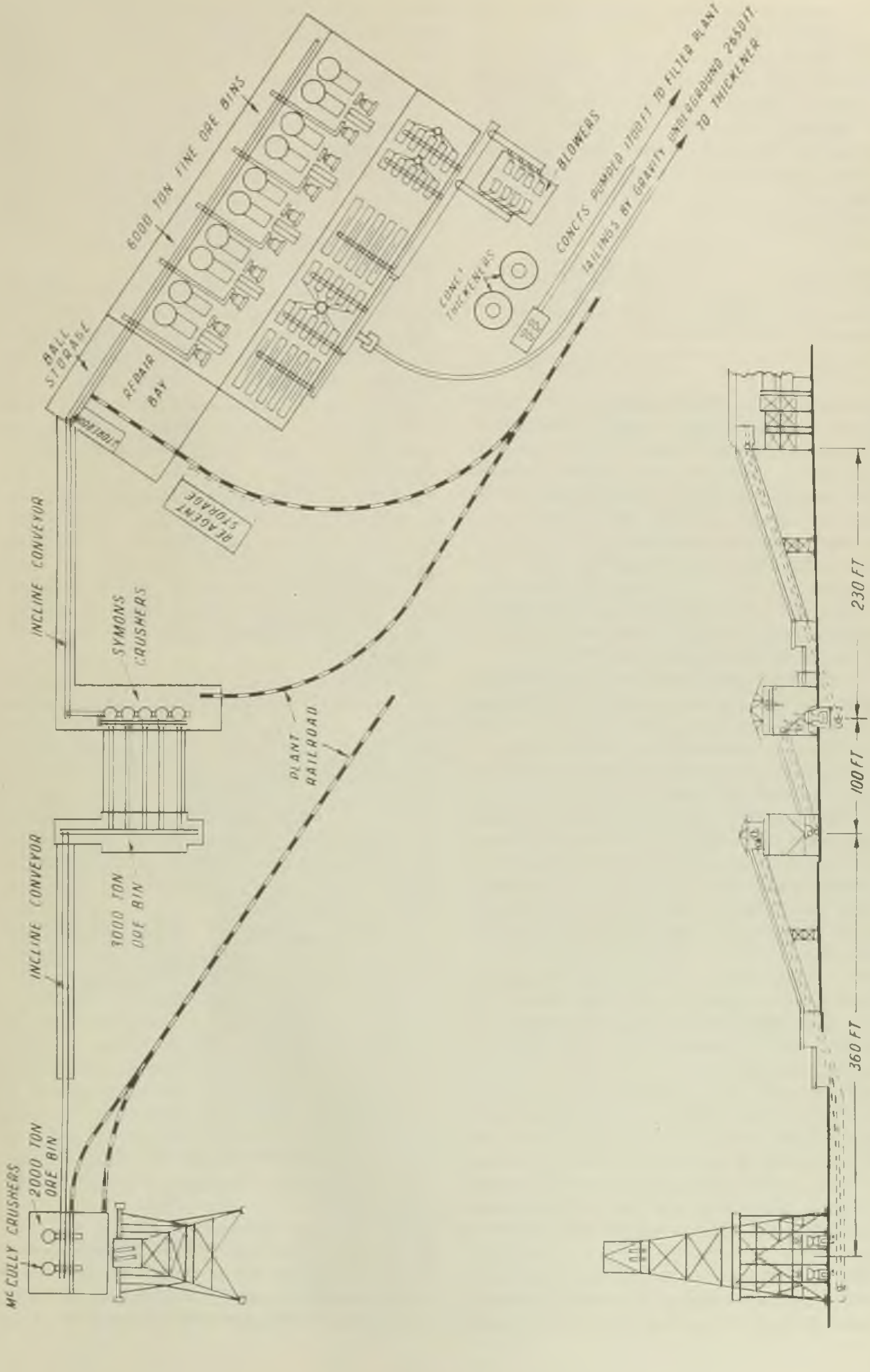


Fig. 1.—Ground Plan of the Roan Antelope Concentrator.

to the fact that a great portion is in the shape of thin slabs.

Two Europeans and nine natives are employed on shift work on this plant. A crusher foreman, one repairman, and four operators comprise the entire coarse and fine crushing European operating force. The cost distribution of coarse and fine crushing and conveying up to the mill bins is shown in Table 4.

TABLE 4

European labour	0·04 shillings per ton.
Native labour	0·01 ,, ,, ,,
Power	0·03 ,, ,, ,,
Maintenance and supplies	0·02 ,, ,, ,,
Total	0·10 shillings per ton.

The mill bin is of the catenary type with capacity of 6,000 tons, which is sufficient for 16 hours' run with two mills per section in operation. Roll feeders driven through worm gear reducers and adjustable as to speed and chute opening deliver mill feed to a cross conveyor which discharges on to an inclined conveyor delivering into the ball-mill scoop-box. The inclined conveyors are equipped with Merrick weightometers. The feed can be held to very uniform rates and variations are seldom over 1%.

The original grinding circuit has undergone several changes, each, however, showing an improvement on the original. The diagrammatic flow-sheets shown in Fig. 3 show the original plan and that at present in use. It will be noted in Fig. 3 that at first both primary and secondary grinding was employed. This proved very satisfactory from a tonnage standpoint and the capacity was finally established at 1,500 to 1,600 tons per day per section at 86% minus 200 mesh grinding. With this tonnage, however, the bowl compartments of the classifier were easily overloaded, resulting in a large amount of oversize in the overflow. To correct this condition the feed was introduced into the rake compartment through a manifold header pipe, the result being practically no load in the bowl. This allowed the speed of the bowl rakes to be reduced from 4 r.p.m. to 2 r.p.m. and the degree of fineness of the overflow increased from 86% minus 200 mesh to 90% minus 200 mesh. Some difficulty was experienced in balancing the load between the primary and secondary mills. It was therefore decided to try out single-stage grinding, the result of this being a record tonnage of 1,100 tons per mill day under ideal conditions and with a monthly average of 1,000 tons per mill day under normal conditions. The tonnage per mill is more or less regulated by the fineness of grinding, which is maintained at 90% through 200 mesh.

Conversion of the existing secondary mills into primary mills is now under way. To make this change it is only necessary to instal a cross conveyor at the head end of the present No. 9 feed conveyor and to furnish a suitable splitter-chute to divide the feed between the two mills.

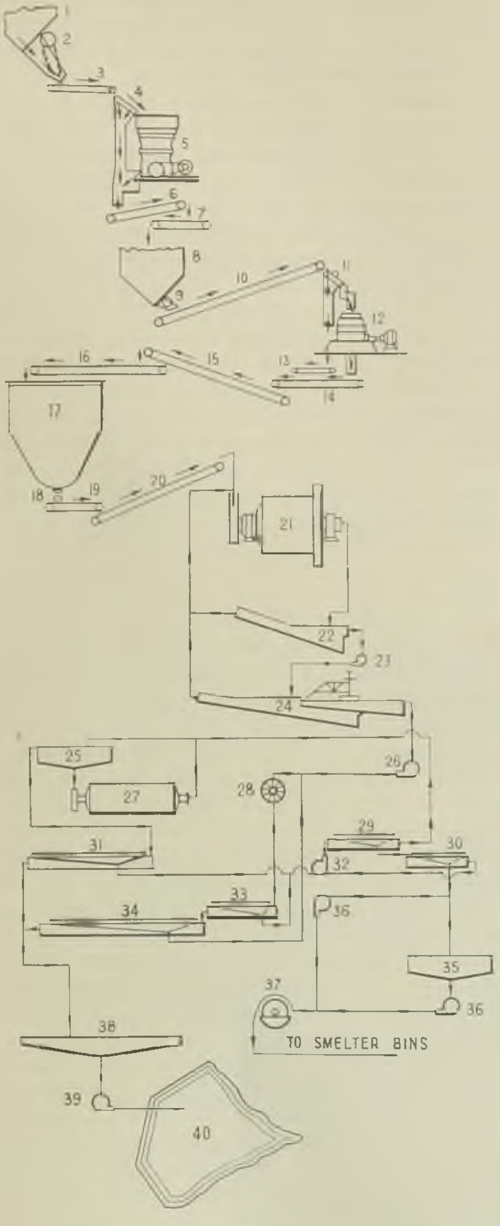
The first of the 12-ft. 4-rake primary classifiers are being divided at the centre to make two separate machines. Gravity flow is obtained from the mill discharge to the classifier and from the sand end of the classifier to the mill scoop-box by simply lowering the classifier 20 in. This at the same time does away with the original scoop lifter.

Section 5, remodelled as outlined, has been in operation four months with an average of 1,986 dry tons per 24 hours. No other major changes will be necessary to step the tonnage up to 9,000 or 10,000 tons per day, which is very nearly double the original rating. The flexibility of smaller units will be apparent.

The indications are that steel consumption will be considerably lowered by operating all mills as primary units. While this is not thoroughly established, it seems reasonable to expect that the primary slime in the feed would have a "lubricating" effect, which is not so with secondary mills grinding classified sands. Figures to date show a total steel consumption of 0·95 lb. of steel per ton ground made up of 0·80 lb. of balls and 0·15 lb. of liner steel.

Increased tonnage from single-stage grinding can be attributed to two factors, the first being the method of feeding the bowl classifiers, which immediately showed a definite improvement in the amount of oversize carried in the overflow, making it possible to increase the tonnage with better classification. Secondly, the sticky nature of the primary slime furnishes the medium which causes a thick coating of pulp to adhere to the balls, which, of course, is ideal. This condition is not easily affected by the pulp density.

The mill-site being practically flat, all return circuits are handled by Wilfley pumps. These pumps are all in duplicate and very few interruptions occur from pump failures. The original estimated life of pump wearing



1. Beatty headframe bins—2,000 tons capacity.
2. Two 6-chain Ross feeders—1¼ r.p.m.—10-h.p. motors through Texrope and reduction gear.
3. Two 60-in. by 16-ft. conveyors—37·5 ft. per minute—5-h.p. motors.
4. Two 6-ft. by 10-ft. grizzlies—4-in. to 3½-in. openings—hinged bottom end—coil springs top end.
5. Two 30-in. superior McCully crushers—180-h.p. motor drive through 14 1½-in. by 1-in. Texropes.
6. One 42-in. belt conveyor (No. 2) 380 ft. long with incline lift of 72 ft.—125-h.p. motor.
7. One 42-in. belt conveyor (No. 3) 109 ft. long with automatic travelling tripper.
8. Symons storage bins—3,000 tons capacity.
9. Five 48-in. drum feeders.
10. Five 24-in. belt conveyors (Nos. 4*A–E*) incline lift of 27 ft.—magnetic head pulleys.
11. Five 4-in. by 6-in. Type 60 Hum-mer screens—V64 vibrator—½-in. by 1¼-in. screen openings at 37°.
12. Five 5½-in. Symons cone crushers direct connected to 150-h.p. motors.
13. One 30-in. collecting conveyor and 30-in. cross conveyor for Hum-mer screen undersize.
14. One 42-in. belt conveyor (No. 5) 85 ft. long.
15. One 42-in. belt conveyor (No. 6) 273 ft. long—incline lift of 75 ft.
16. One 42-in. belt conveyor (No. 7) 375 ft. long with automatic travelling tripper.
17. Fine ore bins—capacity 6,000 tons—1,200 tons per unit.
18. Thirty 18-in. roll feeders—6 feeders per unit.
19. Five 20-in. belt conveyors (No. 8) 46 ft. long—collecting from roll feeders.
20. Five 20-in. belt conveyors (No. 9) 60 ft. long with incline lift of 17 ft.—weightometer on each.
21. Ten No. 98 Marcy ball mills direct connected to 400-h.p. syn. motors.
22. Ten 6-ft. by 20-ft. Dorr circulating classifiers—altered from five 12-ft. by 20-ft. classifiers.
23. Fifteen 6-in. Wilfley sand pumps. Two operating—one spare, for each two mills.
24. Ten Dorr quadruplex bowl classifiers 12 ft. by 32 in. with 18-in. bowls—10- and 5-h.p. motors.
25. One 30-ft. Dorr thickener altered to 6 ft. in height—to classify regrind products.
26. Three 8-in. Wilfley sand pumps. Handling bowl class. Overflow to flotation.
27. One 4-ft. by 12-ft. Fraser and Chalmers ball mill for regrinding.
28. One weir-type flotation feed distributor.
29. Five 22-ft. matless flotation machines—primary cleaners.
30. Five 16-ft. matless flotation machines—secondary cleaners.
31. One 40-ft. matless flotation machine for reground products.
32. Three 4-in. Wilfley sand pumps.
33. Ten 22-ft. matless flotation machines—primary roughers.
34. Ten 60-ft. matless flotation machines—secondary roughers.
35. Two 35-ft. by 10-ft. Dorr concentrate thickeners. Provision made for by-passing.
36. Two 3-in. type "CA" Wilfley pumps—40-h.p. motors—1,700 ft. to filter plant.
37. Three 8-ft. by 8-ft. Oliver filters.
38. One 250-ft. Dorr traction thickener.
39. Four 6-in. Wilfley sand pumps—125-h.p. motors.
40. Tailings dam.

FIG. 2.—GENERAL FLOW-SHEET OF THE ROAN ANTELOPE CONCENTRATOR.

parts handling the relatively coarse primary classifier overflow was three weeks. This has been greatly exceeded and is now fairly well established at three months. Pumps handling the finer products such as flotation feed, concentrates, cleaner tails, etc., have a life undetermined as yet after 21 months of operation.

The ball-mill bay is served by a 90-ton crane capable of lifting a fully-loaded mill. A spare mill with a full charge of balls is kept in reserve, so that it is only necessary to lift out a mill needing repairs and replace it with the spare mill. Approximately six hours are required to make this change. A mill undergoing repairs is placed in a rack fitted with roller trunnions where the mill can be revolved at will and every part reached from the working platform. Relining is a matter of 8 to 10 hours' work. The cost distribution of grinding, classification, and pumping on a basis of 6,000 tons per day is shown in Table 5.

Table 5

6 ball-mill operators—2 per shift	0·03	shillings per ton.
Native labour	0·01	,, ,, ,,
Power	0·31	,, ,, ,,
Grinding material	0·25	,, ,, ,,
Maintenance and supplies	0·06	,, ,, ,,
Total	0·66	,, ,, ,,

Flotation problems may be classed under three separate headings—grinding, oxides, and alumina control. The first of these, having a definite effect on both grade of concentrates and recovery, is the most important. The degree of dissemination of the copper minerals and the softness of the gangue are the controlling factors. Microscopic analyses show that practically 85% of the sulphides lost in the tailings are in the form of chatty material, with grinding at 90% minus 200 mesh. This is true in elutriator products as fine as 800 mesh. In the coarser sizes (over 250 mesh) 95% of the visible sulphides are attached. Finer primary grinding would not seem economical both from the standpoint of costs and lowered capacities for the mills.

Oxides are only of secondary importance at present, as this is only a temporary condition resulting from the mining programme, which calls for mining out the upper levels so that it will not be necessary to return to them at some future time. Increased recoveries can be made by floating part of the oxides. The resulting concentrate, however, would be too low grade to smelt at the present price of copper. Laboratory tests indicate that a saving of two to four pounds of copper per ton can be made by floating a portion of the oxides.

Control of alumina offers a rather difficult problem. Smelting costs increase in proportion to the amounts of alumina in the concentrate. The ideal concentrate for smelting should carry an excess of silica, but, as the gangue (shale) is composed chiefly of silica and alumina, the differentiation is practically impossible. The logical alternative, therefore, is to produce a concentrate with as low an alumina content as possible, which means holding the grade at 58–60% Cu. In making this grade it is necessary to sacrifice recovery to a certain extent, but under present conditions it is economical.

The assays shown in Table 6 will give some idea of the average contents of the Roan concentrates in recent production.

Table 6

Tota Cu.	Ox. Cu.	SiO_2	Al_2O_3	Fe.	S.	CaO	MgO	Res.
58·54	1·09	13·34	4·02	2·97	15·90	0·08	0·70	4·45

The flotation circuit consists of primary and secondary roughers and primary and secondary cleaners. The machines are the pneumatic matless-cell type. The primary roughers are 22 ft. long and the secondaries 60 ft., while the cleaner cells are 22 ft. and 16 ft. respectively. Feed is introduced at the head end of the primary roughers, which make a concentrate that goes to the cleaner circuit and a tailing which goes to the secondary roughers. These produce a secondary concentrate, which is returned to the head of the primary roughers, and a final tailing. The primary rougher concentrates enter the head end of the primary cleaner cells, which make a concentrate and tailing. The concentrates go to the secondary cleaner cells, which make a finished concentrate, with tailings returned to primary cleaner. The primary cleaner tailings are at present going to a bowl classifier, the overflow from which joins the original feed, while the sands are fed direct to the ball-mill with original feed. This is only a temporary expedient at best, pending the installation, now in progress, of a 4½-ft. by 12-ft. mill to regrind cleaner tails. The flotation costs are segregated as shown in Table 7.

Table 7

European labour and salaries	0·04	shillings per ton.
Reagents and royalties	0·18	,, ,, ,,
Low pressure air	0·08	,, ,, ,,
Total	0·30	,, ,, ,,

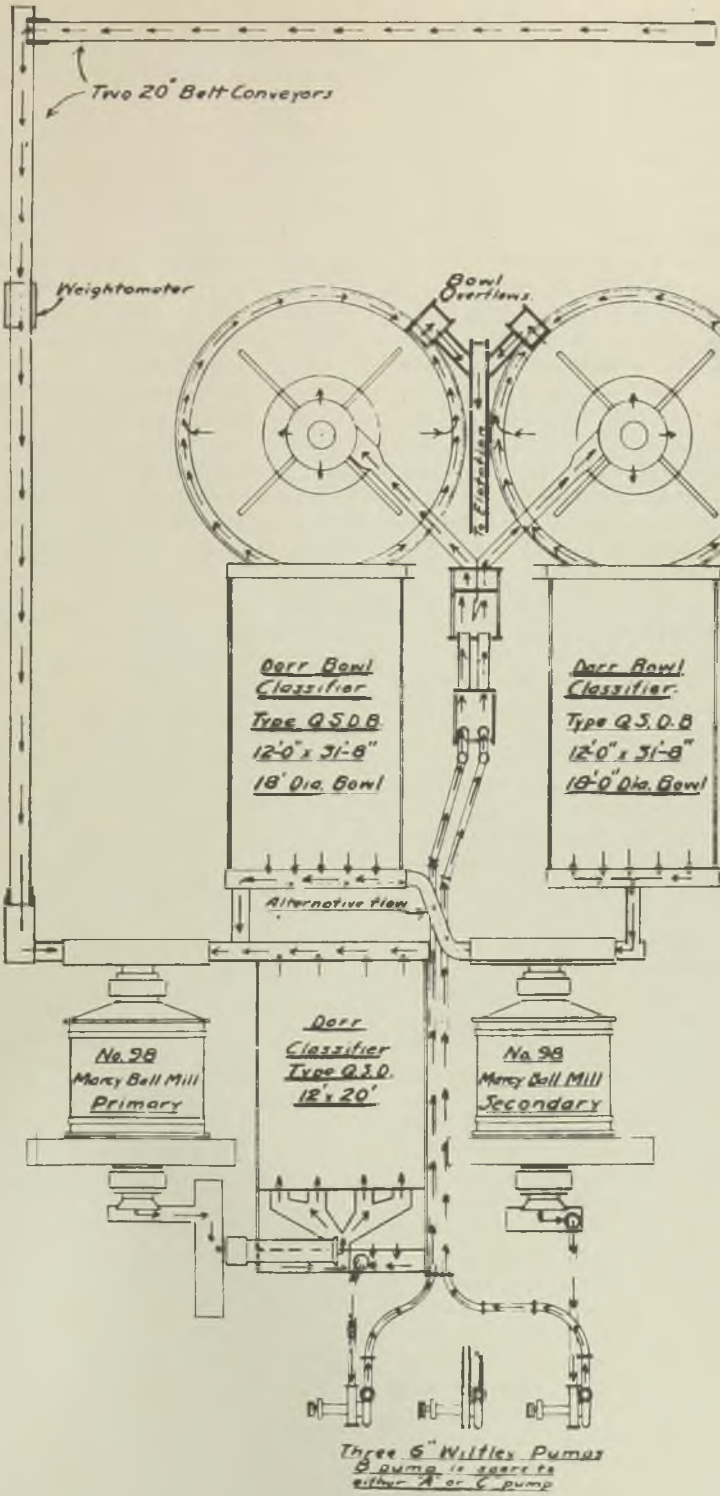


FIG. 3A.—GRINDING UNIT AS ORIGINALLY DESIGNED FOR TWO-STAGE GRINDING.

The regrind unit will consist of a 35-ft. by 6-ft. Dorr thickener speeded up to about one revolution in 1½ minute, with the underflow going to the above 4½-ft. by 12-ft. mill. The overflow from the thickener will go to a separate flotation circuit making finished concentrates and tailings. All middling products will form a circulating load with the regrind unit.

Wet samples are taken automatically by Geary Jennings electric samplers. Shift samples are filtered and dried by flotation operators, while cutting down and further handling is done by a native helper under the supervision of the testing engineer. Moisture samples on mill feed are taken by the ball-mill operators and dried to constant weight in a specially-built, heat-controlled Westinghouse electric oven. Control check samples on feed concentrates and tailings are taken over 24-hour periods and are only handled by the testing engineer.

Reagents are stored and handled in a separate building equipped with off-loading platform, overhead conveyor system, and storage tanks. Mixing vats for chemical reagents are placed immediately above pressure tanks, from where the solution is forced under air pressure to the mill reagent feeders through 1½-in. pipelines. Oils are handled by the same means. Railway service tracks enter the mill at the repair bay, where the 90-ton and a 10-ton crane are available for the off-loading of balls, liners, and other supplies.

Finished concentrates are at present thickened in two 35-ft. by 10-ft. Dorr thickeners. The overflow water is returned to the mill circuit by gravity, while the thickened concentrates at 30% moisture are pumped 1,700 ft. to three stock tanks or direct to 8-ft by 8-ft. Oliver filters. Special Wilfley-type C.A. heavy-duty 3-in. pumps are used for this work. The pumping of concentrates is not a continuous operation and some difficulty was experienced with the pipeline choking if not thoroughly blown out with compressed air after each shut down.

Successful tests have just been completed in filtering concentrates direct from the flotation machines. This will simplify another stage of operations, as it will be possible to short-circuit the present concentrate thickener plant. These tanks will be used as stand-by storage. Concentrate handling costs are 0·02 shillings per ton equally divided between labour and electric power.

The concentrate filter plant as mentioned is situated 1,700 ft. from the mill. Three 8-ft. by 8-ft. Oliver filters, three 18-in. by 9-in. Worthington vacuum pumps, two 12-in. by 9-in. Worthington compressors, and three mechanically-agitated stock tanks comprise the principal machinery of this plant. A series of three 20-in. conveyors deliver the filtered concentrates to three stock bins, each equipped with belt feeders discharging on to an inclined conveyor, which, in turn, discharges into a specially-built weigh-hopper, where the product is weighed in before going to the smelter stock bins.

The only outstanding feature of the filtering operation is the speed at which the filters are run. It was found on starting up that the filter cake had a tendency to build up too rapidly and break away from the drum at the point where it leaves the pulp in the tank. Various dilutions were tried, but with only nominal success. The filter was then speeded up from one revolution in four minutes to one in one-and-a-half minute. The thickness of the cake was reduced from 2½ in. to a maximum of 1 to 1¼ in., with no difference in the moisture content. One filter operating a total of 16 hours is now able to take care of the entire present mill production of 275 tons of concentrates per day. Filtering costs are 0·01 shillings per ton, largely represented by operating labour.

Tailings flow by gravity through 2,500 ft. of 18-in. Victaulic steel pipe to a 250-ft. Dorr traction thickener. The clear water overflow is returned to the mill circuit with sufficient mine water added to make up for losses. Mine water, which is slightly alkaline with a pH value of 8·1, is added to the thickener and serves to dilute the tailings so that settling is more rapid and a clear overflow is obtained.

The thickened tailings (55% solids) are pumped to the tailings-dam launder system by 6-in. high-pressure Wilfley pumps. There are four of these pumps installed, each being capable of delivering 6,000 tons per day through 12 in. steel pipe extending the length of the dam and the emergency dam, a total of 7,000 ft. The uptake pipes are spaced at 800-ft. intervals on the main dam and at 500 ft. on the emergency dam. Dam building is a comparatively simple matter after a toe-wall is established.

The original method of distributing tailings was by means of a wooden launder system extending the length of the dam and about 50 ft. inside the toe. Two inch down pipes

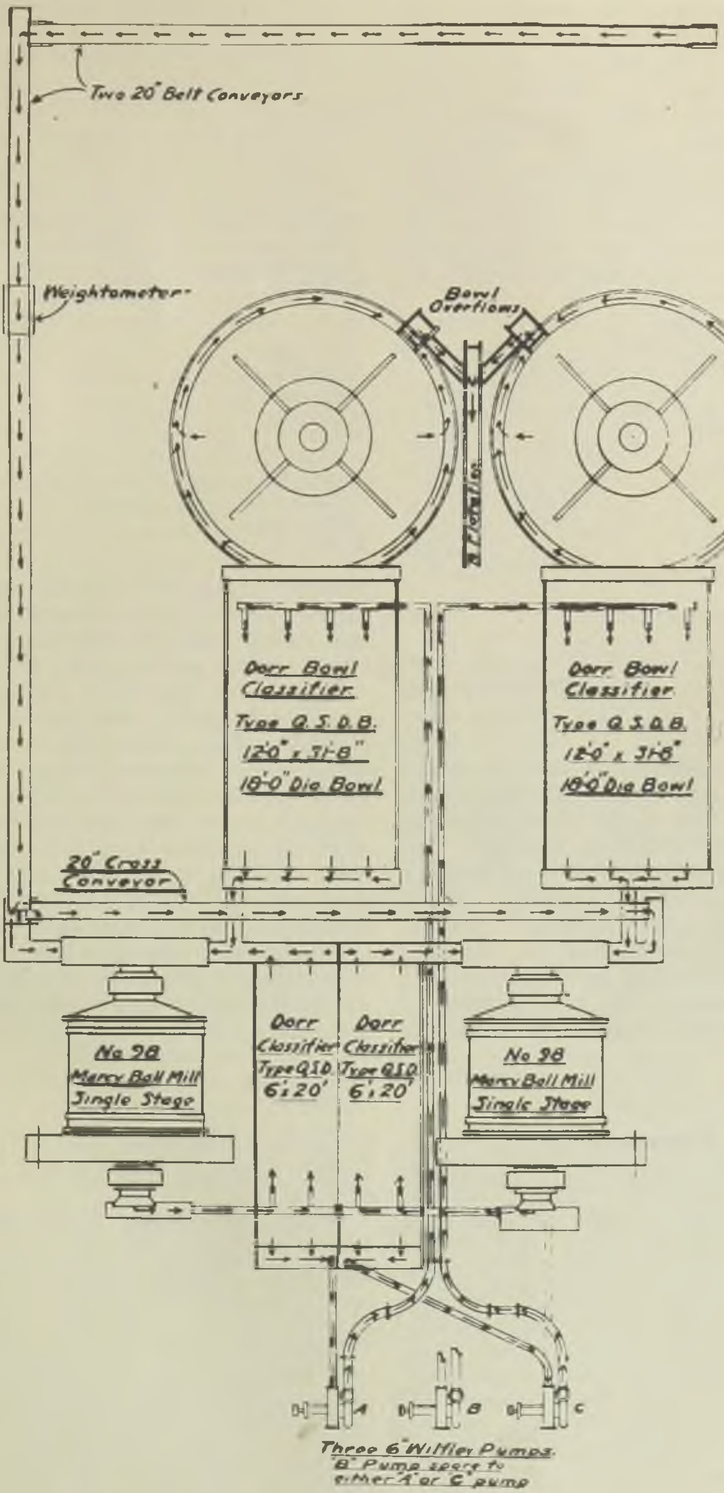


FIG. 3B.—GRINDING UNIT AS ALTERED FOR SINGLE-STAGE GRINDING.

carried thickened tailings to the toe-wall. The toe-wall is kept up by natives each with an allotted task of 20 yards of wall, 2 ft. high, per day. This method of working calls for a minimum of supervision and at the same time is not a difficult task for the boys, as they are generally finished in five to six hours. This method of working native labour has proved very satisfactory, both from the native's point of view and the employer's, but can only be used on routine work of this character.

TABLE 8

Concentrating Costs per ton of Ore Milled.

	Shillings.
Crushing, Conveying, and Screening	0·10
Grinding and Classifying	0·66
Flotation	0·30
Concentrate Handling	0·02
Filtering	0·01
Tailings Disposal	0·05
Assaying and Sampling	0·01
Mill Water	0·01
General Concentrator Expenses	0·09
Total Concentrating Costs	1·25

To overcome the erosion of the dam wall, caused by the heavy rainfall (50 to 60 in. per year), a system of thatching is being tried with apparent success. A layer of long-stemmed grass such as that used in native hut building is laid the length of the wall being built, the tops of the grass projecting outward about two feet from the wall. The new wall is then built on this layer of grass making a thatch-like covering which practically stops all erosion. Serious difficulties were anticipated in building a dam of material as fine as 90% minus 200 mesh. This, however, was not the case, as it has been found that the wall stands perfectly at, say, 30° from vertical. Tailings disposal costs amount to 0·05 shillings per ton milled and are distributed between labour, power, and supplies.

FIG. 4.

Concentrator Superintendent and Assistant.

General Mill Foreman

Operation — *Repairs*

Accounting and Metallurgy
1 Testing Engineer
2 Natives

Crushing Plant
1 Foreman
4 Operators
15 Natives

3 Repairmen
1 Craneman
1 Utility Man
20 Natives

Mill
2 Shift Bosses
18 Operators
40 Natives

Tailings Disposal
1 Foreman
2 Operators
30 Natives

In general, with ores averaging 3·70% total copper and 0·50% oxide copper, the Roan Antelope concentrator will produce a concentrate of 58·00% copper representing 75·00% total recovery and 85·00% sulphide copper recovery, with a ratio of concentration of 21·00 tons into one. General costs on a basis of the previously noted total of approximately 6,000 tons per day are summarized by processes in Table 8.

Concentrator operations are conducted with a crew of 37 Europeans and 110 natives. An organization flow-sheet of personnel is shown in Fig. 4.

Diesel Rail Transport.—Mr. C. J. H. Trutch lectured before the Oil Industries Club on June 13 on Diesel railway traction, which he considered would in due time replace that by steam. While there was a good case for track electrification in dense urban and suburban districts, the lecturer felt that this did not cover main and subsidiary lines, in this country at any rate. With reference to the transmission of power from the Diesel engine prime mover, Mr. Trutch spoke in favour of electric motors, although he indicated the future possibility of some form of perfected hydraulic drive replacing the electric motor in certain instances, and gave particulars of th[e] various types of Diesel-electric locomotiv[es] now in use.

World Petroleum Congress.—At the World Petroleum Congress, which is being held at the Imperial College, South Kensington, from July 19 to July 25 under the auspices of the Institution of Petroleum Technologists, sections before which papers will be presented and discussed include geological, production, refining and chemical engineering, and standardization. In the geological section there are to be a series of papers on geophysics, on aeroplane reconnaissance, and on field methods.

SEKENKE GOLD MINE, TANGANYIKA TERRITORY

By JOHN P. BOLT, A.R.S.M., B.Sc., A.I.M.M.

The author describes the largest gold producer in East Africa, a mine originally worked by the Germans, but now owned by the Tanganyika Central Gold Mines, Ltd.

Recent discoveries of gold in Kenya have focused some attention on the possibilities of East Africa as a gold producer. The author presents a description of the Sekenke mine which, although it is still a relatively small producer, yet boasts the title of East Africa's biggest gold mine and shows promising signs of a greater future.

The mine is something like 150 miles south-east of Mwanza, the port at the southern end of Lake Victoria, and is situated on a low ridge rising from the Wembere Steppe, a vast plain at an altitude of 3,500 ft. above sea-level. This plain extends for over 100 miles from north to south and about the same distance from east to west at the northern end. Like other plains in Central Africa it has no outlet to the ocean, but drains north-eastward into Lake Eyasi, one of the salt lakes west of the main branch of the Great Rift valley. To the east the plain meets the Iramba Plateau in a steep scarp, 1,000 ft. high, which is believed to be a downthrow fault. It is on this plateau that massive kimberlite pipes, the largest in the world, are reported to have been located, but so far as is yet known these are unfortunately barren. Gold also occurs on the plateau, but the reefs so far worked have proved to be faulted and disturbed, rendering development difficult. The Shinyanga district, which has been responsible for Tanganyika's diamond output and still is a small producer, lies 100 miles to the west.

The subject of location raises an interesting question for geologists as to what significance, if any, should be attached to the fact that the present known gold occurrences of East Africa are ranged in a chain which seems to follow roughly the west wall of the main branch of the rift valley from the Eastern Sudan in the north, through Eritrea and Western Abyssinia to the newly-discovered Kakamega goldfield and Lolgorien in Kenya, on into Tanganyika *viâ* the Speke Gulf or Musoma district, then Sekenke, and finally the Lupa district, north of Lake Nyasa.

The ridge on which the Sekenke mine is situated consists of a diorite complex, with various granodioritic intrusions and more recent dolerite dykes. The older rocks may be pre-Cambrian with, of course, younger intrusives, but, pending a detailed geological study, no concise correlation can be attempted. The surface is covered with water-worn gravel, probably lake deposits, and these in places are again covered by younger flows of rhyolite tuffs which, where they have invaded the gravel beds, have somewhat casually been termed conglomerates. It is of

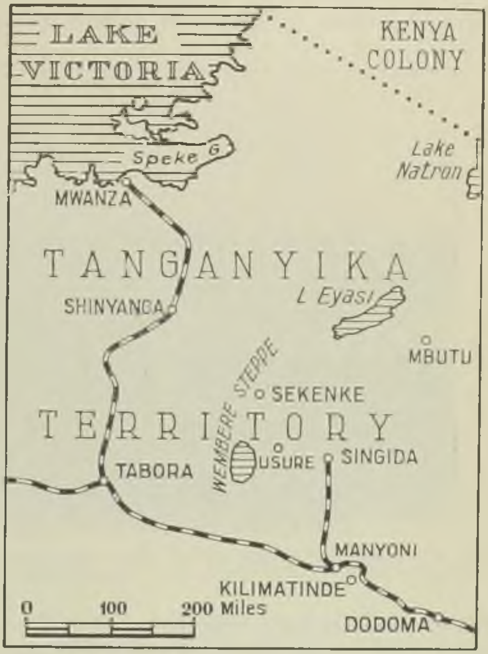


FIG. 1.—SKETCH MAP, SHOWING POSITION OF THE SEKENKE MINE WITH RESPECT TO THE RAILWAY AND LAKE VICTORIA.

interest that Dr. Grantham's description [1] of the geology of the Lupa goldfields mentions a series of geological phenomena apparently resembling those which obtain at Sekenke.

The main mine is on the Dernberg reef, a true fissure vein, which outcrops continuously along the strike for over 1,500 ft. and has been opened up to the fourth level, about 320 ft. below the surface. The reef is approximately vertical and varies in width from a stringer to over 15 ft. and comprises two well-defined pay-shoots, each several

[1] *Bulletin* No. 3. Geological Survey Department, Tanganyika Territory.

hundred feet long, lenticular in shape, and averaging a little under an ounce of gold per ton. The values are not evenly disseminated and individual samples and short runs of ore assaying several ounces to the ton are encountered, alternating with lower-grade ore carrying only a few pennyweights per ton. The quartz is highly mineralized, carrying in places an appreciable percentage of pyrites, some crystals of which enclose specks of native gold easily visible to the naked eye. Galena is occasionally met with and often indicates a high gold content, whilst traces of chalcopyrite occur less frequently. Near the surface some masses of chalcedony were found, occupying cracks both along the walls of the lode and in the quartz. The gold varies from very fine flour gold to quite coarse particles, even small nuggets weighing several pennyweights having been found in the mortar-boxes of the stamp mill. The wall rocks are very much altered, some places showing the development of coarse crystals of secondary pyrite, but carrying no gold, others exhibiting intense alteration and shearing and carrying some gold. To the south-west is a branch lode, which appears to be converging on the main lode in depth. In pre-war days it contributed a considerable tonnage of good ore to the mill and development now in progress is revealing good ore, which suggests that the hopes of enrichment at the junction with the main reef will be realized.

In the northern ore-shoot a large blow of low-grade quartz, over 20 ft. wide, occurs in the west wall of the reef. It is possible that this may prove to be a fold, a fairly common feature in deposits of this type. Further north along the strike occur several smaller lenses, some carrying good values, but so far these have not been developed to any depth. Little evidence of post-mineralization faulting is shown, except, perhaps, for two small unimportant faults cutting obliquely across the south-west branch lode and one of the smaller northern lenses. Several old shafts have been sunk on the lode, the present main shaft being a three-compartment one put down east of the reef to replace the pre-war one destroyed by fire in 1930. To the south is a gap of 3,000 ft., in which surface prospecting has revealed no ore occurrence, and then a small run of ore, known as Shaft V, is encountered. It was followed down about 100 ft. by the Germans and supplied some good ore to the mill. Further south, after a similar gap of nearly one mile, is Shaft VI, sunk on another small but very rich shoot. This also supplied the German company with some valuable ore and is being developed by the present company.

Fig. 2.—Looking North along the Dernberg Reef. No. 4 Shaft is in the foreground and No. 3 (burnt out) beyond.

Both east and west of the main reef are smaller parallel reefs, of which many contributed their quota to the mill in pre-war days. About 300 ft. west of the main reef is a massive parallel reef known as the Pyritic reef. It is about 10 ft. in width and the outcrop carries low values varying from a trace to 2 dwt. On the east the most important of the lesser reefs are the Parallel and Augusta reefs, both of which contain payable ore. Further east again, about half a mile from the main reef, are some massive occurrences of bluish barren quartz, whilst about a mile from the main reef a prominent quartz outcrop, 30 ft. or more wide and several hundred feet long, protrudes from the plain. This apparently bears some resemblance to the Razor Back quartz hills of the Lupa goldfield, except that so far it has proved devoid of values.

Strewn about the property is much float granite which seems to differ from the local outcrops and has probably been carried in early geological times from the south, where there are much larger granite outcrops. The Wembere Plain has a number of salt-pans and quite close to the mine is a small soda-pool, much appreciated by the natives for laundry purposes, whilst another mineral exploited by the natives is a kind of Fuller's Earth which they use to paint themselves with in accordance with certain religious and tribal customs.

The Sekenke mine is said to have been discovered in about 1906 by a German expedition, which, whilst employed in investigating the gold occurrences of the Iramba Plateau, instructed the natives to show them any similar rocks from the surrounding country with the result that they were shown the Sekenke outcrops. There is no evidence of native workings or that any alluvial gold has been worked, although the bottom of the Kironda River, which skirts the property, may carry some values.

A Berlin company commenced operations in about 1911 and by 1914 had extracted gold to the value of £250,000. The first plant was transported *via* the Kenya Railway and Lake Victoria to Mwanza and then by ox wagons across the Wembere Plain. It is interesting to record that this plant was a British one by Bowes, Scott, and Western and comprised ten 850-lb. stamps and a 40-h.p. steam engine with a battery of three 15-h.p. horizontal fire-tube colonial boilers. Later the mill was increased by the addition of fifteen 1,000-lb. stamps and a larger power plant, this time, however, a 135-h.p. loco-type boiler and engine by Wolf. A simple sand-cyaniding plant, consisting of seven 28-ton tanks, extractor boxes, and the usual accessories, was also added. The boiler fuel is African hardwood of the acacia variety, of which there is a good supply on the ridge, but not on the plain. Box and plate amalgamation was practised, only the sands being cyanided. Corduroy strakes below the amalgamating table have been tried, but very little gold was recovered from the concentrates, although the removal of the sulphides had a beneficial effect on cyanide consumption. At first it was necessary to pump water from the Kironda River, which forms the southern boundary of the concession. As mining reached greater depths the influx of sufficient water for milling purposes was welcomed and with the extension of the workings an even larger volume is being handled. The mine water is very brackish, carrying various dissolved salts which act as protective alkali in cyaniding, but render it unsuitable for drinking and troublesome for boiler feed.

FIG. 3.—VIEW OVER THE WEMBERE STEPPE. SEKENKE RIDGE IS IN THE MIDDLE BACKGROUND, WITH THE IRAMBA SCARP BEYOND.

From 1914 to 1916 the gold produced

was sold to the German administration in Tabora and 15 rupee pieces were minted there. In 1916, when the district was occupied by the British, the three remaining German employees were interned and the mine was abandoned. In 1923 Mr. Paul Buttler acquired the property, comprising freehold and mining rights over 5 square miles, from the Custodian of Enemy Property. He worked it himself till 1927, when he sold it to the Sekenke Gold Mining Company, registered in Johannesburg with a capital of £150,000. In 1928 the name was changed to the Tanganyika Central Gold Mines, Limited. At the outset the company experienced various vicissitudes, including troubles with wood-fired boilers, steam mine pumps, transport difficulties in the rainy season—November to May—a famine from crop failure in 1929, and complete isolation by floods in 1930, followed by a mine fire in the same year. Sekenke is about 30 miles from Ussure, famous for man-eating lions, and a serious situation arose when a lion took a boy from the fuel-cutting camp, about 9 miles from the mine. This in itself was serious enough, but the situation was rendered more difficult by the failure to kill the marauder, which twice escaped from the usual traps laid for it. The native mind immediately attributed it to the supernatural and no fuel cutters would work in the bush till the beast was eventually dispatched at night by the expedient of training the headlights of a car on a kill, switching them on when the beast approached, and shooting it.

The installation of two Robey 110 h.p. horizontal twin-cylinder heavy-oil engines has solved the power problem and electrically-driven centrifugal and piston pumps have overcome the water difficulty, whilst the distance of 150 miles from railhead has been halved by the completion of the Government branch railway from Manyoni on the Central line to Singida, 74 miles from the mine. This branch line will continue to Kinyangere, whence an all-weather road is projected to the mine, a distance of 40 miles. The Government, in furtherance of its policy of fostering the gold-mining industry, has facilitated the work in every way, recently improving the road to railhead. The building of a stone and corrugated-iron native compound has now attracted ample labour and famine difficulties are guarded against by the purchase and storage of sufficient corn at harvest time for the whole year. The surrounding country is exceedingly fertile, producing excellent corn and supporting large herds of native cattle, whilst the country abounds in all sorts of game. Although numerically there is ample labour, the agricultural richness of the district removes the necessity to work and it is therefore difficult to secure regular attendance. During the slump, however, Nyasa boys, who are more suitable than the local labour, have presented themselves for work after walking 600 miles from their homes.

Fig. 4.—Motor Cars in the Dry Bed of the Kironda River.

The ore presents no metallurgical difficulties and even in the present simple plant a 90% extraction and over is obtained without difficulty. Although until regular working was attained the limited stoping faces gave for some individual months a mill return of over an ounce per ton, a fair average return is expected to be about 13 dwt. The present plant has a capacity of about 1,800 tons per month, using 800 screen, and the output is now approaching this tonnage. The possible increase of ore supply by the present accelerated development combined with the increased price of gold are factors which may well make finer grinding and improved metallurgical methods profitable and this matter is now receiving attention. The fineness of the mill gold is about 860, the cyanide bullion being, of course, more base.

Only recently has regular running and normal output been reached, so that no precise estimate of costs can be given. They are of the order of 30s. per ton, almost equally divided between European supervision, native labour, and stores. Of these items perhaps the heaviest individual one is oil fuel, which costs approximately £15 per ton at the mine. Even so, the unsuitability both of the local labour and the mine water for steam boilers enables the oil engine to compete with them on favourable terms, both as regards cost and reliability, although some of the old steam plant is still used in the development of the outlying reefs. The modernized equipment will, it is hoped, materially reduce costs and make it possible to mine the lower-grade ore available outside the main ore-shoots.

The various unforeseen difficulties, which here, as with almost every gold mine, have so retarded the initial progress having now been overcome, there seems every assurance of a prosperous future. The bullion produced can now be shipped to London in eight days by Imperial Airways Service from Dodoma, which is only one day's journey from the mine. Still more beneficial is this service for mails, which brings the mine within ten days of London as compared with 30 days by rail and boat. The open plain round the mine would furnish an ideal landing ground for aeroplanes when occasion arises. The present general manager at the mine is Mr. T. H. Bayldon, who is also consulting engineer to the company.

In conclusion the author wishes to thank Tanganyika Central Gold Mines, Ltd., for their permission to publish this article and for supplying the latest information from the mine.

GOLD IN BRITISH COLUMBIA

By H. G. NICHOLS, A.R.S.M., M.I.M.M.

The author reviews the effect of recent developments on calculations as to the life of lode-gold mines in the Province.

The production of gold from essentially base-metal ores has never figured prominently in the annals of the gold-mining industry of British Columbia and for that reason the world-wide influences by which base-metal mining has been affected cannot be charged directly with being of any material significance to the Province's gold output. Indirectly, however, by tending to focus attention upon the comparative attraction of gold-mining enterprise, the depression that has rested so heavily upon copper, lead, and zinc mining activities has resulted in enhancing the prospects for gold production.

It has not always been the case that gold prospects in the Province were related primarily to resources of the gold-silver type of mineralization or to fissure vein deposits. At former periods the gold supply of British Columbia was identified with copper-gold ore-bodies and with replacement occurrences, but, while possibilities in this field may not be exhausted, attention has been directed in recent years to the gold-quartz veins that are related in a marked degree to the areal distribution of the placer deposits that were responsible for the first chapters in the history of British Columbia as a mineral province.

The lode-gold production of British Columbia swung into its stride with the commencement of the century and it is a notable fact that the value of the annual production ever since has varied but little from the average for 33 years—namely, \$4,076,576. It may be noted also, as a coincidence, that the maximum recorded value of placer gold production—for the year 1863—was of practically the same value. Strictly speaking the statement in regard to the uniformity of the production of lode-gold is to be qualified to the extent that there is an extreme variation as between the minimum and maximum productions during a limited number of unusual years, amounting to about 80% of the average, but a perusal of the statistics is sufficient to establish the exceptional character of these fluctuations and the statement may be accepted as a general measure of the existing potentiality of the Province in the field of lode-gold production. In regard to placer gold it is to be recorded that no exception is evidenced to the rate of exhaustion of known occurrences that is representative of this branch of mining and the value of the annual production has fluctuated around $300,000 for the past 15 years.

Observing that an upward tendency is featured in the present rate of production, it may be assumed that we have a fair index of the existing potentiality of gold production and it may be interesting to inquire as to the rating of the Province in the world-scale and as to the relation that exists between the present status and future possibilities. These two factors are of supreme importance in estimating the degree of attraction to investment that is represented by the gold situation in British Columbia.

In regard to the first aspect of the case due credit is to be given to the fact that British Columbia ranks third among the provinces of the Dominion, which occupies second place in the gold production of the world. In point of fact the gold production of British Columbia represents about 6·5% of that of the whole of Canada and the Dominion contributes about 14% of the world's supply. On the score, therefore, of producing less than 1% of the world's supply of gold and quite apart from considerations involved with the second phase of the inquiry it is to be conceded that no marked prominence is to be attached to the western province as a lure to investment in its gold-mining industry.

Passing on to the consideration of factors bearing upon the future possibilities the sequence of discoveries by which production has been maintained in the past has been described in official reports. In these accounts there is to be found evidence of response to exploration that has been rendered possible by improved means for opening up the country and this feature is of no small moment in mountainous regions. The variety of the types of mineralization is also apparent, as is the genetic relationship of almost all the known occurrences. A generalization of greater weight is in connexion with the limit of persistence in depth of the gold deposits. In publication No. 10 of the Economic Geology Series of the Geological Survey of Canada H. C. Cooke has cited the fact that most of the large ore-bodies of British Columbia have been found to be worthless at comparatively shallow depths and tentatively attributes the cause to the relatively insignificant depth at which these ore-bodies of Mesozoic age were formed. This factor is evidently of great significance as affecting future prospects that are dependent, basically, upon the two elements of areal distribution and depth persistence. (In passing it is but proper to observe that the publication in question is submitted as a summary and that the data and conclusions therein presented may be supplemented and modified in the detailed report, of which it is the forerunner.) The point is of particular importance also as affecting the quality of investment, whether it is to be directed towards areal investigation or to the development of individual occurrences. The grounds, therefore, upon which the applicability of the generalization in regard to depth depends are deserving of consideration. In an analysis of the evidence of limitation of ore-bodies in the Cordilleran belt to a depth of about 1,900 ft. it is apparent that the tentative explanation of zoning due to relatively near-surface conditions of formation confines the argument to ore deposition of a certain period or periods and this limitation is understood as being in relation to the Mesozoic intrusions of the Coast-Range batholithic rocks. A further point may be raised as to the degree of proof of exhaustion of the ore deposits that have been accepted as examples and a third suggestion occurs in connexion with the unproved possibilities of ore-bodies of Mesozoic age in which no evidence of zoning may have been noted and that do not appear to owe their localization to some particular lithological or structural features. There are thus three points to be considered — (*a*) exceptions to the genetic relationship, (*b*) evidence of premature abandonment, and (*c*) live possibilities of deep development.

In relation to the third subdivision of the inquiry we are dealing with possibilities that lie outside the scope of the generalization, which is based upon the past record. Considerations are limited further to exclude all such ore deposits as, from the localized conditions affecting their occurrence, are clearly not comparable with deep-seated veins in other countries or of another age. The Bridge River veins are selected as types. According to former geological reports these veins are characterized by lack of variation, compatible with the suggestion of zoning, in their mineralization and have been described as indicating opportunity for profitable mining to the limit of the depth to which the host rock persists. As this rock was identified with a late augite-diorite phase of the Coast-Range batholith it is apparent that a generous interpretation might be given to this allowance. The greatest depth yet attained is about 1,600 ft. on the Pioneer vein and no important change either in the characteristic sharply-defined fissuring or in the mineralization has been noticed. There is, of course, some distance yet to be explored before the record depth is reached. The picture that is presented of gold-quartz veins of an average uniform degree of mineralization in sharply-defined fissures in a homogeneous stock of intrusive rock is favourable to the conception of persistence related to deep-seated origin. Recent geological research, however, has resulted in casting some doubt upon the identity of the host rock as an integral stock and the suggestion is conveyed of a variably-digested mass of rocks of volcanic and sedimentary origin that have been intruded by more dyke-like bodies of the augite-diorite. Economic sections of the veins are confined more or less to areas of the greatest degree of alteration, approaching the original intrusive in texture. Under the latter interpretation of the conditions there would be less assurance of persistence and as at present no definite forecast may be made. On the score, therefore, of current possibilities connected with ore-bodies within the scope of the common genetic relationship no positive argument may be advanced against the previously expressed generalization.

In regard to premature abandonment of mines there is much to be said and in the present tendency towards the re-opening of old properties and in the renewed activities that are centred around old mining camps there is abundant evidence of a belief that ultimate possibilities were not exhausted in the earlier days of mining. A notable example is to be found in the case of the Sheep Creek camp and in the Nelson district generally. Recent work in the Sheep Creek camp has opened up a wide field of exploration by proving a valuable primary content in veins that were formerly thought to be unprofitable below a zone of secondary enrichment. The depth to which these veins may carry may, or may not, constitute a challenge to the record of persistence, but the fact of the discovery furnishes a telling commentary upon the exhaustiveness of earlier investigation. There are numerous other instances of new work at old mines, but beyond evidencing incompleteness of the cited record no more definite conclusions may be adduced having a direct bearing upon the question of depth. This phase of activity will be referred to later.

Coming to the question of exceptions to the general rule of genetic relationship we approach a subject of potentially dominating importance to the main issue. It is significant of the suddenness with which the gold-quartz possibilities of the Cariboo district have claimed serious recognition that no mention is made of this area in the geological summary that has been quoted. The lode-gold deposits of the Barkerville area occur in pre-Cambrian formation and their origin has been referred to the same period. The veins, therefore, are immune from the strictures that have been imposed with general application to the Mesozoic mineralization of the Province. A comprehensive outline of these occurrences is to be found in the geological memoir by Johnston and Uglow and it will suffice for the purpose of these notes to mention the following views from the late Dr. W. L. Uglow's report. The series of discontinuous "A" veins occupy compression fractures and zones of close folding and shearing, developed during the formation of a main anticlinal structure. These veins consist of large bodies of almost barren white quartz, with a prominent cross-vein jointing. The "B" veins occupy cross-range fissures and faults of subsequent development and in many cases occur in closely-spaced parallel groups cutting across the foliation and the "A" veins. Shoots of sulphide minerals are observed to occur in veins of the "A" type where they are intersectioned by a number of "B" veins, carrying metallic minerals. The shoots are, therefore, strung out intermittently along the belts of "A" veins where the "B" vein fissures intersect them. The "B" veins are quite continuous and although well mineralized the localization of ore-shoots at intersections is represented as being characteristic of their economic importance, though to a lesser degree than in the case of the belts of "A" veins. The recent interest in the area has been inspired by the results obtained in the driving of a tunnel to a distance of 1,500 ft., attaining a depth of 500 ft. below surface, in which nine "B" veins were encountered, of good average width and value. This performance is considered, rightly, to afford encouragement to the prospect of developing commercial ore at depth, but, in view of the fact that the tunnel has been driven along the line of strike of a belt of "A" veins, it would be premature to assume that the economic values encountered are representative of the "B" veins in general. This aspect of the case is stressed in a recent pronouncement upon the activities of the company, in which it is stated that tonnage rather than high values is relied upon for commercial success and it is indicated that such tonnage is to be sought in the great development of quartz in the "A" series of veins. It is stated, moreover, that work so far has been confined to the area following "one strike, shear or break that accompanies the main uplift," and practically no lateral development along the strike of the cross "B" veins has been attempted. The substance of the development, therefore, is the establishment of conditions that point to the improvement with depth in the economic importance of ore-shoots at and around intersections of the two series of veins. The degree of this encouragement need not be enlarged upon here; it is probable that further exploration is necessary before any definite appraisal may be made. It is clear, however, that there are great possibilities of depth development in connexion with proved conditions of structure and mineralization in this pre-Cambrian formation.

Turning to the subject of areal distribution one may find many features of interest. The direction of attention to old mining camps of the Province has been alluded to already and in it there is at least as much significance in relation to the characteristic features of the mineralization in general as to the particular mines that are being re-opened.

Encouraging features that have been brought to light in recent developments at the Reno property are of application to the whole of the Sheep Creek area, in which economic ore-shoots have been found to be developed in sections of an extensive series of fissure veins within regular belts of quartzite formation. In the Nelson Map area the large number of gold-quartz veins in the Nelson batholith and Rossland volcanic series have been alluded to as affording possibilities for a considerable aggregate production. In the Fairview camp attention is again being directed to the possibility of utilizing the great reserves of low-grade gold-quartz that have so far defied the efforts of individual operators and in connexion with recent endeavour in general it would appear that it is the field, rather than the property, that constitutes the initial element of attraction. Available geological knowledge has a great deal to do with the renewal of interest and tribute is due to the Geological Survey for valuable assistance in this direction. Improvements in metallurgical treatment also have much to do with the recognition of new opportunity, but the feature of principal relevance to the present argument is embodied in the fact of the accumulated evidence of opportunities that, from one cause or another, have been overlooked heretofore.

Referring once more to the Bridge River area in this connexion of distribution, the modification of the geological concept, by which the economic area has been held to be delimited, may have far-reaching effects upon the areal extent of the gold mineralization and upon further discovery.

We come back finally to the possibilities associated with the pre-Cambrian formation and note that the particular area with which the noted occurrences previously referred to are identified is characterized by certain conditions of elevation and glaciation. Outside the immediate confines of this area it is reasonable to admit a certain latitude in regard to the occurrence of similar features of structure and mineralization to those which are here represented at the accidental surface. With the definite establishment of economic gold values associated with the pre-Cambrian of British Columbia there may be allowed a wide field for speculation in regard to areas of the Interior Plateau belt, which are underlain, presumably, by this formation. This is admittedly speculation and is referred to for the purpose of giving point to the representation that gold mining in British Columbia appears to have passed through one stage of selective operation and has entered upon another of intensive areal investigation. Within reasonable bounds, therefore, the conception may be entertained that further possibilities in regard to the production of gold from lode deposits are not to be measured entirely in terms of past records, but offer considerable attraction to speculative investment in this specific direction. Similarly any major increase in the production of placer gold is calculated to be in relation to the investigation of buried alluvial, demanding expenditure upon a scale denied to individual operators. The probable existence of buried Tertiary placers, particularly in the country lying to the south of the Barkerville area, has been pointed out by R. W. Brock.

EARTH MOVEMENTS

By C. P. STROMEYER

The author's theory of earth movements is illustrated by reference to particular areas on the earth's crust.

The often-repeated analogy about the earth contracting like a drying apple, the core diminishing in size while the tough shell shrivels up, is evidently quite unsatisfactory when contemplating the enormous foldings of surface strata which have taken place and the analogy cannot explain at all the innumerable cracks and dykes which are found all over the earth's surface.

The following general cooling conditions are here mentioned only to be dismissed :—

Case I : Assuming that the earth were cooling at a uniform rate throughout its whole mass, then there would be neither puckers nor cracks, unless the thermal contractions differed for the different layers. Mathematical considerations show that the temperature distribution would be according to parabola, as shown in Fig. 1, and that therefore the earth's central temperature would be twice the temperature gradient at the surface multiplied by the radius. Assuming a temperature gradient of 1° F. in 50 ft. and a radius of 21 million ft., then the central temperature should be 211,000° F.

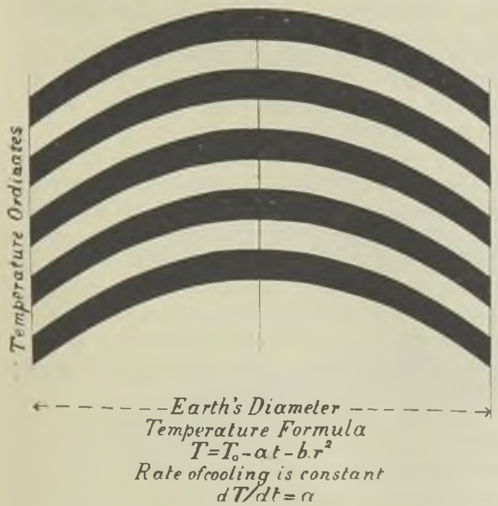


FIG. 1.

Case II : Assuming that the earth is cooling at an increasing rate with time, then the temperature curve would be a hyperbolic cosine (Fig. 2) and the central temperature

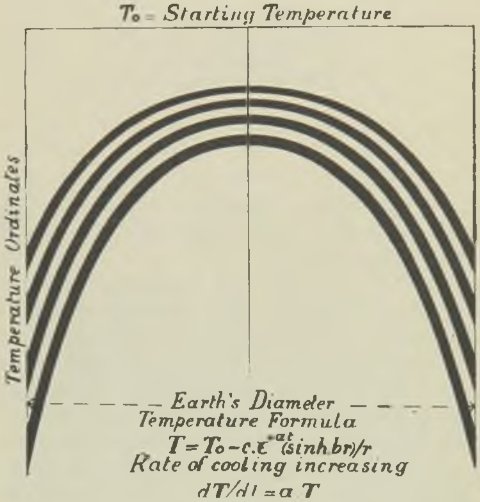


FIG. 2.

would be less than in Case I. In this case cracks would occur on the surface, but the assumed cooling conditions are not likely to have occurred. A very similar temperature curve could be obtained on the assumption that heat is being generated in the interior of the earth due to radio-activity. If this internal heat generation is balanced by external radiation, then there would be no changes with time and neither puckers nor cracks would occur.

Case III : Assuming that the loss of heat from the earth's surface is proportional to its surface temperature—this is the assumption made for hot stars by Lord Kelvin—then the temperature curve would be expressed by the term sin T/T (Fig. 3). The central temperature would be twice as high as for Case I and more heat would be lost from the core than from the crust, so that puckers would occur

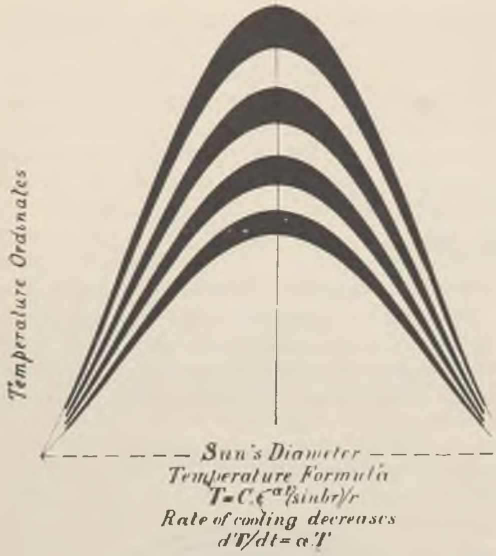


FIG. 3.

as with an apple, but they would be very slight, even for a very large lowering of the surface temperature.

Case IV : Lord Kelvin suggested that the earth was originally fluid throughout, that during the early cooling period any solid crust which was formed at the surface would be heavier than the magma and would sink towards the centre of the earth. This process would continue until the whole earth would be solid and at a nearly uniform temperature of about 7,000° F. From then onwards the crust would gradually cool below that temperature. Fig. 4 represents Lord Kelvin's temperature curve for a lapse of time of 100 million years. The perceptible cooling would penetrate to only about 160 miles, or about 4%, of the earth's radius. The curve at the upper edge of the diagram represents the cooling curve for a period of 32,000 years, of which Fig. 5 is a large-scale reproduction. As these general cooling conditions afford no satisfactory explanation for the puckers and cracks of the earth's surface, local changes of temperature will have to be considered.

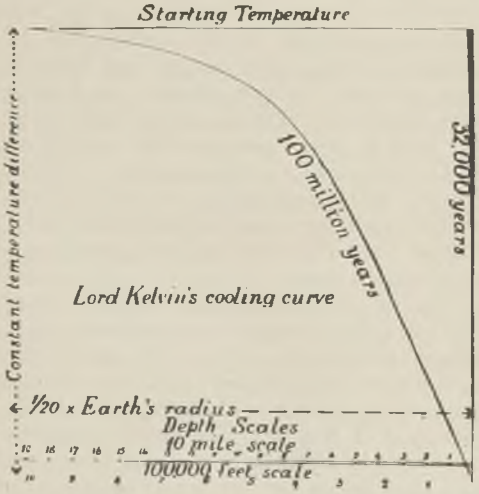


FIG. 4.

Fig. 5 consists of a series of temperature curves created by a sudden but then permanent change of temperature, a condition which would be created by a sudden flooding of a hot desert by cold water or by covering it with a large sheet of hot lava. It will be seen that near the

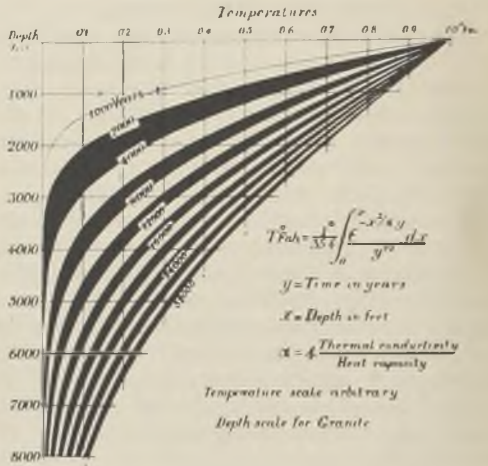


FIG. 5.

surface the temperature gradient is at first very steep and the expansion near the surface being greater than below serious puckers would occur.

Fig. 6 represents the condition of a gradually increasing or diminishing surface temperature. Fairly constant temperature gradients would be created and therefore no violent changes of form. This condition would exist under advancing or retreating sheets of ice and also under the conditions to be considered of erosion due to ice or rain and to sedimentary depositions on the sea bottoms.

Gradual local changes are illustrated in Figs. 7, 8, 9, and 10, which are intended to be diagrammatic representations of an east–west section through the Continent of South America. The prevailing wind, heavily laden

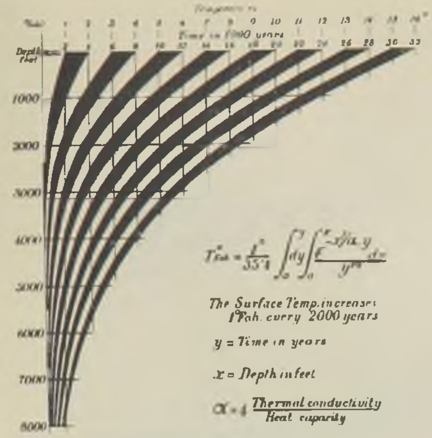
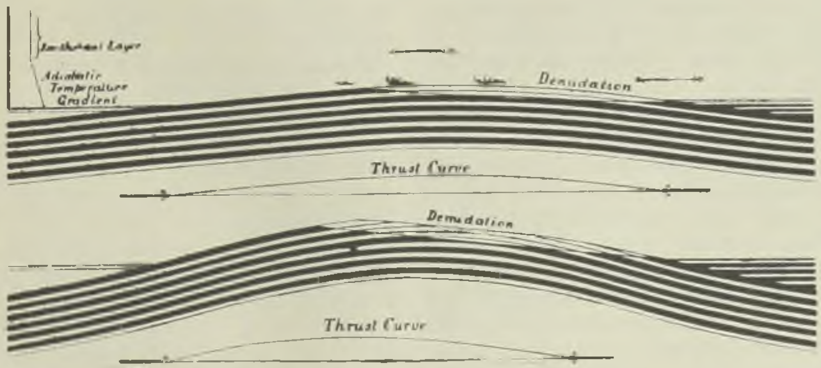


FIG. 6.

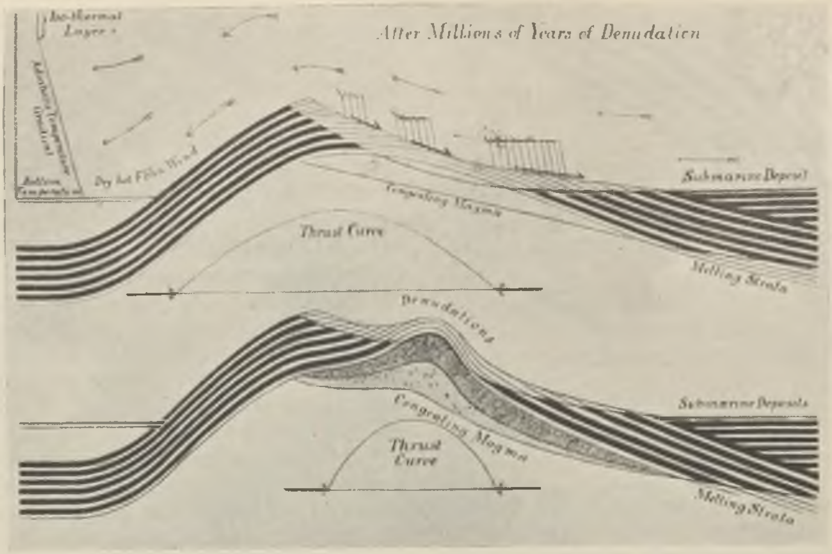
with moisture, is supposed to be blowing from east to west. As the air rises over the sloping ground it expands, cools, and parts with its moisture as rain or snow, which washes away the surface soil and rock and gradually exposes lower and lower strata. After a time the whole thickness of the stratified crust under the denuded surface will be cooling at a steady rate, whereby a continuous contraction will be effected both in an east–west and in a north–south direction.

Assuming the denudation to be progressing at the rate of 1 ft. in 100 years and that the local temperature gradient is 1° F. per 50 ft., then after every 10,000 years 100 ft. of crust will have been removed and the underlying crust will have been cooled 2° F. down to the temperature of the mountain air with which the exposed crust is in contact. On the sea bottom the washed-down sediment adds thickness to the underlying crust and acts as a blanket, causing the underlying crust to grow warm and to expand. It is immaterial as regards the average contraction and expansion of the earth's crust whether the denuded and deposited areas are equal, for the thinner the deposit the larger the area, and if—as for instance in line with the Amazon River—the two areas lie side by side the contraction of the mountain area is balanced by the expansion of the adjoining sea bottom. For instance, north and south contraction of the Andes ridge is balanced by the depositions of the Amazon and other South American rivers and by those of the Mississippi and St. Lawrence rivers, but this balance is conditional on very severe shearing forces, which may cause earthquakes. If the abraded and deposited volumes do not balance each other, if the volume of deposit in one area is larger or grows more quickly than the denuded volume in the adjoining area, then the expanding sea-bottom will exert a thrust on an adjoining mountain range and cause its curvature to be increased, which means that a mountain range will rise more quickly than it is being abraded. The process is a slow one and accurate measurements do not appear to have been carried out, but it is known that both the Andes and the Alps are of modern growth, which may be taken to imply that the puckering or upheaval of the massive has progressed more rapidly than the washing away of the surface.

The above assumption for the rate of denudation—*viz.*, 1 ft. in 200 years—is probably below the mark, but even at this rate, assuming that the Andes are rising as suggested, the once red-hot lower strata will have risen to the mountain tops. The necessary period is about four million years. The underlying magma will have congealed and will also have risen to the surface in that



FIGS. 7 AND 8.



FIGS. 9 AND 10.

time and will have appeared there as a plutonic intrusion. The nature of the process is illustrated in Figs. 7–10, which show the mountain tops being worn away and the debris deposited on the sea bottom. The underside of the sea bottom increases its temperature and melts. Probably the heavy ingredients will sink towards the earth's centre, while the lighter ones wander towards the cavities under the mountain tops and congeal.

(*To be concluded.*)

NEWS LETTERS

JOHANNESBURG

June 8.

East Rand Lease Area.—The Government is inviting tenders for the leasing of areas in the " Boksburg Gap " portion of the East Rand comprising about 2,594 claims in a compact block and adjoining the properties of Brakpan Mines, New Kleinfontein Co., East Rand Proprietary Mines, and Van Dyk Proprietary Mines. The areas are on the following farms : Rietfontein No. 4, about 1,517 claims ; Vogelfontein No. 5, about 44 claims ; Leeuwpoort No. 4, about 985 claims ; Finaalspan No. 3, about 48 claims. Tenders must be in the hands of the Government Mining Engineer not later than noon on July 12 next. It is stipulated that " the application shall state whether the applicant proposes—(*a*) to form a company which will work the leased ground separately ; or (*b*) to form a company which will work the ground conjointly with adjoining ground ; or (*c*) to form a company which will hereafter amalgamate with any other company holding adjoining ground ; or (*d*) to form no new company, but to amalgamate immediately with adjoining ground. Within a period not exceeding two months after the acceptance of an application, or such further period as the Minister of Mines may allow, the successful applicant shall form a company with limited liability to carry out the terms of the lease."

Prospecting Results.—Satisfactory progress has been made in the preliminary prospecting work which is being carried out on the Lydenburg Gold Farms Company's farm Vlakfontein No. 21 on the Far East Rand. In the first bore-hole the main reef leader horizon was struck at a depth of 2,143 ft. The second bore-hole stopped after piercing the Kimberley shale, the indicated depth to the main reef leader horizon being 1,830 ft. In the third bore-hole the main reef leader horizon was struck at 1,563 ft. This line of bore-holes has since been completed by the sinking of three more holes, which intersected the main reef leader horizon at depths of 1,297 ft., 1,006 ft., and 451 ft. respectively. The distance from the first bore-hole, which is known as U.A., to the sixth bore-hole, known as U.F., is approximately 11,000 ft. The Union Corporation states: "The line appears to be more or less on the dip and the geological data as to the lie of the strata may be regarded as very encouraging. However, in no case were there more than a few pebbles on the contact, so that there is no interesting information as to values to report. Since the end of the year a further four holes, U.G., U.H., U.J., and U.K., have been put in hand. Three of the holes, of which two are completed, lie to the west of the main line of bore-holes and one to the east and, as further drilling would be required to complete the survey of the property, an extra drill has recently been engaged so as to expedite the work." An aerial survey of the property has been carried out by the corporation. The photographs, in the opinion of the corporation, should ultimately prove of value in conjunction with the bore-hole data.

More Drills in the South-West.—A bore-hole will be commenced by the Western Reefs Exploration and Development Co. in the immediate future on the farm Rietfontein, on the east of the company's line of properties, with a view to intersecting the Upper Witwatersrand formation, while geophysical work is proceeding so as to enable additional bore-holes to be placed in the most advantageous positions. Further to the west, on the farm Palmietfontein, a shallower bore-hole is also being commenced shortly. It is hoped that the exploratory work will be successful in disclosing payable reefs. The company's area extends from the townlands of Potchefstroom to the townlands of Klerksdorp.

Randfontein Estates.—Preliminary plans for increasing the scale of operations at the Randfontein Estates' mine have been completed and a start made on all the necessary work. The service incline shafts are being deepened as rapidly as possible to expedite development and a sub-vertical circular shaft has been started from the 30th level of the south vertical section. A cross-cut has been driven east into the hanging wall of the Main Reef Series from the 30th level No. 2 north shaft, a distance of 2,710 ft., with a view to arriving at the position for a sub-vertical shaft to serve this area. The strata in the eastern portion of the cross-cut, which overlay the reefs by approximately 800 ft., have now assumed a reverse dip—that is, they are dipping a few degrees to the west—thus demonstrating the existence of the syncline which had been anticipated. In addition to work of a capital nature the decision to increase the reduction plant necessitated a larger development programme to place the mine in a position to deliver the extra tonnage; this programme is now in full operation. It is anticipated that work on the reduction plant will be completed by the end of this year and the power, compressor, and hoisting plants early next year.

Luipaards Vlei.—It is reliably stated that the rapid change in the strike of the Battery Reef outcrop on the Tudor and Rip areas of the Luipaards Vlei Estate and Gold Mining Co. appears to be similar to that found on the southern portion of the Battery Reef workings on Randfontein Estates, where a complete syncline has now been proved. Should a similar state of affairs be found to exist on this newly acquired section of the Luipaards Vlei Estate it must have a wonderful effect on the future prospects of this company, which would be in a position to mine its entire ore-bodies at a depth which would never approach anything like the limits to which mining has been carried out on the Central Rand. As far as the strike of the Main Reef is concerned on the eastern section of this area, there does not appear to be any tendency for the strike to alter in sympathy with that of the Battery Reef and the results obtained in the bore-holes would lead one to expect the reef to be flattened by means of upthrow faults with very little change in the strike of the series. As one proceeds westwards, however, it would appear feasible that a syncline movement would gradually evolve to conform with the overlying Battery Reef formation and fit in with the conditions existing on the West Rand Consolidated and Randfontein properties.

Southern Rhodesia.—In the course of his review of the mining industry of Southern Rhodesia at the recent meeting of the Rhodesia Chamber of Mines Mr. R. E. Bayliss, president of the chamber, had a good word to say for the work of the Geological Survey Department, which he described as excellent. He pointed out that the continuous prospecting activity witnessed during the year had made increasing calls upon this department, especially as regards the sampling of abandoned claims and the

NORTHERN

In view of the article on Roan Antelope appearing mine is of interest, showing as it

PANORAMIC VIEW OF THE

re-opening of old workings. Advice had been freely given to prospectors and old mine records had been made available for their use.

Middle Witwatersrand Company.—The Middle Witwatersrand (Western Areas), Ltd., has exercised its option over the farms Etta No. 23 and Safsit No. 58 on the South-West Rand, comprising approximately 900 morgen. The properties are favourably situated near the Western Reefs' farm Eleazar, where active prospecting is proceeding. The remaining ground held under option by the Middle Witwatersrand company exceeds 28,000 morgen. Dr. Heimburg, the eminent German geologist and a colleague of Dr. Krahmann, the West Witwatersrand Areas' geophysist, has been engaged to complete the electro-magnetic survey of the Middle Witwatersrand ground and will be arriving in South Africa shortly. In the meantime the company's ground parties, under Mr. A. H. Hooper and Mr. A. K. Parrott, are understood to have located some interesting geological features on the farms Katdoornsbosch and Du Toit's Spruit, adjoining the West Witwatersrand farm Kiel.

Rezende Mines.—It was stated at the annual meeting of the Rezende Mines, Ltd. (Southern Rhodesia), that the ore reserve should allow at least another year of normal operating results at the present rate of crushing. After that the mine may be kept going for a time on lower grade ore but, with correspondingly reduced profits. The option over the Andrada—an alluvial gold dredging proposition in Portuguese East Africa—was exercised in July last and the company has received in respect of its interest in the option vendor shares in the new company styled "The Revue Dredging Company, Limited," formed to take over the option. The dredge is now being dismantled and will be transported, in sections, to the

RHODESIA

in this issue, this panoramic view of the N'Kana does the character of the country.

N'Kana Mine, looking South.

Lower Revue River, where it will be re-erected. It is anticipated that dredging operations in the new area will commence within the next three months.

Vereeniging Collieries.—The Vereeniging Estates, Ltd., has purchased a controlling interest in Meyerton Collieries, Ltd., taking over at the same time the administration and technical control of this company.

Swaziland Concessions.—Pigg's Peak and Ruby Creek Concessions, in Swaziland, have been purchased by Mr. Arthur Youldon, of Johannesburg, for £3,250. The two properties are 40,000 acres in extent and the concessions include the water rights and the gold mine in Pigg's Peak, in regard to which the concession is until 1970. The Ruby Creek concession runs until 1987. It is stated that £78,000 had been spent on development of this gold- and asbestos-bearing area.

BRISBANE

May 29.

Mount Isa.—Speaking at the annual conference of the Institution of Engineers of Australia, held in Melbourne, Mr. A. F. McCaskell, chief engineer of Mount Isa Mines, Ltd., said the system of mining being carried out at the Mount Isa mine is novel and that mining engineers throughout the world are awaiting the result with interest. He stated that Mount Isa is the largest producing metal mine in Australia and that £3,673,229 had been expended on it before the production stage had been reached in July, 1931. It was explained that the mining is done with explosives, that the ore is mechanically handled throughout, and that the treatment of a huge tonnage by this system enabled production costs to be minimized. The Government inspector of mines at Cloncurry (Mr. F. Young) reports that at the mine the first firing out of a modified sub-level stoping method in the Black Star section was inaugurated on April 27, when four "rings" of holes were fired and shot down a quantity of ore estimated at 374 tons for each ring. Mr. Young explains that the term "ring" is used because of the fact that a machine is rigged and the country rock drilled with a complete circle of holes in one rigging. The amount of drilling completed in one operation totals 185 ft., divided into 19 holes. The holes are exploded electrically—a big factor in itself for the saving of time and expense. This method, the inspector states, is new in Australia and seems to be adaptable for stoping large ore-bodies where big tonnages and low costs are essential. At Mount Isa the method was introduced underground as a substitute for the glory-hole system of mining, which is worked from the surface and to which, in the opinion of Mr. Young, it promises to become a worthy rival. Cheap power and efficient drilling machines play an important part in the new process. Preparations are now in progress for the sinking of a new shaft on the main haulage level in the Lawlor section on the Rio Grande lode—a work which will be commenced when circumstances permit. In the following table are given details of the production for April, with comparisons for March :—

	March	April
Ore mined, tons	56,811	67,286
Ore milled, tons	59,203	66,245
Assaying—		
Lead, per cent	10·9	9·8
Silver, oz.	5·8	3·4
Lead concentrates produced—		
Flotation, tons	9,277	10,224
Assaying—		
Lead, per cent	42·9	41·5
Silver, oz.	20·3	20·2
Jig, tons	2,233	1,621
Assaying—		
Lead, per cent	50·1	48·4
Silver, oz.	21·8	24·4
Silver-lead bullion produced, tons	5,215	4,636

Mount Coolon.—The Mount Coolon Gold Mines, N.L., which is operating on the Mount Coolon goldfield, Queensland, lately held its first annual meeting in Melbourne. The chairman (Mr. C. Fraser) stated that, owing to the increased cost of equipping the property and to sundry capital charges associated with the establishment of the enterprise, it was apparent that the issue of further capital, to the extent of approximately £70,000, was necessary. This amount, it is safely anticipated, will be more than provided by Gold Mines of Australia, Ltd., exercising at no distant date the option it holds over 100,000 of the unissued shares at 15s. a share.

Mount Morgan.—Official news to the end of April is to the effect that at Mount Morgan the open-cut was easily producing the ore necessary to keep the concentrator going. Work in the No. 1 drive in the Linda level has been completed. A ladderway has been put down the pocket as far as the main shaft. Early in May this shaft was being timbered around the foot of the pocket. When the scheme is finished a jaw-breaker, sufficiently large to take a rock 3 ft. 6 in. by 3 ft., will be installed at the top and this will break to a minimum size of 5 in.

Mount Wandoo Mine. — The mining warden at Chillagoe, North Queensland, in his report for March stated that at the Mount Wandoo mine, the lease of which is now held in the name of Gold and Rare Metals, N.L., all work both at the mine and mill had been suspended pending a reorganization. Reporting for April the same officer says that following on the reorganization the mill continued to be shut down in that month and that mining development was continued.

Gold in the Northern Territory.—Notwithstanding the set-back caused by failures at the Granites, attention is still being given to gold mining in the Northern Territory of Australia. It is now announced that the North Australia Mines, N.L., with a capital of £50,000 in 1s. shares, has been registered at Canberra. This company has a working option over an area of 80 acres situated within half a mile of the Pine Creek-Darwin railway and about 140 miles from Darwin. The mine already has a shaft timbered to 200 ft. and surface machinery to be installed is now on its way to the property. The lode at the bottom of the shaft is said to be from 15 ft. to 20 ft. wide. What is unusual in this region is that there is plenty of timber and water available and it is intended to start operations immediately.

Guinea Gold, N.L.—This company has declared a dividend of 1s. a share at the close of its first year. The revenue earned consisted mostly of interest on investments. The dredging operations of the Bulolo Company, in New Guinea, in which company Guinea Gold, N.L., holds an interest, is reported as continuing to show marked success. The two dredges operating on the Bulolo River in the twelve months ended March 31 last treated over 4,000,000 yards of gravel, with one of the dredges working only half the year, the gold won by them being given as 84,729 oz. Two more dredges are to be put on the ground.

Mount Lyell. — The directors of the Mount Lyell Mining and Railway Company, Tasmania, announce that owing to the low price of copper during the six months ended March 31 the company's mining operations have been unprofitable and that consequently no interim dividend can be paid.

New Caledonia Nickel.—The French island of New Caledonia, in the South Pacific ocean, some thousand miles from the east coast of Queensland, was noted as a considerable producer of nickel. The Caledonian Nickel Company is starting to reopen its hydro-electric works and it is thought will be at work in two or three months. At the Doniambo works the cupolas are in full swing. The extraction in the mining centres of Voh and Thio will be increased towards the end of this year.

VANCOUVER

June 10.

Bridge River.—With important developments at the two major operations in this gold-producing area seasonal exploration is in full swing upon a scale that is unprecedented. The Pioneer mine, paying dividends at the rate of 60% per annum, achieved a record gross production valued at $205,000 for the month of May and with a new outlook in regard to ore reserves from lateral developments on the main vein mining and milling activities have been stepped up to concert pitch. At the recent annual meeting the managing director stated that the east drift in the seventh level had been advanced 657 ft. into new ore of a higher grade than the average and that three other levels that were being driven rapidly in the same direction had encountered excellent showings. In regard to developments in the opposite direction it had been found that a sharp swing of the vein fissure opened up wide possibilities of lateral extension within the Pioneer boundaries. The completion of the three-compartment shaft had enabled the company to cut costs and to get ahead with development. Mr. Sloan stated that during the past year a small pocket of exceptionally rich ore above the 8th level west had yielded an amount of $250,000. Milling capacity had been brought up to 350 tons per day and he expected that this amount would be increased, even with the existing equipment, probably reaching 400 tons per day during the present year. Highly encouraging accounts were presented in the annual report of Bralorne Mines, Ltd., and it is understood that these will be amplified at the general meeting of the company that is being held this month. It is now established that reserves of ore have been proved, as a result of the recent extended development, sufficient to maintain the present rate of production of 130 tons per day for three years. These reserves are related mainly to a new ore-body that has been opened up towards the north-western end of the holdings by cross-cutting from the shaft on the King vein. As reported by R. Bosustow, the mine manager, this ore-body has a known length of 400 ft. in the 8th level, with an average width of fully 12 ft. It has been followed already for a distance of 350 ft. in the 10th level and its downward continuation, over greater lengths, appears to be more than probable. No definite statement of value of this new ore is made, but it is understood to be in excess of the average grade of $16·00 per ton for the ore supplied to the mill during the past year's operations. During this first year of production the mill treated 32,657 tons of ore, with a recovery of bullion and concentrate valued at over $500,000. Consolidated Mining and Smelting Company has taken a working option on the property of Bridge River Consolidated Mines, including the Why Not and Forty Thieves claims. It is reported that Ira B. Joralamon, consulting engineer for B. R. X., Ltd., has found improved values as a result of the recent development of the California vein. According to an announcement by officials of Red Hawk Gold Mines, Ltd., Col. H. H. Yuill, who is credited, incidentally, with the recommendations that led to the ultimate discovery of the new ore-bodies in the Bralorne mine, has been appointed to survey and supervise development of the company's properties on the upper reaches of Cadwallader Creek. The results of preliminary work are believed to have afforded encouragement to deeper development. Wayside Consolidated Gold Mines, Ltd., is carrying out active developments on the Wayside property in the Bridge River valley and, according to Purvis Ritchie, the managing director, two important discoveries have been made recently. The work is confined for the greater part to continuation of the original shallow tunnels on the vein from which some high assays were obtained in past operations. Tentative arrangements are in hand with a view to early installation of a treatment plant, for which, as well as for development purposes, additional power equipment is being provided.

Lillooet.—In this district and outside the Bridge River area there is a considerable amount of activity in the McGillivray creek section, where National Gold Mines, Ltd., is reported to have completed the purchase of a 200-ton treatment plant for early installation. The development of the mine is being pushed ahead under the direction of B. W. W. McDougall and it is understood that the No. 4 tunnel is to be driven to a distance of about 800 ft. and connexions made with a view to blocking out tonnage rapidly. It is stated that some streaks of high-grade ore are being encountered in this work. Several other interests are engaged in this section. Announcement has been made by A. F. Noel, who was identified prominently with the earlier history of the Bridge River mines, that Cache Bonanza Gold Mines, Ltd., has been incorporated to undertake the further development of the Golden Cache mine on Cayoosh Creek, which was located by Mr. Noel in 1895 and sold to a Vancouver company that opened up a very rich pocket of gold ore but failed to develop further reserves.

Cariboo.—Exploratory work on the numerous properties that were acquired, early in the year has been delayed by the lateness of the season, but is now well under way. A promising outlook was presented to shareholders in Cariboo Gold Quartz Mining Company, at the recent annual meeting, when the president announced that satisfactory arrangements had been concluded for the further financing of operations on a greatly increased scale. It was stated that ample funds were on hand for carrying out the programme of development recommended by Fred M. Wells, with a view to the early installation of a treatment plant with a capacity of from 500 to 1,000 tons per day. It is understood that this work has been started already and considerable additions to the equipment are being made in order to ensure rapid progress. The mine has produced 2,760 oz. of gold since milling operations with a pilot plant were commenced at the beginning of the year. This mill is now treating at the rate of 60 tons of ore per day and this amount is to be increased pending the new installation. Mr. Wells stressed the fact that the company is in a stage of development and that the existing treatment plant is to be looked upon as a means for making a practical test of the value of ore-bodies that are being explored with a view to large tonnage operations. Richfield Cariboo Gold Mines, Ltd., has been incorporated with a capitalization of 3,000,000 shares of no par value to develop a group of 21 claims situated on Bald Mountain, in the centre of the Barkerville area. It is claimed that there are five known gold-quartz veins on the property and that a tunnel that was driven on one of them in the old days of the camp encountered ore averaging \$17·50 per ton. A. G. Henderson, one of the old locators, states that two additional veins about 6 ft. wide were also traced on surface, with heavy sulphide mineralization. H. G. Randelsome has been engaged by the company to carry on development, which is to be continued from the original tunnel in the first place, and it is anticipated that enough ore will be blocked out to warrant the installation of a pilot mill pending deep-level development that is projected. Initial financing by a public issue of shares at 50 cents per share is planned to net the company about \$120,000 and it is provided that no amount is intended to be paid for promotion. The purchase consideration is represented by 1,200,000 shares, of which 400,000 are to be allotted immediately and held in escrow until the company has \$100,000 in the treasury for working expenses.

Nelson.—In the Nelson district, which embraces the Nelson, Ymir, and Sheep Creek camps, in the West Kootenay country, assurances of profitable operation at the Reno mine are stated to be enhanced considerably by successful developments on the No. 5 level, where the "inner" sulphide ore-shoot has been encountered, showing values stated to be around \$50 per ton.

The Queen property, which is credited with a production valued at about \$1,000,000 from former operations, is reported to have been acquired from the Wisconsin owners by W. E. Wittier and associates of Moscow, Idaho, and work has been commenced with a view to early resumption of production. Satisfactory financial arrangements have been made for a considerably increased scale of operations at the Kootenay Belle mine, in the same camp, by the issue of 150,000 shares in the company at 35 cents per share, which was over-subscribed. In the Ymir camp it is reported that a long-term bond has been secured on the old Ymir property by Vancouver and Victoria interests, represented by J. F. Coates, who are operating the adjoining Goodenough property. Humming Bird Gold Mining Company, Ltd., has been incorporated to acquire and develop a group of claims at the head of Roaring Creek, in the Nelson camp, where it is stated that a series of veins, ranging from 1 to 5 ft. wide, occur under conditions similar to those of the typical veins of the Ymir camp. About 200 ft. of driving was carried out on one of these veins, which is said to reach a width of 8 ft. in one place, and a number of samples taken from different points on the properties are said to indicate a value of around $40 per ton. An issue of 400,000 shares at 20 cents per share is being offered out of a capitalization of 1,000,000 shares.

Coast.—Interests representing Vancouver and Calgary capital are reported to have acquired the old Surf Inlet property on Princess Royal Island, together with adjoining properties. The Surf Inlet mine was operated successfully by Belmont Surf Inlet Mines, Ltd., from 1916 to 1925, with a total production valued at about $7,500,000 in gold, silver, and copper. The property is well equipped in every way and it is understood that the facilities thus afforded are to be employed in the development of the other claims now acquired, which have been reported upon favourably. Development work that is under way at the Enid-Julie property, at Phillip's Arm, owned by Glasair Mining Company, is reported to have been successful in uncovering two good shoots of sulphide ore carrying high gold values. It is planned to develop these ore-bodies at depth and a tunnel has been commenced already for this purpose.

TORONTO

June 16.

Gold Production of Ontario.—Gold production in Ontario for May totalled $3,654,442 from 475,971 tons of ore milled, a decrease of $27,359 from the $3,681,801 total for April, when 449,650 tons were milled. Production for May of last year was $4,079,320 from 469,626 tons. The average grade of ore milled during the past month ran $7·68 per ton, compared with $8·27 in April.

Porcupine.—This field was the largest producer for the month, with a total output of $1,830,930 from 287,229 tons, compared with $1,783,004 from 276,879 tons for April. Dome Mines, the most important producer of the district, treated 46,500 tons of ore during the month, producing bullion valued at $415,932, an average recovery of $8·94 per ton. This figure is the highest for the year, comparing with $403,268 in April and $412,565 in March. Production for the five months ending with May totalled 228,300 tons, with a total value of $1,978,007 and an average recovery of $8·67 per ton. This figure represents a gain of $254,667 over the total of $1,723,330 for the corresponding five months of 1932. High-grade ore was encountered in cutting the station for the twenty-fourth level in the winze and samples were heavily sprinkled with free gold. It is expected that the 25th level will yield even better values, as diamond drill intersections showed 178 ft. of ore averaging $14·50 per ton in gold. According to the latest reports development work at the Dome is fully justifying the predictions made by officials at the company's annual meeting. Work on the 1,400-ft. level at Vipond Consolidated Mines has opened up 200 ft. of ore averaging more than $7 per ton in gold and a programme of deeper development to search for the new ore-body at lower levels is being planned.

Kirkland Lake.—The total May production in this area was $1,702,493 from 154,255 tons, a decrease from the April total of $1,764,347 from 143,880 tons. At the Wright-Hargreaves mine milling operations average about 800 tons a day, with average heads between $11 and $12 per ton. It is expected to have the new mill unit ready for operation early in July, which will bring the mill rate to about 1,000 tons. Good values are being opened up by development of new levels below the 3,000-ft. horizons, while on the 3,900-ft. horizon a good stretch of high grade is being developed. Development work on the lower levels of the Teck-Hughes property has opened up a section of ore that compares with the best that has yet been found in this mine. The main extension of the south shaft is now down below the 40th level about 700 ft. Sylvanite Gold Mines produced bullion valued at $795,642 from 96,140 tons of ore during its fiscal year ending March 31. Exchange on bullion amounting to $103,905 and $24,983 from investments brought the gross income to $924,530. After deducting $626,403 for operating and administrative costs and $96,204 for depreciation and taxes, a net profit of $201,922 remained, before providing for mine exhaustion, equivalent to 6·12 cents per share. The total of 96,140 tons of ore milled was an increase of 1,864 over the preceding year. Development work from the No. 2 shaft section during the year revealed a fair tonnage, on and above the lowest level, of what is considered a new source of ore. The No. 2 shaft, which is now going down, is at a depth of 3,100 ft., with an objective of 3,500 ft. As a result of developments at the Macassa mine the management is planning the erection of a new mill with a 200-ton daily initial capacity. If the present rate of progress continues it is expected that the mine will be producing before the end of the year. The Canadian Kirkland Mines has obtained sufficient capital from New York interests to re-open its property and sink its shaft from its present depth of 150 ft. to 250 ft. Underground development has been resumed at the Barry-Hollinger mine, following the installation of new equipment to replace that damaged by fire in the Boston Creek area. It is planned to start diamond drilling from the 1,875-ft. level to pick up the No. 1 vein and to probe for new veins in this area. A survey of geological conditions on the Galatea Gold Mines property has revealed an extremely favourable structure, with much rich gold ore in a central zone. Rail transport and a hydro-electric power transmission line now pass close to the property. A large programme of underground development will be carried out on the Kirkland Gold Belt property in the eastern section of the Kirkland Lake area. A new syndicate has acquired control of the Iroquois-Kirkland Mines Corporation, whose property adjoins Sylvanite, and extensive development work is planned on the property. Bidgood Consolidated Mines is re-opening its mine in the eastern section of the Kirkland Lake camp, with a view to bringing it into production. A drive is being pushed from the property of the Kirkland Lake Gold Mining Company into the Grozell property on the 4,900-ft. level.

Sudbury.—Chibougamou Prospectors, Ltd., has 12 men engaged in exploration work on 22 claims in the Swayze district and good surface showings with veins carrying free gold have been revealed. Sinking operations are being carried on at the property of Kenty Gold Mines, in the Swayze area, and good mineralization has been cut in the No. 2 shaft at a depth of 280 ft. The No. 1 shaft, which is located about 1,400 ft. east of the No. 2 shaft, is expected to be finished within several weeks. McMillan Gold Mines, Ltd., has obtained funds for the reopening of its property and an extensive programme of development. Exploration work on the property of the Swayze Huycke Gold Syndicate, in the Swayze gold area, shows good values in gold from surface trenching and test pitting. Four ore-bodies have been explored and free gold has been panned from a number of places. The present surface development will be followed by diamond drilling. Good progress is reported by Falconbridge Nickel Mines, new equipment having been installed recently at the company's mine, where 865 tons of ore is being handled daily. Additions to the company's Norway refinery will be finished shortly. An extensive programme of diamond drilling is being undertaken by the Consolidated Mining and Smelting Company, which has acquired an option on control of the McNeeley-McCullough property, consisting of 12 claims in Swayze township, to the west of the Kenty Gold mine. Drilling will be carried on with the object of picking up the westerly extension of the Kenty break, which has yielded the greatest values on the Kenty property to date. Encouraging discoveries have been made on the property of Halcrow-Swayze Mines, Ltd., within recent months. No. 2 vein has been opened up on surface for a length of 1,600 ft., with every pit showing mineralization. No. 1 vein showed values of $12 from channel assays across a 3-ft. width of vein matter and No. 4 vein gave returns on surface of $30 a ton over a width of 12 inches. The old Shakespeare Mines, near Webbwood, have been taken over by Richmac Gold Mines, Ltd., a new organization, which has started development work. The Sudbury Diamond Drilling Company has secured an option on the Tycon property, in the Shoal Lake gold area, near Kenora, where diamond drilling has revealed good values.

Quebec.—Siscoe Gold Mines, one of the most important producers in the Siscoe gold area of Quebec, had a total gold production of $99,908 from 8,914 tons during the month of May, an increase of $28,938 over the April figure of $70,970. This was obtained from 8,914 tons, the recovery averaging $11·16 per ton. In April 6,792 tons were treated, the average recovery being $10·45 per ton. Development work on the lower levels is proceeding favourably and preparations are being made for the sinking of a new shaft. A large development programme being undertaken by Granada Gold Mines calls for continuing the incline shaft from the 1,225-ft. level to a depth of 3,000 ft. At the McWatters Gold Mines, in the Rouyn district, sinking operations are being carried on, with the shaft down to about 350 ft. An entirely new vein has been discovered on surface, approximately 500 ft. north of the shaft. Excavation work for a new mill is going forward rapidly on the property of Greene Stabell Mines, Ltd., in North-Western Quebec, and preparations are being made for the moving of machinery from Amos, Quebec, to the property. A compressor of 1,000 cu. ft. capacity has been ordered and it is planned to commence production this summer. Financed by English interests, the Stadacona Rouyn Mines, Ltd., will begin a programme of diamond drilling. It is planned to deepen the present shaft from 300 to 1,000 ft. at a later date. Operations will be started shortly by East Rouyn Gold Mines, Ltd., a newly organized company, on a group of claims east of McWatters Gold Mines, in Rouyn township. Preliminary work will consist of trenching and diamond drilling. South Tiblemont Mining Syndicate has been organized to take over and develop a group of 20 claims in Tiblemont township.

Manitoba.—A large programme of development is being undertaken by the Oro Grande Development Company, Ltd., which is installing a mining plant and constructing a mill of 75-ton capacity. It is proposed to start the mill with about 30 tons a day, which will be stepped up to keep pace with development at the mine. Production will be commenced by mid-summer, it is expected. The company's property comprises 242 acres in the same area as the San Antonia and Central Manitoba mines. A discovery of major importance has been made by Smelter Gold Mines on its property at God's Lake. A vein has been traced for nearly 1,000 ft. in length, having a width of from 3 ft. to 10 ft. Sampling has disclosed consistently high gold values and working forces have been increased. The Little Long Lac Gold Mines, in the Little Long Lac area, has installed a mining plant and equipment and is starting a programme of development on a large scale. Preliminary work has revealed high-grade ore in narrow veins.

North-Western Ontario.—Howey Gold Mines is constructing an addition to its mill and preparing for increased production. A large tonnage of ore is available for mill-feed and heads average between $3·25 and $3·50 per ton, according to estimates. The Sinco Mines Company, controlled by American interests, will open up the property of the Nortricia Mining Company, in the Red Lake district. Development is proceeding at the MacKenzie Red Lake Mines property, in the Red Lake district, where an incline shaft is being put down. A mining plant and equipment are being installed. Favourable results are being obtained by Coniagas Mines from exploration work on the Michael-Boyle claims, in the Manitowick Lake district, and the installation of a plant to enable underground development is being considered.

PERSONAL

A. C. J. Anderson is returning from Nigeria.

S. Bracewell has left for British Guiana.

Boris Bryner has returned from France.

L. Maurice Cockerell has returned from New York.

H. O. Crighton has left for Uganda.

E. F. Dark is leaving for Portugal.

W. S. Dyer and party are examining the Matachewan area, Ontario.

W. A. Edwards has left on a visit to a number of Australian mines.

Rowland C. Feilding, having returned from Canada, has left for Germany and Poland.

B. G. Gahan has left for Kenya.

D. Gilchrist is now in West Africa.

R. Glossop is leaving for the Gold Coast.

D. R. Grantham has left for British Guiana to take charge of a special Government geological survey in connexion with gold resources.

Sir Richard Gregory has been elected a Fellow of the Royal Society.

Sir Robert Hadfield has been awarded the decoration of Commendatore of the Order of the Crown of Italy.

W. A. Hardy has left for the Gold Coast.

A. H. Hooper has been appointed a technical adviser to Middle Witwatersrand (Western Areas), Ltd.

M. E. Hurst and party have gone into the Red Lake area, Ontario.

R. Underwood Jarvis has left for the Gold Coast.

A. J. Kelman has returned to Malaya.

Ross Knuckey has returned from Greece and is leaving at the end of the month for Italy.

H. C. Laird will examine the area between Chester Township and the Shining Tree section, Ontario.

H. W. Lake and H. E. Nicholls have dissolved partnership. The business of Lake and Currie will continue to be carried on by Mr. Lake at 12a, Charterhouse Square, London, E.C. 1, and the future address of Mr. Nicholls will be 73, Basinghall Street, London, E.C. 2.

G. F. Laycock has left for Newfoundland.

C. W. Lock is home from Malaya.

Brigadier E. E. B. Mackintosh has been appointed Director of the Science Museum in succession to Colonel Sir Henry Lyons, who retires in October.

H. E. McKinstry is here from the United States on his way to Melbourne.

A. K. Parrott has joined the staff of Middle Witwatersrand (Western Areas), Ltd.

Tom Penhale has left for the Gold Coast.

A. E. Pleming has left for the Gold Coast.

R. S. H. Richards is home from Portugal.

H. C. Rickaby is examining the Swayze area in Ontario.

W. C. Simmons is returning from Uganda.

N. L. Smith has left for Uganda.

J. E. Thomson is in the Manitou country in the Kenora district, Ontario.

J. B. Tyrrell has been awarded the Flavell Medal by the Royal Society of Canada.

G. Williams has left for British Guiana.

Noel Barber died on June 8 at Takoradi, Gold Coast Colony, at the age of 46. He graduated from the Camborne School of Mines in 1905 and had a wide experience of mining in Colorado, Nevada, Mexico, and the Gold Coast Colony, to which he returned after the War (when he served in the Royal Engineers) and for a number of years held the position of managing director of the General Engineering and Construction Company. Mr. Barber was a Member of the Institution of Mining and Metallurgy.

Robert Gilman Brown died on July 6, following an operation for appendicitis. One of the earliest appointments held by Mr. Gilman Brown in this country was in connexion with the Ymir Gold Mines and he was afterwards for some time associated with the management of the Geevor Tin Mines. Later he was identified with the Burma Corporation and at the time of his death was on the boards of the Mining Trust and the Russo-Asiatic Consolidated. Mr. Gilman Brown was a Past President of the Institution of Mining and Metallurgy.

TRADE PARAGRAPHS

Thomas Smith and Sons (Rodley), Ltd., of Leeds, have prepared a fully-illustrated catalogue describing their electric cranes. This gives dimensions and essential mechanical details, together with a number of illustrations, showing examples of the machines at work both as cranes and as grab excavators.

Philips Metalix, of Philips House, 145, Charing Cross Road, London, W.C. 2, publish a booklet describing their industrial X-ray service, which sets out the value of X-ray examination of a variety of engineering products with a view to determining the internal characteristics, points of weakness, etc. The firm offers a service to engineers for the testing of machinery plants.

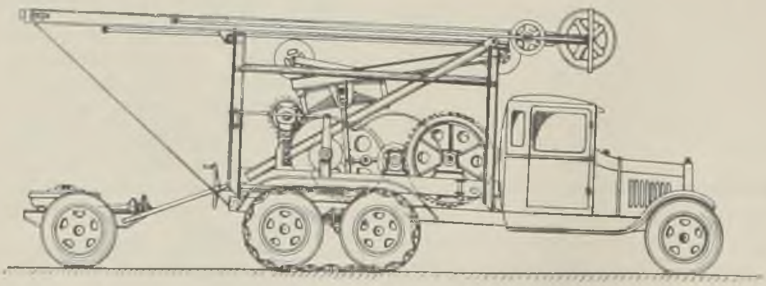
Head, Wrightson, and Co., Ltd., of Stockton Forge, Norton Road, Stockton-on-Tees, are sending out a catalogue describing the Colorado ball-mill. This contains particulars of sizes and capacities in which this machine is made and details of the lining and of the method of drive. Its use in closed circuit with the Akins classifier, another speciality marketed by this firm, is also indicated.

Demag, A.G., of Duisburg, Germany, in their *Demag News* for May have articles on iron ore winning with Demag scrapers, the economic efficiency of deep undercutting in moderately steep coal seams, and straight haulage roads for undulating seams. There is another on the best kind of charging pipe for compressed-air locomotives and also on lifting appliances in gallery and tunnel construction.

Sir Isaac Pitman and Sons, Ltd., of Parker Street, Kingsway, London, W.C. 2, have published parts 15, 16, 17, 18, and 19 of their *Engineering Educator*. The first of these commences with the subject of machine tools, which is continued in the next part and this goes on to jigs and tools, while part 17 commences the use of gauging and inspection. Part 18 continues the subject of soldering, brazing, and welding, and is followed by works organization and management and by training of mechanical engineers. The subject of engineering specifications is commenced in part 18 and continued in part 19, which is completed with chapters on the theory of heat engines.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report having received the following orders :—For England : One 5-ft. by 36-in. Hardinge ball-mill for grinding limestone, two No. 80 "Impax" pulverizers for grinding coal, three 4-ft. by 5-ft. Hum-mer screens for no stated problem, one 50-sq. ft. Rovac filter for treating caustic lime sludge, and three Ro-Tap testing sieve shakers for testing. For Wales : One 5-roller Raymond mill for grinding gypsum. For Scotland : Two 4-ft. by 8-ft. type 38 Hum-mer screens for screening cork. For abroad : One 3-ft. by 8-in. Hardinge mill for grinding gold quartz ore. For Italy : One 7-ft. by 36-in. Hardinge mill for grinding galena and blende (dolomitic gangue).

Werf Conrad N.V., of Haarlem, Holland, are sending out through their London representatives, Curchin and Watson, of Bevis Marks House, Bevis Marks, E.C. 3, a pamphlet describing their Conrad DD 2 combination rig, which is intended to meet the demand for an all-purpose rig and for which the makers claim that it combines the simplicity of the cable tool drill with the speed of the rotary and the accuracy of the coring system. Folded for road transport it will travel with the speed of an ordinary heavy truck and is supplied with special transmission and tracks round the wheels for covering heavy ground. Other features are the



Conrad DD 2 Combination Rig.

patent friction drive, telescopic mast, shock absorbing spudder, and friction clutches. Special gearing running in oil provides two speeds for the mud pump, the latter being of special construction, with nitrated steel seats and rubber disc valves. The worm-gear feed for cable tools is provided with a counterbalance for regulating the weight of the bit for diamond or rotary drilling and disconnects automatically when hoisting. The following are the capacities of the machine :—1,000 ft. depth, 10 in. to 8 in. hole for cable tool drilling, 1,700 ft. depth, 7 in. to 6 in. hole for rotary tool drilling, 3,000 ft. depth, 6 in. to 3½ in. hole for diamond core drilling.

General Chemical and Pharmaceutical Co., Ltd., of Sudbury, Middlesex, issue a number of leaflets drawing attention to their special reagents of interest to the assaying and analytical chemist. Among these mention can be made of aluminon for the detection of aluminium, α-benzoine monoxime for the determination of copper, salicylaldoxime for the detection and determination of copper, α-benzoin monoxime for the determination of molybdenum, tetrahydroxy-anthraquinone for the determination of small quantities of aluminium, magnesium, and beryllium, benzildioxime for the determination of nickel, particularly in the presence of a large excess of cobalt, and magneson II for the detection of small quantities of magnesium. Each leaflet describes the method of using the reagent and other leaflets refer to special pure acids—acetic and sulphuric.

Sir W. G. Armstrong Whitworth and Co. (Engineers), Ltd., of Scotswood Works, Newcastle-upon-Tyne, have published a fully illustrated booklet entitled "The Selection of a Diesel Shunting Locomotive." This opens with some general considerations with regard to traction problems and makes comparison between Diesel electric and steam engines, graphically illustrated. There is a section dealing with the estimation of working costs, followed by specifications of the different sizes of locomotives, and electric transmission is dealt with in some detail. The locomotives are made in sizes ranging from 10 to 40 tons in weight. In each case the power unit is an Armstrong-Saurer six-cylinder Diesel engine, with airless injection, which is direct connected to a generator which through the controlling switch supplies current to the driving motor. There is thus no clutch or gear box.

Wallach Bros., Ltd., of 49, Tabernacle Street, London, E.C. 2, are sending out a leaflet calling attention to their carbon monoxide detector which utilizes the fact that when this dangerous poison gas comes into contact with a mixture of iodine pentoxide and fuming sulphuric acid the iodine is liberated, which according to its volume changes an indicator to various shades of blue-green. The appliance consists of a nickel-plated cylindrical body, containing a layer of activated charcoal for keeping back such gases that may interfere with the measurement. It also contains a test tube filled with the indicator and a comparison tube and has at one end a compressible rubber ball for forcing the air through the test tube. For making the tests in inaccessible places a 10-ft. extension tube is employed, which is fixed to the nozzle of the rubber ball. This hose is wound on a metal reel fitting into the lid of the container. The comparison tube is fitted with three layers of finely-granulated material of three shades of green each denoting a different concentration of CO and is marked with a scale showing this clearly.

METAL MARKETS

Copper.—Standard copper values registered a small loss during June, although they closed well above the lowest figures witnessed in the middle of the month. Demand in Europe was quiet on the whole, waiting on developments at the World Economic Conference, although at times there was a disposition for the Continent to convert surplus cash balances into metal on fears of inflation. In the United States consumption has expanded, but the stocks there provide a serious problem and the price has kept fairly steady around 8 cents per lb. delivered Connecticut Valley. Electrolytic c.i.f. Europe fluctuated fairly widely, opening the month at 7·75 cents per lb. and closing at 7·95 cents.

Average price of Cash Standard Copper : June, 1933, £36 16s. 1d. ; May, 1933, £34 2s. 1d. ; June, 1932, £26 18s. 4d. ; May, 1932, £28 11s. 11d.

Tin.—Prices advanced quite smartly early in June, rising from £209 cash to £227 5s. cash in just over a week. Subsequently rather steadier conditions prevailed and prices closed round £221 10s., American buying being a pronounced feature. There is danger of a famine developing in market supplies owing to "Pool" control and June saw the appearance of a "backwardation." The immediate future of prices may depend largely on American industrial policy and whether the "Pool" decides to release any of its holdings.

Average price of Cash Standard Tin : June, 1933, £220 1s. 8d. ; May, 1933, £186 5s. 10d. ; June, 1932, £114 12s. 11d. ; May, 1932, £122 7s. 6d.

Lead.—Fairly steady conditions prevailed in June, sentiment being cheerful despite the fact that world stocks remained excessive. Demand in this country has increased substantially this year and this has, of course, assisted the undertone. In America the market has shown greater activity, but disappointment is expressed that the stocks there have not yet begun to diminish.

Average mean price of lead : June, 1933, £13 8s. 6d. ; May, 1933, £12 4s. 8d. ; June, 1932, £9 15s. 0d. ; May, 1932, £10 17s. 1d.

Spelter.—Prices have fluctuated rather erratically, but the tendency has been upwards, sentiment being undoubtedly strengthened by the steady downward trend of the Cartel stocks, which indicates that consumption, as far as the position outside America is concerned, is definitely in excess of production. In America the record stocks are at last beginning to decline.

Average mean price of spelter : June, 1933, £16 17s. 7d. ; May, 1933, £15 11s. 7d. ; June, 1932, £11 14s. 1d. ; May, 1932, £12 11s. 1d.

Iron and Steel.—The British pig-iron market continued quite active last month and Cleveland stocks were reduced further. Home prices were steady. There is talk of additional furnaces being blown in if existing conditions are maintained. No. 3 Cleveland g.m.b. is still priced at 62s. 6d. per ton delivered Middlesborough zone. East Coast mixed numbers of hematite had a firmer undertone, but the quotation remained around 59s. The British steelmasters are cheerful, but their order books are still rather patchy. The Continental steel market has become quiet.

Iron Ore.—New business is mainly confined to odd cargoes for, whilst consumption has shown some improvement, most users are well bought. Prices are quotably unchanged, with best Bilbao rubio around 15s. 6d. per ton c.i.f.

LONDON DAILY METAL PRICES.

Copper, Tin, Zinc, and Lead per Long Ton; Silver per Standard Ounce; Gold per Fine Ounce.

	Copper. Standard. Cash.	Copper. Standard. 3 Months.	Copper. Electrolytic	Copper. Best Selected.	Tin. Cash.	Tin. 3 Months.	Zinc (Spelter).	Lead. Soft Foreign.	Lead. English.	Silver. Cash.	Silver. Forward.	Gold.
June.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
12	35 14 4½	35 18 1½	40 17 6	—	222 16 3	222 16 3	16 11 3	13 6 3	14 15 0	19 7/16	19½	122 2½
13	36 6 3	36 10 0	41 0 0	39 0 0	224 2 6	224 2 6	16 17 6	13 7 6	14 15 0	19 7/16	19½	122 2
14	35 18 9	36 3 9	41 0 0	—	221 17 6	221 17 6	16 13 9	13 3 9	14 10 0	19 7/16	19 7/16	122 1
15	35 15 7½	35 19 4½	40 10 0	—	221 12 6	221 12 6	16 15 0	13 0 0	14 10 0	19 9/16	19⅝	122 2
16	34 16 3	35 0 7½	40 0 0	37 10 0	212 5 0	212 5 0	16 10 0	12 11 3	14 0 0	19¼	19 5/16	122 1
19	35 10 0	35 15 0	40 0 0	—	216 2 6	216 2 6	16 10 0	12 16 3	14 5 0	19 3/16	19¼	122 2
20	37 4 4½	37 8 1½	41 0 0	39 5 0	225 2 6	224 17 6	17 2 6	13 5 0	14 15 0	19 3/16	19¼	122 1
21	36 2 6	36 5 7½	40 10 0	—	220 10 0	220 12 6	17 2 6	13 3 9	14 15 0	19 1/16	19⅛	122 2
22	36 10 7½	36 14 4½	40 10 0	—	222 8 9	221 17 6	17 2 6	13 3 9	14 15 0	19	19 1/16	122 3
23	36 7 6	36 10 7½	40 10 0	38 15 0	219 17 6	219 2 6	17 5 0	13 5 0	14 15 0	18½	18⅝	122 2
26	36 13 1½	36 17 6	40 15 0	—	221 2 6	220 12 6	17 7 6	13 8 9	14 15 0	18 9/16	18 11/16	122 4
27	37 8 1½	37 11 10½	41 7 6	39 15 0	225 0 0	224 0 0	17 13 9	13 10 0	14 15 0	19 1/16	19 3/16	122 0
28	37 13 9	37 16 10½	41 10 0	—	225 7 6	224 5 0	17 18 9	13 11 3	14 15 0	18 15/16	19 1/16	122 4
29	37 1 3	37 4 4½	41 0 0	—	222 17 6	222 2 6	17 10 0	13 7 6	14 15 0	18⅝	18½	122 4
30	36 14 4½	36 16 10½	41 0 0	39 15 0	221 5 0	220 15 0	17 15 0	13 6 3	14 15 0	18½	18¾	123 0
July.												
3	37 18 9	38 1 3	41 10 0	—	223 7 6	222 12 6	17 10 0	13 7 6	14 15 0	18 9/16	18 15/16	123 1
4	38 6 3	38 8 9	42 5 0	40 15 0	223 17 6	223 6 3	17 10 0	13 10 0	15 0 0	18⅞	18 15/16	122 10
5	38 19 4½	39 1 10½	42 15 0	—	225 8 9	224 17 6	18 0 0	13 13 9	15 0 0	18 15/16	19	123 7
6	38 16 3	38 19 4½	42 15 0	—	223 7 6	222 12 6	18 5 0	13 15 0	15 0 0	18 7/16	18 9/16	124 1
7	38 14 4½	38 16 10½	42 10 0	41 0 0	221 12 6	221 7 6	18 10 0	13 16 3	15 0 0	18 5/16	18 7/16	124 3
10	38 19 4½	39 1 10½	42 15 0	—	215 17 6	215 17 6	18 11 3	13 12 6	15 0 0	17⅞	18	124 6

ANTIMONY.—For a time China adopted a much firmer attitude during June and prices advanced quite sharply, but demand failed to improve to the extent hoped for and at the moment the market is quiet. Metal for forward shipment from China is about £24 to £24 5s. c.i.f., with English regulus £37 10s. to £40.

ARSENIC.—Foreign material is easier, down to about £15 10s. c.i.f. now being quoted, but Cornish white remains at about £16 10s. f.o.r. mines.

BISMUTH.—The official price is unaltered at 4s. 3d. per lb. for 5 cwt. lots.

CADMIUM.—Demand is quietly steady, with prices at present about 1s. 2½d. to 1s. 3d. per lb.

COBALT METAL.—A little more inquiry is reported, but quotations are unchanged at 5s. 6d. per lb.

COBALT OXIDES.—Business has not been very brisk, but values remain at around 4s. 7d. to 5s. per lb. for black and 5s. 2d. to 5s. 5d. for grey.

CHROMIUM.—There is a demand for plating purposes at the unaltered price of 2s. 8d. per lb.

TANTALUM.—In the absence of any particular demand prices are unchanged at £15 per lb.

PLATINUM.—The official price is steady at £7 15s. per oz., although now and then one hears of business at rather lower levels.

PALLADIUM.—Business is anything but brisk, but quotations are without change at £3 10s. to £4 5s. per oz.

OSMIUM.—Quotations remain at £12 to £13 per oz., demand continuing light.

IRIDIUM.—Little interest is shown in sponge and powder, but holders still ask £9 to £10 per oz.

TELLURIUM.—About 15s. to 16s. per lb. is named as the current value of this metal.

SELENIUM.—A steady business continues at the unaltered prices of 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse, for high-grade black powder.

MANGANESE ORE.—Here and there are signs of increasing interest on the part of buyers, but for the most part actual orders are confined to small lots. Prices are steady at 9½d. per unit c.i.f. best Indian and 8½d. to 9d. c.i.f. for 50 to 52% washed Caucasian.

ALUMINIUM.—Business in raw aluminium is not particularly active, but with production pretty well in line with consumption the market has quite a good undertone and prices are upheld at £100 for ingots and bars and £102 for rolling billets both less 2% delivered.

SULPHATE OF COPPER.—Current quotations are about £16 15s. to £17 5s. per ton, less 5% for English.

NICKEL.—Demand for this metal continues to broaden and production schedules are being increased. Quotations, however, are steady at £225 to £230 per ton, according to quantity.

CHROME ORE.—The market generally continues to wear a rather quiet appearance, but leading interests still quote 80s. to 85s. per ton c.i.f. for first quality 48% Rhodesian ore and 100s. to 105s. c.i.f. for 55 to 57% New Caledonian.

QUICKSILVER.—Demand is still rather restricted, but prices keep pretty steady at around £9 10s. per bottle for spot material.

TUNGSTEN ORE.—The low prices recently have led to a reduction in output and stocks in China are now very low. Holders accordingly are very reserved and latterly quotations have begun to advance, the present value of forward shipment being around 13s. 3d. to 13s. 9d. per unit c.i.f.

MOLYBDENUM ORE.—The market is quiet, but quotations remain at about 44s. to 45s. per unit c.i.f. for 80 to 85% concentrates.

GRAPHITE.—The position shows little change, the market being quietly steady, with 85 to 90% raw Madagascar flake about £19 to £21 per ton and 90% Ceylon lumps £15 to £17 c.i.f.

SILVER.—Prices moved rather uncertainly during June, the market inevitably being affected by developments at the World Economic Conference. Spot bars, which stood at 18⅜d. on June 1, gradually improved to 19 9/16d. on June 15, but, despite many resolutions urging the remonetization of silver and other measures for raising its price, the failure of anything concrete being done led to an easier tendency and on June 30 spot bars had receded to 18½d., notwithstanding some temporary improvements during the second half of the month.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
June, 1932	913,297	45,714	959,011
July	933,947	47,213	981,160
August	943,174	48,148	991,322
September	912,870	48,631	961,501
October	926,686	48,279	974,965
November	930,085	48,631	978,716
December	931,749	48,869	980,618
January, 1933	919,125	48,332	967,457
February	835,931	47,214	883,145
March	896,728	50,135	946,863
April	845,099	49,998	895,097
May	893,464	51,140	944,604
June	868,834	49,799	918,633

TRANSVAAL GOLD OUTPUTS.

	May.		June.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	118,500	£219,061	114,000	£213,290
City Deep	97,500	22,205	100,000	21,249
Cons. Main Reef	80,500	24,167	80,500	23,744
Crown Mines	296,000	89,061	290,000	86,329
Daggafontein	52,500	£120,607	56,000	£120,968
D'rb'n Roodepoort Deep	52,000	14,609	51,100	14,091
East Geduld	74,000	25,172	73,000	24,837
East Rand P.M.	166,000	41,252	162,500	40,506
Geduld	91,500	27,910	88,000	27,068
Geldenhuis Deep	77,400	15,916	78,000	15,267
Glynn's Lydenburg	7,600	2,668	7,500	2,675
Government G.M. Areas	216,000	£529,096	208,000	£510,966
Kleinfontein	54,000	9,975	52,000	9,507
Langlaagte Estate	80,000	£137,183	77,000	£130,895
Luipaard's Vlei	36,500	8,499	36,400	8,293
Modderfontein New	179,000	54,179	173,000	52,031
Modderfontein B	77,500	17,570	75,000	16,970
Modderfontein Deep	46,000	19,704	45,100	19,107
Modderfontein East	78,000	19,911	76,500	19,518
New State Areas	95,000	£265,653	91,000	£255,775
Nourse	72,000	18,449	71,000	18,270
Randfontein	263,000	£432,629	262,000	£419,418
Robinson Deep	100,000	26,980	100,000	26,774
Rose Deep	65,000	12,308	63,000	11,887
Simmer and Jack	91,500	20,984	89,200	20,951
Springs	84,500	£222,528	84,500	£218,496
Sub Nigel	38,300	36,103	39,700	35,956
Transvaal G.M. Estates	20,600	5,278	20,000	5,053
Van Ryn	52,500	£60,732	52,000	£58,633
Van Ryn Deep	77,000	£131,002	77,000	£126,559
West Rand Consolidated	98,000	£150,176	95,000	£144,758
West Springs	84,500	£106,957	86,000	£106,307
Witw'tersr'nd (Knights)	75,000	£73,525	72,000	£71,460
Witwatersrand Deep	47,200	15,088	47,500	14,437

Gold at 120s. per oz.

COST AND PROFIT ON THE RAND, Etc.

Compiled from official statistics published by the Transvaal Chamber of Mines.

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
March, 1932	2,901,300	27 10	19 7	8 3	1,200,278
April	2,883,500	27 9	19 5	8 4	1,196,011
May	2,964,100	27 6	19 2	8 4	1,228,198
June	2,927,200	27 9	19 3	8 6	1,241,392
July	2,993,600	27 5	19 0	8 5	1,260,744
August	3,027,700	27 6	19 1	8 5	1,277,923
September	2,940,800	27 6	19 1	8 5	1,234,584
October	2,994,500	27 5	19 0	8 5	1,263,274
November	2,949,050	27 8	19 2	8 6	1,256,717
December	2,972,000	27 10	19 5	8 5	1,255,797
January, 1933	3,029,000	37 10	19 4	18 6	2,802,754
February	2,802,600	37 0	19 9	17 3	2,414,758
March	3,087,860	36 1	19 7	16 6	2,549,179
April	2,922,200	36 1	19 9	16 4	2,381,971
May	—	—	—	—	2,556,066

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
June 30, 1932	217,077	11,833	—	228,910
July 31	217,525	12,056	—	229,581
August 31	217,658	11,727	—	229,385
September 30	216,398	11,642	—	228,040
October 31	216,298	11,353	—	227,651
November 30	219,024	11,207	—	230,231
December 31	221,008	11,310	—	232,318
January 31, 1933	222,005	11,292	—	233,297
February 28	222,589	11,472	—	234,061
March 31	223,490	11,626	—	235,116
April 30	225,279	11,611	—	236,890
May 31	227,178	11,562	—	238,740
June 30	229,751	12,059	—	241,810

PRODUCTION OF GOLD IN RHODESIA.

	1930	1931	1932	1933
	oz.	oz.	oz.	oz.
January	46,121	45,677	42,706	48,656
February	43,385	42,818	45,032	47,661
March	45,511	42,278	47,239	49,929
April	45,806	43,776	46,487	53,559
May	47,645	43,731	46,854	53,358
June	45,208	44,118	48,441	—
July	45,810	44,765	47,331	—
August	46,152	43,292	49,254	—
September	46,151	42,846	50,198	—
October	45,006	44,260	50,416	—
November	44,351	44,516	48,082	—
December	46,485	50,034	52,096	—

RHODESIAN GOLD OUTPUTS.

	May.		June.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,600	9,576	25,600	10,466
Globe and Phœnix	6,080	5,395	6,078	5,419
Lonely Reef	11,500	1,327	11,000	1,917
Luiri Gold	—	—	—	—
Rezende	6,500	2,402	6,500	2,279
Sherwood Star	6,800	1,892	6,900	£1,904
Wanderer Consolidated	10,000	3,653	15,600	3,517

WEST AFRICAN GOLD OUTPUTS.

	May.		June.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	7,173	£23,944	—	—
Ashanti Goldfields	13,610	14,809	13,625	14,808
Taquah and Abosso	10,458	3,131	10,181	3,338

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
June, 1932	50,079	—	920
July	53,585	—	1,391
August	51,536	—	1,026
September	54,427	—	1,160
October	51,236	—	2,169
November	53,956	—	4,386
December	52,282	38,612†	4,602
January, 1933	45,755	9,133	4,005
February	47,281	—	4,365
March	47,105	5,747	4,758
April	52,909	—	—
May	53,300	—	—
June	53,451	—	—

† Period Jan.–Nov. 1932.

AUSTRALASIAN GOLD OUTPUTS.

	May.		June.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,267	5,476	5,249	6,126
Blackwater (N.Z.)	4,100	1,932*	3,817	1,613*
Boulder Persev'ce (W.A.)	7,009	3,225*	7,083	13,668
Grt. Boulder Pro. (W.A.)	6,884	5,361*	6,436	5,329*
Lake View & Star (W.A.)	42,796	78,933	—	—
Sons of Gwalia (W.A.)	11,540	15,577	12,026	14,417
South Kalgurli (W.A.)	9,517	13,489	9,650	14,262
Waihi (N.Z.)	17,728‡‡	5,072* 29,846†	—	— —
Wiluna	35,033	9,500*	—	—

* Oz. gold. † Oz. silver. ‡‡ To June 10.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	May.		June.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Champion Reef	9,290	5,282	9,150	5,256
Mysore	14,860	7,669	14,545	7,640
Nundydroog	18,094	9,689*	18,115	9,183†
Ooregum	11,804	3,997	13,508	4,196

* 1,134 oz. from 932 tons Balaghat ore. † 425 oz. from 749 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	May.		June.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	167,117*d*	—	168,987*d*
Chosen Corp. (Korea)	12,460	19,549	—	—
Frontino Gold (C'lbia)	4,690	24,885	4,400	24,294
Fresnillo	69,411	49,563*d*	—	—
New Goldfields of Venezuela	—	2,976	10,722	3,419
Oriental Cons. (Korea)	—	84,683*d*	—	86,644*d*
St. John del Rey (Brazil)	—	38,000	—	30,000
Santa Gertrudis (Mexico)	15,653	4,645*d*‡	—	—
Viborita	—	—	—	—
West Mexican Mines	1,130	17,400*d*	—	—

d Dollars. ‡ Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 72% of Concentrate shipped to Smelters. Long Tons.

July, 1932	1,437	January, 1933	2,312
August	1,164	February	2,154
September	1,123	March	1,506
October	2,273	April	2,589
November	2,242	May	1,917
December	1,590	June	1,092

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Apr.	May.	June.
Ayer Hitam	68¼	29¼	—
Batu Caves	22½	9	—
Changkat	60	55	58
Gopeng	—	—	68*
Hongkong Tin	—	—	85½*
Idris Hydraulic	20¾	12¾	—
Ipoh	54¾	40¾	51
Kampar Malaya	—	—	—
Kampong Lanjut	—	—	—
Kamunting	145	146	118
Kent (F.M.S.)	—	—	—
Killinghall	—	—	64¾*
Kinta	—	—	32*
Kinta Kellas	36½	—	—
Kramat Tin	85	80	67
Kuala Kampar	—	—	—
Kundang	—	—	—
Labat	12⅛	11¾	6
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	68½	80	—
Malim Nawar	—	—	—
Pahang	72	72	72
Penawat	45	40½	50
Pengkalen	—	—	62½*
Petaling	152	100	—
Rahman	23	—	—
Rambutan	—	—	—
Rantau	39½	—	—
Rawang	23	20	32
Rawang Concessions	23	40	28
Renong	27	28¼	—
Selayang	—	—	—
Southern Kampar	75	—	—
Southern Malayan	53½	47½	50
Southern Perak	51	—	—
Southern Tronoh	17	17	17
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	56½	47½	—
Taiping	12½	17	—
Tanjong	—	—	—
Tekka	—	—	36*
Tekka Taiping	—	—	61*
Temoh	—	—	—
Tronoh	37	37	37
Ulu Klang	—	—	—

* 3 months to June 30.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Apr.	May.	June.
Anglo-Nigerian	17½	21⅞	14½
Associated Tin Mines	110	110	109¾
Baba River	3	3	3
Batura Monguna	—	—	—
Bisichi	25	30	—
Daffo	—	—	—
Ex-Lands	—	—	15½
Filani	—	—	—
Jantar	12	10	10
Jos	8¼	8¼	—
Juga Valley	3¼	5¼	5½
Kaduna Syndicate	11	14	—
Kaduna Prospectors	6	6	—
Kassa	3	4½	4¾
London Tin	86	80	74
Lower Bisichi	3¼	3¼	—
Naraguta Extended	—	—	—
Nigerian Consolidated	5	—	—
Offin River	—	—	—
Ribon Valley	9½	12	9
Tin Fields	—	—	—
United Tin Areas	9	11	8¾
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Apr.	May.	June.
Anglo-Burma (Burma)	21¾	24¾	—
Aramayo Mines (Bolivia)	108	98	96
Bangrin (Siam)	61½	44	43½
Beralt	24*	26¼*	—
Consolidated Tin Mines (Burma)	72	61	67
East Pool (Cornwall)	44	46½	—
Fabulosa (Bolivia)	32	31	—
Geevor	52	66	—
Kagera (Uganda)	25	25	25
Kamra	—	—	32¼
Malaysiam Tin	13¼	13¼	13¼
Mawchi	224*	234*	224½*
Patino	—	—	—
Pattani	—	—	55
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	140	94	109¾
South Crofty	52	58¼	54¾
Tavoy Tin (Burma)	45½	67½	43½
Tongkah Harbour (Siam)	32	30	26
Toyo (Japan)	71	80½	70¾
Zaaiplaats	—	—	—

* Tin and Wolfram.

COPPER LEAD, AND ZINC OUTPUTS.

		May.	June.
Britannia Lead	Tons refined lead	4,594	—
	Oz. refined silver	217,194	—
Broken Hill South	Tons lead conc.	5,679	6,104
	Tons zinc conc.	6,481	6,574
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	520,909	520,332
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	400	400
	Tons yellow metal	505	530
Messina	Tons copper	733	786
Mount Isa	Tons lead bullion	4,906	—
Mount Lyell	Tons concentrates	2,900‡	3,028*
North Broken Hill	Tons lead conc.	5,380†	—
	Tons zinc conc.	4,992	—
Rhodesia Broken Hill	Tons Zinc	1,655	1,600
	Tons V_2O_5 conc.	—	—
Roan Antelope	Tons blister copper	—	—
Sulphide Corporation	Tons lead conc.	1,709	—
	Tons zinc conc.	2,262	—
Trepca	Tons lead conc.	5,560	4,897
	Tons zinc conc.	7,229	6,405
Zinc Corporation	Tons lead conc.	5,623	—
	Tons zinc conc.	3,604	—

* To June 14. † To May 20. ‡ To May 17.

IMPORTS OF ORES, METALS, Etc., INTO UNITED KINGDOM.

		April.	May.
Iron Ore	Tons	252,315	242,177
Manganese Ore	Tons	8,840	11,156
Iron and Steel	Tons	70,891	84,927
Copper and Iron Pyrites	Tons	23,648	25,296
Copper Ore, Matte, and Prec.	Tons	3,594	4,391
Copper Metal	Tons	40,547	13,703
Tin Concentrate	Tons	2,730	4,058
Tin Metal	Tons	200	85
Lead Pig and Sheet	Tons	24,382	30,405
Zinc (Spelter)	Tons	6,339	6,809
Zinc Sheets, etc.	Tons	973	1,473
Zinc Oxide	Tons	93	24
Zinc Ore and Conc.	Tons	10,529	10,502
Aluminium	Cwt.	6,850	9,358
Mercury	Lb.	231,511	92,434
White Lead	Cwt.	5,363	7,728
Barytes, ground	Cwt.	22,056	26,853
Asbestos	Tons	1,575	2,508
Boron Minerals	Tons	681	992
Borax	Cwt.	6,144	8,642
Basic Slag	Tons	450	—
Superphosphates	Tons	7,796	3,164
Phosphate of Lime	Tons	26,077	14,091
Mica	Tons	102	130
Tungsten Ores	Tons	304	374
Sulphur	Tons	4,484	3,651
Nitrate of Soda	Cwt.	20	1,702
Potash Salts	Cwt.	180,751	84,017
Petroleum: Crude	Gallons	38,849,347	32,968,868
Lamp Oil	Gallons	21,478,195	12,690,692
Motor Spirit	Gallons	83,067,288	109,354,596
Lubricating Oil	Gallons	8,520,338	9,496,787
Gas Oil	Gallons	13,285,295	11,882,010
Fuel Oil	Gallons	42,382,095	47,271,485
Asphalt and Bitumen	Tons	7,161	4,357
Paraffin Wax	Cwt.	52,804	81,909

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	Apr.	May.	June.
Anglo-Ecuadorian	15,024	15,852	—
Anglo-Persian	569,000	624,000	—
Apex Trinidad	47,990	47,700	44,130
Attock	1,242	1,233	1,135
British Burmah	5,225	4,854	4,810
British Controlled	37,945	36,488	31,155
Kern Mex	857	873	808
Kern River (Cal.)	3,187	3,485	2,881
Kern Romana	207	156	172
Kern Trinidad	3,937	4,571	3,985
Lobitos	21,614	22,221	—
Phœnix	63,255	65,400	64,623
St. Helen's Petroleum	3,797	3,850	4,006
Steaua Romana	88,084	90,457	—
Tampico	2,378	2,442	2,220
Tocuyo	1,042	1,095	1,052
Trinidad Leaseholds	32,450	30,450	32,150

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	June 9, 1933.			July 10, 1933.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		12	6		14	0
Anglo-Egyptian B	1	10	0	1	10	0
Anglo-Persian 1st Pref.	1	9	0	1	10	0
,, ,, Ord.	1	15	6	2	2	6
Apex Trinidad (5s.)	1	3	3	1	6	0
Attock		10	0		10	9
British Burmah (8s.)		4	9		5	0
British Controlled ($5)		4	6		5	3
Burmah Oil	3	7	6	3	17	6
Kern River Cal. (10s.)		3	9		4	9
Lobitos, Peru	1	16	9	2	3	9
Mexican Eagle, Ord. (4 pesos)		7	3		8	0
,, ,, 8% Pref. (4 pesos)		7	0		9	0
Phœnix, Roumanian		10	0		12	9
Royal Dutch (100 fl.)	20	5	0	21	10	0
Shell Transport, Ord.	2	7	6	2	13	0
,, ,, 5% Pref. (£10)	11	15	0	11	12	6
Steaua Romana		8	3		12	0
Trinidad Leaseholds	2	11	9	2	16	9
United British of Trinidad (6s. 8d.)		4	9		5	0
V.O.C. Holding	1	15	0	1	17	6

PRICES OF CHEMICALS. July 11.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.	1	0	9
,, ,, 80%	,,	1	18	5
,, ,, Glacial	per ton	59	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	1
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate (Mono- and Di-)	,,	58	0	0
,, Sulphate, 20·6% N.	,,	6	15	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	18	0	0
Barium, Carbonate (native), 94%	,,	4	10	0
,, Chloride	,,	9	10	0
Barytes	,,	8	5	0
Benzol, standard motor	per gal.		1	5
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	,,	16	10	0
Boric Acid	,,	26	10	0
Calcium Chloride, solid, 70/75%	,,	5	5	0
Carbolic Acid, crude 60's	per gal.		3	0
,, ,, crystallized, 40°	per lb.			10½
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.			9½
Copper Sulphate	per ton	17	0	0
Creosote Oil (f.o.b. in Bulk)	per gal.			3⅛
Cresylic Acid, 98–100%	,,		1	3
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine Resub. B.P. (28 lb. lots)	,,		14	11
Iron, Nitrate 80° Tw.	per ton	6	0	0
,, Sulphate	,,	1	12	6
Lead, Acetate, white	,,	31	10	0
,, Nitrate (ton lots)	,,	27	10	0
,, Oxide, Litharge	,,	28	0	0
,, White	,,	37	10	0
Lime, Acetate, brown	,,	9	10	0
,, ,, grey, 80%	,,	15	10	0
Magnesite, Calcined	,,	9	10	0
Magnesium Chloride	,,	6	10	0
,, Sulphate, comml.	,,	5	0	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	0
Nitric Acid, 80° Tw.	per ton	21	10	0
Oxalic Acid	per ton	48	0	0
Phosphoric Acid. (Conc. 1·750)	per lb.			10
Pine Oil	per cwt.	2	7	6
Potassium Bichromate	per lb.			5
,, Carbonate, 96/98%	per ton	30	0	0
,, Chlorate	per lb.			4½
,, Chloride, 80%	per ton	9	10	0
,, Ethyl Xanthate	per 100 kilos	7	8	0
,, Hydrate (Caustic) 88/90%	per ton	40	0	0
,, Nitrate	,,	30	0	0
,, Permanganate	per lb.			8½
,, Prussiate, Yellow	per ton	75	0	0
,, ,, Red	per lb.		2	0
,, Sulphate, 90%	per ton	10	10	0
Sodium Acetate	,,	22	0	0
,, Arsenate, 45%	,,	23	0	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			4
,, Carbonate (Soda Ash), 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	2	6
,, Chlorate	,,	32	0	0
,, Cyanide, 100% NaCN basis	per lb.			8
,, Ethyl Xanthate	per 100 kilos	7	0	6
,, Hydrate, 76/77%	per ton	14	0	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (refined)	,,	8	10	0
,, Phosphate, comml.	,,	12	0	0
,, Prussiate	per lb.			4¾
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	3	3	6
,, Sulphide, Conc., 60/65%	,,	10	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	9	10	0
,, Roll	,,	9	10	0
Sulphuric Acid 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw.	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	4	0
Tartaric Acid	per lb.			11¾
Turpentine	per ton	54	0	0
Tin Crystals	per lb.		1	0
Titanous Sulphate (Stabilized)	,,			9
Zinc Chloride	per ton	9	10	0
,, Dust, 90/92%	,,	20	0	0
,, Oxide (White Seal)	,,	35	0	0
,, Sulphate	,,	9	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:

	June 9, 1933. £ s. d.	July 10, 1933. £ s. d.
SOUTH AFRICA:		
Brakpan	5 10 0	5 12 6
City Deep	1 5 6	1 6 3
Consolidated Main Reef	2 3 9	2 2 6
Crown Mines (10s.)	8 5 0	8 16 3
Daggafontein	3 7 6	4 2 6
Durban Roodepoort Deep (10s.)	1 12 6	1 16 3
East Geduld	4 17 6	5 12 6
East Rand Proprietary (10s.)	1 7 6	1 6 6
Geduld	5 17 6	6 7 6
Geldhenhuis Deep	1 7 6	1 6 3
Glynn's Lydenburg	1 0 0	1 0 0
Government Gold Mining Areas (5s.)	2 5 6	2 11 3
Grootvlei	2 15 0	3 2 6
Langlaagte Estate	1 8 9	1 7 6
Luipaard's Vlei (2s.)	9 6	10 3
Modderfontein, New (10s.)	3 3 9	3 5 0
Modderfontein B (5s.)	18 0	18 6
Modderfontein Deep (5s.)	18 0	17 6
Modderfontein East	2 17 6	3 3 9
New Kleinfontein	1 3 6	1 9 0
New State Areas	3 1 3	3 1 3
Nourse	1 17 6	2 0 9
Randfontein	2 10 9	2 10 9
Robinson Deep A (1s.)	13 9	12 6
,, ,, B (7s. 6d.)	1 9 9	1 12 6
Rose Deep	1 1 9	1 0 0
Simmer and Jack (2s. 6d.)	7 9	8 9
Springs	4 18 9	5 2 6
Sub Nigel (10s.)	7 17 6	8 11 3
Van Ryn	1 5 0	1 5 6
Van Ryn Deep	1 12 6	1 11 3
Village Deep (9s. 6d.)	1 3	1 3
West Rand Consolidated (10s.)	1 1 9	1 1 6
West Springs	1 8 9	1 9 3
Witwatersrand (Knights)	1 1 3	1 2 6
Witwatersrand Deep	1 7 6	1 5 6
RHODESIA:		
Cam and Motor	2 8 0	2 10 9
Globe and Phœnix (5s.)	17 0	1 0 0
Lonely Reef	10 0	9 6
Luiri Gold (5s.)	9	6
Rezende (17s. 6d.)	1 8 9	1 7 6
Sherwood Starr (5s.)	11 9	13 6
Wanderer	18 9	18 9
GOLD COAST:		
Ariston (2s. 6d.)	7 9	8 3
Ashanti (4s.)	2 7 0	2 9 9
Taquah and Abosso (4s.)	11 0	12 6
AUSTRALASIA:		
Associated Gold (4s.), W.A.	3 3	3 0
Boulder Perseverance	2 6	2 3
Golden Horseshoe (3s.), W.A.	4 0	3 6
Great Boulder Propriet'y (2s.), W.A.	7 9	8 9
Lake View and Star (4s.), W.A.	19 0	1 1 0
Sons of Gwalia (10s.), W.A.	1 2 0	1 6 0
South Kalgurli (10s.), W.A.	1 7 6	1 10 9
Waihi (5s.), N.Z.	18 3	18 6
Wiluna Gold, W.A.	2 4 0	2 8 6
INDIA:		
Champion Reef (10s.)	1 3 0	1 3 6
Mysore (10s.)	14 0	15 0
Nundydroog (10s.)	2 8 3	2 10 0
Ooregum (10s.)	6 9	6 9
AMERICA:		
Camp Bird (2s.), Colorado	8	8
Exploration (10s.)	3 6	3 6
Frontino and Bolivia, Colombia	1 7 3	1 8 0
Mexican Corporation (10s.), Mexico	6 6	8 0
New Goldfields of Venezuela (5s.)	6 6	7 6
St. John del Rey, Brazil	1 1 6	1 1 0
Santa Gertrudis, Mexico	6 0	6 3
Viborita (5s.), Colombia	3 6	4 0
MISCELLANEOUS:		
Chosen, Korea	12 6	15 6
New Guinea	5 0	5 0

COPPER:

	June 9, 1933. £ s. d.	July 10, 1933. £ s. d.
Bwana M'Kubwa (5s.), Rhodesia	5 9	6 0
Esperanza	6 3	6 3
Indian (2s.)	2 0	2 3
Loangwa (5s.), Rhodesia	1 9	1 7
Mason and Barry	12 6	15 6
Messina (5s.), Transvaal	11 3	12 0
Mount Lyell, Tasmania	18 0	17 6
Namaqua (£2), Cape Province	3 6	3 6
Rhodesia-Katanga	10 0	11 3
Rio Tinto (£5), Spain	18 0 0	20 15 0
Roan Antelope (5s.), Rhodesia	1 3 0	1 5 9
Tanganyika Concessions	14 3	16 6
Tharsis (£2), Spain	3 8 9	3 18 9

LEAD-ZINC:

	June 9, 1933. £ s. d.	July 10, 1933. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	8 3	8 3
Broken Hill Proprietary, N.S.W.	1 6 9	1 6 6
Broken Hill, North, N.S.W.	3 5 0	3 8 9
Broken Hill, South, N.S.W.	2 2 6	2 6 3
Burma Corporation (10 rupees)	13 6	13 9
Electrolytic Zinc Pref., Tasmania	16 0	1 4 3
Mount Isa, Queensland	9 0	8 6
Rhodesia Broken Hill (5s.)	2 0	2 0
San Francisco (10s.), Mexico	13 6	15 0
Sulphide Corporation (15s.), N.S.W.	8 0	8 0
ditto, Pref.	11 3	12 6
Trepca (5s.), Yugoslavia	12 3	14 0
Zinc Corporation (10s.), N.S.W.	1 4 0	1 3 9
ditto, Pref.	4 0 0	3 18 9

TIN:

	June 9, 1933. £ s. d.	July 10, 1933. £ s. d.
Aramayo Mines (25 fr.), Bolivia	17 6	18 9
Associated Tin (5s.), Nigeria	6 6	6 6
Ayer Hitam (5s.), Malay	13 6	14 3
Bangrin, Siam	17 6	19 0
Bisichi (10s.), Nigeria	7 6	7 9
Consolidated Tin Mines of Burma	4 3	4 9
East Pool (5s.), Cornwall	1 0	1 0
Ex-Lands Nigeria (2s.)	2 6	2 6
Geevor (10s.), Cornwall	7 0	7 3
Gopeng, Malay	1 13 9	1 13 9
Hongkong (5s.), Malay	15 0	14 3
Idris (5s.), Malay	7 0	6 0
Ipoh Dredging (16s.), Malay	1 1 6	1 3 9
Kaduna Prospectors (5s.), Nigeria	7 0	7 0
Kaduna Syndicate (5s.), Nigeria	16 0	15 6
Kamunting (5s.), Malay	9 3	9 3
Kepong, Malay	10 0	10 0
Kinta (5s.), Malay	6 6	6 9
Kinta Kellas (5s.), Malay	6 0	5 6
Kramat Pulai, Malay	1 0 6	1 0 6
Kramat Tin, Malay	1 11 6	1 10 0
Lahat, Malay	—	—
Malayan Tin Dredging (5s.)	1 3 9	1 3 3
Naraguta, Nigeria	10 0	10 0
Pahang Consolidated (5s.), Malay	7 3	7 0
Penawat ($1), Malay	2 0	2 0
Pengkalen (5s.), Malay	10 0	10 0
Petaling (2s. 4d.), Malay	13 3	12 9
Rambutan, Malay	5 0	5 0
Renong Dredging, Malay	1 2 9	1 3 9
Siamese Tin (5s.), Siam	12 9	18 0
South Crofty (5s.), Cornwall	3 9	3 6
Southern Malayan (5s.)	13 0	12 9
Southern Perak, Malay	1 6 9	1 8 9
Southern Tronoh (5s.), Malay	6 3	6 6
Sungei Besi (5s.), Malay	11 3	11 0
Sungei Kinta, Malay	11 0	11 9
Tanjong (5s.), Malay	7 0	7 0
Tavoy (4s.), Burma	6 0	6 0
Tekka, Malay	10 0	10 0
Tekka Taiping, Malay	11 3	10 9
Temoh, Malay	15 0	15 9
Toyo (2s. 6d.), Japan	3 0	3 0
Tronoh (5s.), Malay	17 6	17 0

DIAMONDS:

	June 9, 1933. £ s. d.	July 10, 1933. £ s. d.
Consol. African Selection Trust (5s.)	1 5 0	1 7 6
Consolidated of S.W.A. (10s.)	6 6	6 3
De Beers Deferred (£2 10s.)	5 16 3	6 10 0
Jagersfontein	1 7 6	1 9 6
Premier Preferred (5s.)	2 0 0	2 0 0

FINANCE, ETC.:

	June 9, 1933. £ s. d.	July 10, 1933. £ s. d.
Anglo American Corporation (10s.)	16 6	18 6
Anglo-Continental (10s.)	5 0	5 0
Anglo-French Exploration	1 2 6	1 3 0
Anglo-Oriental (5s.)	7 3	7 3
ditto, Pref.	15 6	15 3
British South Africa (15s.)	19 3	1 2 3
Central Mining (£8)	15 17 6	16 15 0
Consolidated Gold Fields	2 17 6	3 7 6
Consolidated Mines Selection (10s.)	11 3	11 6
Fanti Consols (8s.)	10 6	11 3
General Mining and Finance	2 0 9	2 3 6
Gold Fields Rhodesian (10s.)	6 3	7 3
Johannesburg Consolidated	2 6 3	2 9 6
London Tin Corporation (10s.)	14 0	13 6
Minerals Separation	4 10 0	4 7 6
Mining Trust	5 0	4 9
National Mining (8s.)	9	9
Rand Mines (5s.)	5 10 0	5 12 6
Rand Selection (5s.)	14 9	15 0
Rhodesian Anglo American (10s.)	16 0	17 6
Rhodesian Selection Trust (5s.)	9 0	10 9
Rhokana Corp.	6 5 0	6 15 0
Tigon (5s.)	3 9	3 9
Union Corporation (12s. 6d.)	4 6 3	4 13 9
Venture Trust (6s. 8d.)	7 6	8 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

THE SCOTTISH ALUMINIUM INDUSTRY

In a paper read before the Institution of Mechanical Engineers at Edinburgh on May 30 last Mr. George Boex gives an account of the aluminium industry in Scotland. The methods of production described are those followed by the British Aluminium Company, which started operations at Foyers in Inverness-shire, at Greenock, at Larne, County Antrim, Northern Ireland, and at Milton, Staffordshire, in 1896, but it can be said that in general these methods are broadly the same as those of other manufacturers of the metal.

The author says that although there is probably more aluminium ore in the crust of the earth than that of any other metal yet for economic reasons it follows that the most suitable ore only is used. This is bauxite containing some 55% of alumina, the remainder being ferric oxide, silica, and small quantities of other impurities and combined water. The bauxite ore reserves of the British Aluminium Company are situated in the South of France, the Gold Coast, and in British Guiana.

Since the ore has to be shipped to this country from overseas, it follows that these works should be adjacent to a port which can deal with vessels of from 5,000 to 10,000 tons. The chemical process demands large quantities of steam so that cheap coal is necessary. There must also be a good supply of water of suitable quality and, finally, it must be possible to dispatch the alumina economically to the various reduction works. The Burntisland works are placed close to the vast Fife coalfield and the harbour deals satisfactorily with the incoming ore and with the outgoing alumina intended for the reduction works of the subsidiary companies in Norway just across the North Sea. It is also well placed for rail transport of the alumina powder by tank wagon to the Lochaber factory at Fort William, Inverness-shire, belonging to the associated company, the North British Aluminium Company.

The Bayer process for the production of aluminium oxide Al_2O_3 is the most widely used and is that followed by the British Aluminium Company at Burntisland. The process is started by grinding the bauxite. Within limits the finer the product the better is the efficiency of the next step in the process. Grinding is carried out, if possible, without recourse to preliminary drying, since this is costly. An average analysis of bauxite is as follows :—

Alumina	54·5	per cent.
Silica	3·3	,, ,,
Ferric Oxide	22·6	,, ,,
Titanium Oxide	2·8	,, ,,
Loss on ignition	11·3	,, ,,
Moisture	5 to 6	,, ,,

The next stage involves the mixing of the bauxite powder with caustic soda liquor. Very careful weighing has to be done and the correct strength of liquor used. The mixture is then pumped to the digesters or "kiers." During the period of digestion or "kiering" solution of the alumina content of the bauxite takes place with the formation of sodium aluminate, leaving in solid form the impurities, including ferric oxide, silica, and titanium oxide. The contents are heated and agitated continuously and the ratio of soda to alumina has to be such that no separation of the latter takes place at this stage.

When digestion is complete the contents of the kiers are blown into tanks and from them—at the correct temperature and diluted in strength—the liquor is pumped to the filter presses. From the presses, the red mud is scraped off into chutes, and is then diluted to a slurry and run away to either the red oxide production plant or to a "slobland." If the operations have been carried out correctly, the sodium aluminate liquor should contain but the smallest traces of silica, ferric oxide, and other impurities and it can be run into the decomposer tanks, care being taken that no separation of the alumina content occurs.

The action of the decomposers is interesting and is based on the discovery of Bayer, that if, under correct conditions of strength and temperature, a solution of sodium aluminate is properly agitated with "seed" aluminium hydrate, the alumina in the sodium aluminate solution will separate out, leaving a soda liquor containing but a small percentage of alumina in solution. It will be clear that very careful control of temperature and strength of solution is necessary here, to obtain the maximum extraction and the correct size of "seed" to produce alumina of the grain size suitable for the reduction furnaces. It takes some 100 to 120 hours for the complete cycle of decomposition of the solution, during which time the temperature is allowed to drop at a predetermined rate.

The contents of the decomposers are pumped to plate filter presses, but sufficient aluminium hydrate is left in the decomposer to act as seed to attack the next lot of sodium aluminate liquor. The filtering operation produces a cake of Al_2O_3 plus combined water and it is necessary to wash very thoroughly the hydrate cake whilst in the presses by means of fresh water under pressure to remove adhering soda, which otherwise represents a waste and an impurity. The soda liquor and a portion of the washing water containing soda are pumped to the evaporation plant, where the caustic soda liquor is concentrated to the strength necessary to attack the bauxite at the start of the process. A make-up of caustic soda is necessary, as an amount combines with the silica, calcium oxide, and other impurities present in the original bauxite and is lost in the red mud stage. The loss depends principally on the silica content of the bauxite. The make-up of caustic soda is supplied by means of soda ash, which is causticized on site and added to the strong liquor from the evaporators.

The aluminium hydrate cake from the filter presses contains, in addition to chemically combined water, a considerable quantity of free water. This can be reduced by a further filter press operation and the hydrate is then ready for sale to the manufacturers of aluminium sulphate, etc. The hydrate is sold usually on the basis of 52% Al_2O_3, the balance being water.

For the production of aluminium, pure non-hygroscopic alumina containing no chemical water is required, and a calcination process is necessary. It should here be remarked that careful attention is required to ensure not only the correct size of the alumina particle, but also the proper specific gravity of the material, as the results obtained in the reduction furnaces are dependent on these qualities. The alumina as it goes into the rotary calciner is in the form of hydrate and a temperature of about 1,300° C. is necessary to remove all combined water and to produce an alumina which is non-hygroscopic and which has a specific gravity averaging about 3·9. The material as it issues from the cooler of the rotary furnace is either bagged for dispatch overseas or is conveyed to a large bunker for subsequent transport in bulk by tank wagon to the Lochaber works.

The analysis of normal alumina is given to show the change which has taken place :—

Alumina	99·15 per cent.
Silica	0·03 ,, ,,
Ferric Oxide	0·02 ,, ,,
Soda	0·40 ,, ,,
Loss on ignition	0·40 ,, ,,
Moisture	—
Specific Gravity	3·85–3·90

It will be seen that the iron and silicon impurities of the bauxite have been eliminated to such an extent that, allowing 1·9 tons of alumina to produce one ton of aluminium, the iron in the metal from this source would be only 0·027 per cent and the silicon also 0·027 per cent.

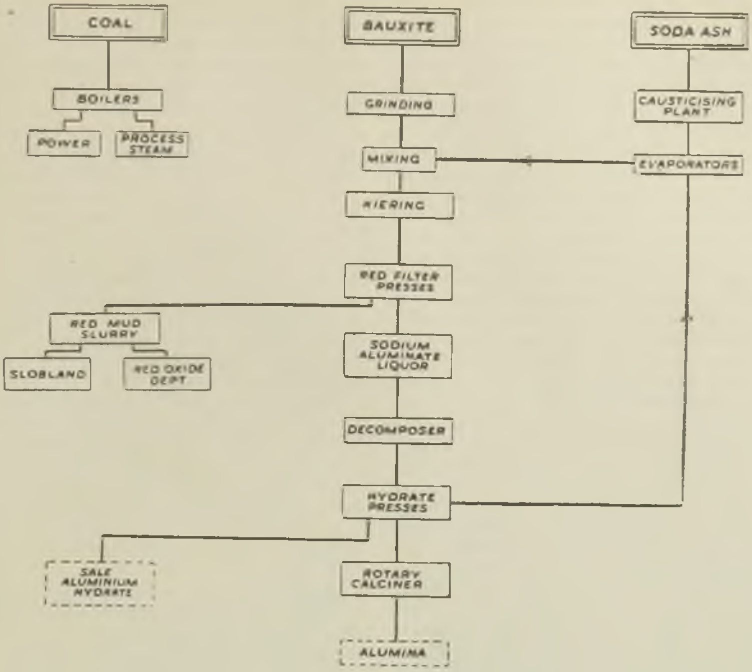
Considerable quantities of steam are required in the conversion of bauxite to alumina by the Bayer process, amounting to approximately 30,000 lb. per ton of alumina, or 60,000 lb. per ton of aluminium. Cheap steam production is therefore essential to the economic manufacture of aluminium. The greater portion of it is used at low pressures and ample electric power can, therefore, be generated economically by using back-pressure prime movers. For long periods the steam load is a fairly steady one, but when an evaporator set is put into or taken out of operation a very considerable change is involved for a short period. There is nothing of very special note about the boiler plant, the chief characteristic being simplicity and reliability. The original equipment comprised four Babcock and Wilcox water-tube boilers of the W.I.F. type. Each has an evaporative capacity of 22,000 lb. per hour at a pressure of 180 lb. per sq. in. and the steam is given a superheat of 100 to 120° F. in view of the considerable distances to which it is transmitted. Later boilers are of the Babcock and Wilcox C.T.M. type. Each is capable of dealing with a normal evaporation of 60,000 lb. per hour, has a continuous overload rating of 75,000 lb. per hour, and is designed to work at 350 lb. per sq. in. pressure, with a final steam temperature of 750° F. The boilers are fed with distilled water obtained from the process, care being taken to ensure that there is no undue risk of contamination from excess soda content. The fuel used is Fife washed singles, having an average calorific value of 12,500 B.Th.U. per lb., and on the whole very satisfactory results are obtained with this fuel.

As already stated, the bauxite has to be ground very finely. Providing the moisture content is not too great this work can be done either in edge-runner, ring-roller, or impact-type mills after coarse crushing in jaw breakers. The edge-runner is very reliable and economical, but in spite of provision for enclosing the mills, conveyors, and sieving apparatus, it is quite impossible to prevent the ground powder from spreading. This does not make for easy and comfortable working conditions and later mills have been of the ring-roller type, provided with air separation, so that the whole circuit is enclosed. The whole process of grinding is still not considered satisfactory and various alternative methods are being considered.

The kiers or digesters have to withstand very heavy duties. The steam used in the jacket is at a pressure of 120 lb. per sq. in. and a temperature of about 190° C. The mixed bauxite powder and caustic liquor, some 7½ tons in weight, are charged into the inner vessel at atmospheric temperature and at the end of the period of digestion attain a pressure of about 85 lb. per sq. in and a temperature of about 165° C. As soon as this hot charge is emptied a fresh cold charge is introduced and it will therefore be seen that considerable allowance has to be made for expansion stresses or movement. In the early days kiers were of very robust construction without any provision at all for expansion. But it was thought to be wrong in principle to work on this method and that it would be much safer to arrange for fairly free expansion to take place. One type of kier has an inner shell attached to the outer one at both ends and provision for expansion is made by means of a bowling hoop in the middle of the outer shell, this bowling hoop being attached to the adjacent plates by electric welding. In this design the shaft carrying the paddles passes through both ends, two stuffing boxes being provided. The packing has to be renewed about every three weeks and so constitutes a heavy item of maintenance.

A new welded type of kier designed to give entirely free movement to the inner vessel is under construction. The inner vessel is riveted to the shell at the charging end only, the other end being entirely free ; suitable distance pieces are used to keep the inner vessel correctly in position. In this kier the paddle shaft passes through the charging end only, and is carried at the other end in a bearing supported on a bracket inside the dished end of the inner vessel. The shaft is provided with a stub end to reduce costs of renewal as the wear on the shafts and bearings of kiers is extremely high, due to the fact that they are immersed in an abrasive slurry at a high temperature. Cast iron is the best material for bearings. All kiers are very efficiently lagged to reduce radiation losses. The total steam consumption is many thousands of pounds per hour and efficient means have to be maintained for removing the condensate. Originally small groups of kiers had their own steam trap, but the practice nowadays is to connect all drain pipes to a central battery of very large traps which work very efficiently and call for little attention and maintenance. The condensate is discharged direct to another part of the process where the heat is utilized.

The filter presses are of the standard plate type with cotton cloth as the filtering medium. The only modification of any note found desirable by



Flow-Sheet of Alumina Process.

experience is to increase the plates or chambers to the maximum efficient size.

The decomposers are vertical cylindrical vessels 20 ft. high and 20 ft. in diameter holding about 215 tons of material. Originally these were of riveted construction, but the penetrative power of the liquor at the pressure head available is considerable and difficulty was always found in maintaining the joints absolutely tight. All decomposer tanks of later installation are of electric welded construction and extremely satisfactory results are obtained. The agitating gear in the decomposers is of special construction and the gear for several tanks is driven by belting from one motor.

The modern design of calcining furnace is of the rotary type, very similar to that employed in the cement industry. Oil fuel is used as this attains the temperature required, is clean, and permits of the flexibility of control which is essential for satisfactory operation. Powdered fuel could not be used as the alumina would be unduly contaminated by the ash and producer gas would necessitate the use of very expensive heating stoves to permit of the requisite temperature being attained. A special feature of these rotary furnaces is the care that has to be taken with the lining, as this does not receive any protection such as the slurry gives in cement kilns. The refractory bricks and bonding material are very carefully selected and every individual brick is ground exactly to size to ensure the minimum thickness of joint between individual pieces. The latest calciner has a shell 250 ft. long and a maximum outside diameter of 9 ft. 7½ in. This operates at a speed of less than 1 r.p.m. and is carried on six steel tyres. Great credit is due to the manufacturers for the skill with which this furnace was aligned, for although the complete weight of the rotary portion is about 560 tons, it is so well balanced that the power required to drive it is only 20 h.p., and a 25 h.p. motor of the slip-ring induction type has no difficulty in starting it from rest. A calciner will produce from 70 to 80 tons of alumina in 24 hours.

Although the velocity of the gases through the calciner is relatively low, a very large portion of the throughput of alumina is carried off. This calcined alumina is an expensive material, having a selling price in the open market of about £20 per ton, and it is essential that dust losses should be kept to a minimum. The gases, therefore, are discharged through an electrostatic dust precipitating plant and this works extremely efficiently. After allowing for all miscellaneous losses as well as any dust that might pass through the precipitating plant, the recovery of calcined material is not less than 99% of the hydrate charged to the furnace.

The direct current required for the precipitating plant is supplied from electrostatic rectifiers of the arc type fed with single-phase alternating current at 60,000 volts, which is transformed up from 440 volts. The chambers of each unit are in two halves, so that the power can be cut off from one to permit of cleaning and repairs to the other half. In addition, the precipitating plant of the separate furnaces are interconnected electrically.

A considerable amount of evaporating plant is employed, but there is nothing of special interest about its design, the units being chiefly of the triple-effect type.

Belt conveyors are used largely in the bauxite grinding department, but the latest conveyors are of the " vibro " tube type. They are employed for dealing with both the hydrate and the calcined material. The recovered material from the precipitation plant is fed back into the vibro conveyor feeding the hydrate to the rotary calciner so that the two types of material become intimately mixed, thus preventing the recovered material, which is extremely fine, from being blown back again to the precipitators. This arrangement permits of a very regular feed to the calciner.

On the outgoing side, the rotary furnaces discharge through automatic weighing machines into vibro type tube conveyors, so that the material travels in a closed circuit all the way and no loss of dust or trouble are occasioned.

Throughout the whole process the materials in all but the final stages are conveyed chiefly by pumping. Various materials are used in the construction of the pumps for different purposes, for it has to be borne in mind that at some stages the dominating influence of the material being handled is corrosion, whilst at others it is erosion or aeration. For pump casings and end covers cast steel or cast iron are used chiefly, and for certain purposes these casings are provided with a renewable protective lining. Stainless steel, plain cast steel, and bronze impellers are used, and in some pumps stainless steel shafts are also adopted. In view of the fact that these pumps are handling chiefly strong caustic liquors, it is essential that the material of which they are constructed should be free of any trace of copper, zinc, antimony, or lead. Journal bearings of the ring-lubricated type are adopted as standard.

The most recent plant erected consists of a vertical bucket elevator receiving the calcined alumina from vibro conveyers and discharging into a 450-ton bunker. The bunker is both riveted and welded as the fine alumina will leak through an ordinary riveted joint unless careful caulking is carried out. The bunker straddles a railway siding and the material is discharged into special tank wagons which carry the alumina to the Lochaber works.

There is only one by-product from the alumina industry and that is the red oxide. This material as it comes from the presses is taken to a special department where it is retreated and re-pressed. It can be sold in this re-pressed state, but it is difficult to handle as it is in the form of a stiff clay-like cake containing about 40% of moisture. It is very cheap, and is mixed with clay for the manufacture of red bricks or material which requires a colouring agent.

Until a few years ago the electrodes used in the aluminium reduction furnaces were made in nearly all cases from petroleum coke from the United States and from shale-oil coke produced in the Glasgow district. These cokes were hard with a black sponge-like appearance and contained less than 1% ash and had a volatile content of 7% to 9%. With the development of the "cracking" process for the production of light oils, the quantity of suitable coke available from the United States has decreased, while it is preferable not to have to buy from foreign countries if this can be avoided. The total production of coke from the Scottish oil industry has been taken for many years by the British Aluminium Company, but owing to the quantity available diminishing steadily year by year, it represents now but a small percentage of the tonnage required for electrode production.

To produce electrodes it is necessary to eliminate all the volatile content in the carbon materials and therefore cokes and anthracites containing from 7% to 9% volatile matter will, after the devolatilization process, have an increased percentage ash content due not only to the loss in weight of the volatile matters driven off, but also to the loss of carbon which takes place at the high temperatures necessary to complete the devolatilization. A solution of the problem was found in the "super" coke produced by Messrs. William Baird and Company of Glasgow and Messrs. Pease and Partners of Darlington. These firms installed specially a flotation treatment plant and by selecting the best coal seams they have succeeded in obtaining coke containing under 1·5% of ash and occasionally, with rather special material, as little as 1% of ash; and as the volatile content is also under 1% there is no further increment of ash content as no devolatilization treatment is necessary at the carbon works. The material is not ideal for electrode manufacture, but by suitable blending with other cokes it is used to a very considerable extent.

One of the most promising raw materials for electrode manufacture is coke made by the coking of pitch. This pitch coke is produced in the United States and in Germany. In the latter country it is made in a modified form of horizontal coking retort and it forms a very valuable material, low in ash and volatile content, hard, and having certain qualities which ensure its use in the aluminium industry.

Apart from the solid carbons mentioned above a "binder" is necessary and either this will consist of a special soft pitch, or the electrode maker buys pitch and tar to his specifications and blends them in accordance with his requirements.

In the case of cokes containing more than 1% volatile matter the devolatilization or calcining process will necessitate special ovens or the operation can be carried out in vertical shaft furnaces supplied with an air blast. When no calcining treatment is necessary a drying process is followed, as no trace of moisture must remain in the materials. The actual drying treatment is not an easy one since allowance has to be made for up to 10% of moisture, which should be reduced to one-tenth of 1%. In addition, dust losses must be kept to the minimum. A type of dryer recently installed at Kinlochleven has longitudinal louvres fitted to the interior surface of a rotating cylinder and hot gases are blown out through these louvres and through the coke layer, the hot gases coming out of the louvres where there is a layer of coke. On trial this machine has given promise, but has only recently been put into regular production. Another type of dryer used is the vertical shelf type with "rabbling" arms, on the lines of an ore roaster.

Following this stage either of calcination or of drying, blending of the various cokes takes place and the addition, in some cases, of butt ends of electrodes returned from the reduction furnaces. The materials are stored in bunkers and are drawn off and weighed before going to the grinding units, which consist either of pan mills with perforated plates through which the material is discharged—the diameter of the perforations being adjusted to suit the various materials used—or runner mills, or ball mills. Following the grinding comes a further quick-drying stage in case moisture has been picked up in stock bunkers and mixing then takes place in steam-heated mixers of the Pfleiderer type. These mixers hold some 600 lb. at a time and when the material is hot the binder is added in weighed quantities; mixing continues until the appearance and feel of the mixture is judged to be correct by the foreman. The contents are then tipped into edge runners or " pugging " mills, where the mass is thoroughly kneaded. The edge runners have two rollers weighing 4 tons each and revolve at about 16 r.p.m. The temperature of the material is in the neighbourhood of 100° C. when it is ready for the pressing operation.

The binder is prepared at Kinlochleven by melting pitch and mixing in certain proportions with tar. After mixing the binder is transferred to steam-heated vessels and is drawn off through steam-jacketed pipes to the cocks placed near the mixing units. The mixture is discharged from the pugging mills into a bogie which takes it to the press in action. The quantity necessary for one electrode is weighed in a scoop-shaped container from which the contents can be tipped into the press container.

(*To be concluded.*)

DRIVING IN BROKEN GROUND

In the *Proceedings* of the Australasian Institute of Mining and Metallurgy No. 88 E. B. Dow describes the standard method of driving through broken ground that has been adopted at the Central mine, Broken Hill. The author points out that owing to " creeps " and consequent movements in the mine, followed by the recent fire in the southern workings, the whole of the ore-body above the 800-ft. level at the Central mine is now very much crushed and broken. The same applies to the hanging-wall or over-wall country, which has subsided towards the workings, so that for some years past all development work within the lode has had to be carried out with extreme care. The continual but slow subsidence of the overburden into the stopes necessitates a periodical renewal of all gangways in the lode and, as the subsidence amounts to as much as 60 ft. in places, these new gangways must necessarily pass through the mullock-filling of old stopes in addition to broken ore. They at times pass into the broken ground of the hanging-wall for some distance, where the ore-body has widened underneath by the original folding and puckering.

In the fire area, especially, very bad ground is encountered, due to the calcining effect of the heat on the ore and mullock-filling. Some of this old mullock-filling now consists of fire-glazed stones in a matrix of very fine powdered and burnt material. This has no cohesion when opened up ; it cannot be wetted with water and when the loose powder is allowed to run away there is left an unstable mass of loose stones of varying sizes, which readily collapses with the slightest provocation. To overcome the difficulties in making an opening through such material a standard method of attack has been adopted which, though not altogether new, is worthy of description as it is adaptable to all kinds of loose, broken, and running ground.

Figs. 1 and 2 give a cross-section and longitudinal section showing the outlines of the method. These are known as " Clap-me-down " sets, as they consist of simple butt timbers without framing, but the same system is used when advancing with square-sets in gangways or stopes. A set consists of two 8-ft. 10-in. by 10-in. legs standing on a 7-ft. 10-in. by 6-in. sill-piece and surmounted by a 7-ft. 10-in. by 10-in. cap. Spreaders, 5 ft. 4-in. long, of 10-in. by 4-in., are then placed top and bottom between the legs, the top spreader being spiked to the cap. On each end of the cap a 10-in piece of 5-in. by 4-in. is placed as a blocking piece, being wedged up on the forward side to give the necessary angle for driving forward the back laths. On top of the blocking a 7-ft. bridge is laid and this is either 10-in. by 2-in. or 10-in. by 4-in., depending on the room available and the pressure of the back.

The whole set is securely blocked in position from top and sides with wedges and short pieces of waste timber and is ready for the insertion between the bridge and the cap of the back laths or driving laths. These are of 5-in. by 4-in. Oregon pine and 8 ft. long, with a chisel point at the forward end, the point assuring that the lath will travel at an angle above the horizontal. There is sufficient length under the bridge to insert 14 of these laths and, in fine powdery material, this number is used to prevent leakage of the fines, but in big ground or ordinary ore a smaller number may be used, depending on local conditions.

If it should be necessary to fire any big stones in the face, the set has to be secured against displacement by flying stones. Fig. 3 shows the usual arrangement for " tomming " the centre of the cap and bridge. A short piece of 10-in. by 2-in. reaches from the back laths of the previous set to the bottom of the spreader and is tommed back to the cap of the previous set, with 10-in. by 2-in. timbers. Cleats and wedges hold these in position as shown. A similar arrangement is used on each leg, making sure that the 10-in by 2-in. covers the joins between cap and leg to prevent displacement.

The points of the driving laths are now inserted, one or two at a time, over the cap, and driven forward. A start is made at one side and only sufficient opening is made in the ground to allow access of the laths. One man drives the lath forward with a special broad-faced hammer, while his mate, with a pinch-bar, eases the ground ahead of the points. In bad ground a side-breaster is inserted and

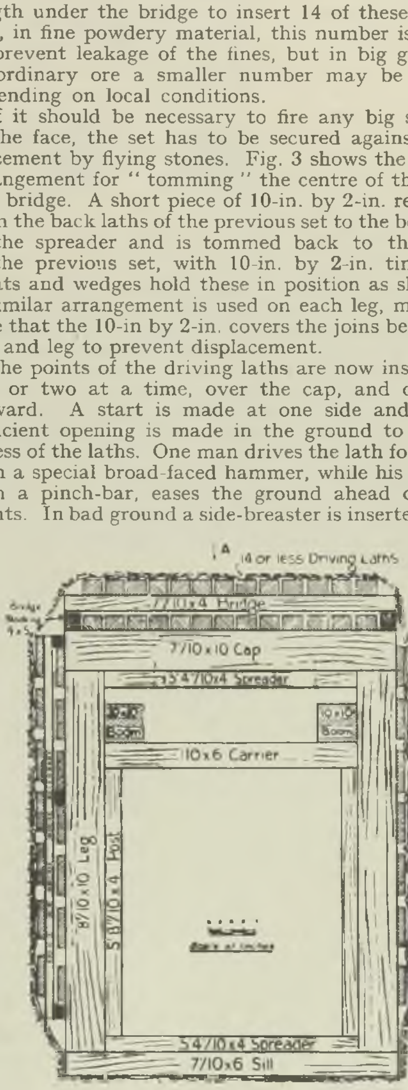


FIG. 1.

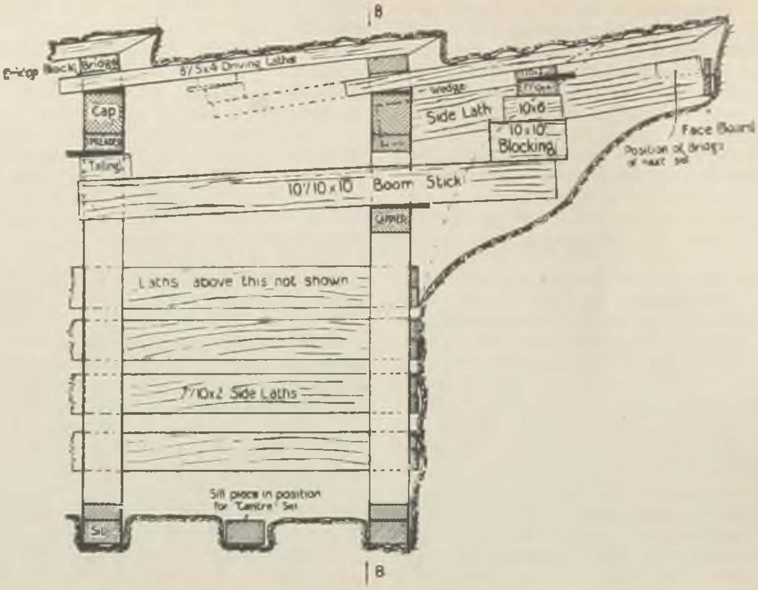


FIG. 2.

driven ahead at the same time as the lath or laths (see Fig. 2), to prevent any running from the side.

When the back laths have all been advanced about 3 ft. 6 in. beyond the set, it is the usual practice to insert the booms. The section of the face will appear somewhat similar to that shown by broken line in Fig. 2, only sufficient ground having been removed to give free access for the back laths. The back ends of the laths will be tailed down from the back laths of the previous set to ensure that the points are kept at a sufficient height. This height must be such that there will be ample room to stand the next set below the points of the laths when they are right home.

An overhang of 3 ft. 6 in. is considered the limit for 5-in. by 4-in. timber ; hence the necessity of booming up the points of the laths in case a sudden movement overhead should throw too much weight on the back laths, causing them to break or bend.

A double boom is adopted, one stick being used on each side of the set. This is found preferable to a single boom supported on a king-post in the centre of the set. This latter method restricts the room for mining operations. A single boom is not always of sufficient strength to support the pressure encountered. Fig. 1 shows how the 10-ft. cantilevers are supported on two 10-in. by 4-in. posts and a 10-in. by 6-in. carrier and Fig. 2 illustrates the general arrangement for blocking to the back laths and " tailing down " under the cap of the previous set. The booms are blocked lightly to the driving laths to prevent friction and the operation of driving the laths is continued. In many cases the ground is so loose that it will not stand the shock of hammering and under such conditions each lath is forced home with a small screw-jack.

Having driven all the back laths home, the face will appear as in Fig. 2, which also shows side-lath and face-board in position. The boom is now securely blocked and wedged to keep the back laths in position and everything is ready for removing the rest of the ground from the new set.

This work is started at the top, only sufficient ground being taken out to make room for a ring of " breasters." Side-laths or side-" breasters " are half-joggled at the forward end, while face-boards are half-joggled at each end, thus forming a locked ring when in position. With very badly running ground, resort is had to the old type " he and she " boards, enabling the miner to work across the face in sections.

Work proceeds in this manner from the top downwards, successive rings of " breasters " being put in until the whole opening is supported. The sill-piece of the new set is then placed in position, legs stood, cap and spreaders put on, blocking-pieces and bridge placed. The blocking is then removed from the booms, allowing the laths to settle down on the bridge of the now completed set. The boom sticks are now run back on carriers and left two or three sets back until they are again required.

In the main gangways, " centre sets " are always erected midway between the main sets. Fig. 2 shows the sill-piece placed in position, before that set is covered with sollars and truck lines laid. The centre sets can be erected at any convenient time, usually being three or four sets behind. Although not shown in the figures, it is essential

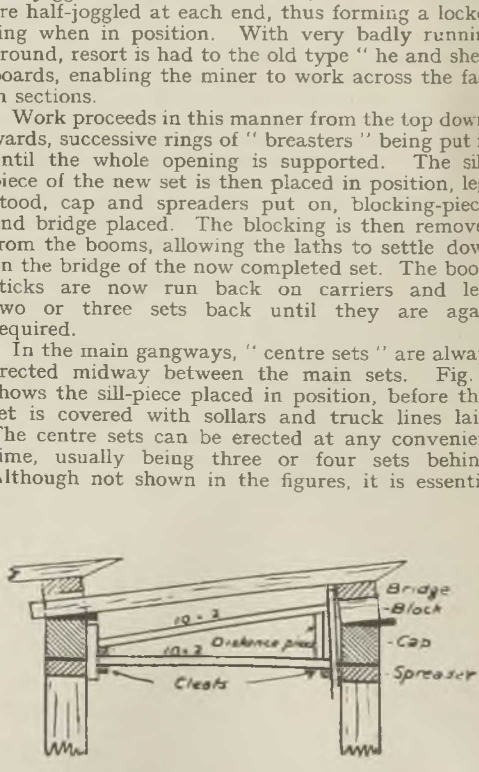


FIG. 3.

that all timbers are securely blocked to the ground, and all loose spaces behind the legs and breasters filled with waste rock and scrap timber.

In cases where the ground is very heavy, pressure may cause bending or squeezing of the bridge, making it difficult to allow the laths to enter. Heavy pressure on the laths often causes the soft Oregon pieces to bite into one another, thus greatly increasing friction. Under such conditions hardwood (Karri) driving laths, 5 in. by 3 in., are used with advantage, the friction being much less, and the smaller depth of 3 in. allows them to be started off in a reduced opening.

Timber Required and Costs

Main Set

2 Legs	8 ft.	10 in. by 10 in.
1 Cap	7 ft.	10 in. by 10 in.
1 Sill	7 ft.	10 in. by 6 in.
2 Spreaders	5 ft. 4 in.	10 in. by 4 in.
1 Bridge	7 ft.	10 in. by 4 in.
14 Side laths	6 ft.	10 in. by 2 in.
14 Driving laths	8 ft.	5 in. by 4 in.
Wedges, blocking, etc., cut from waste.		
Total		558 super ft. = £6 6 4

Centre Set

2 Legs	8 ft.	10 in. by 10 in.
1 Cap	7 ft.	10 in. by 10 in.
1 Cap	7 ft.	10 in. by 6 in.
1 Sill	7 ft.	10 in. by 6 in.
2 Spreaders	5 ft. 4 in.	10 in. by 4 in.
Wedges, blocking, etc., waste.		
Total		297 super ft. = £3 2 0

Thus, the total cost of timber for 6 ft. of advance is £9 8s. 4d. or £1 11s. 4d. per foot. In average bad ground a party of four experienced miners, working five shifts of seven hours each, should advance 1½ sets or 9 ft. per week.

THE BOISE-ROCHESTER MINE, ATLANTA, IDAHO

In the 34th annual report of the mining industry of Idaho for 1932 the inspector, Mr. Stewart Campbell, gives an account of the Boise-Rochester gold mine, Atlanta, Idaho, which is worked by the St. Joseph Lead Co. The author recalls that the gold veins in the Atlanta district were discovered in 1864 and some of the first mills constructed in the State were in this district. It has a production record totalling many million dollars and for many years it was one of the principal mining districts of the State. The Boise-Rochester mine is located near the head of Montezuma Gulch, about two miles south of Atlanta, which is situated in the north-east corner of Elmore County, 80 miles by road, north-east of Mountain Home, the county seat, and about 58 miles almost due east by air line from Boise.

The first 13 miles of road north from Mountain Home to Toll Gate is a standard gravelled highway. From Toll Gate to Atlanta it is a fairly-well graded road maintained in part by the county and in part by the U.S. Forest Service; 28 miles north of Mountain Home it descends along Camas Creek to the South Fork of the Boise River which it follows to Featherville. From Featherville to Rocky Bar it passes through narrow gulches and over a low divide. The difference in elevation between Mountain Home and Rocky Bar is approximately 2,000 ft. In going from Rocky Bar, elevation about 5,000 ft., it follows Blake Gulch and then winds around Baldy Mountain to the divide between the South Fork and the Middle Fork of Boise River, a distance of 6 miles and a gain in elevation of 3,000 ft. From the divide it follows down James Creek to its junction with the Middle Fork, a distance of 4 miles and a drop in elevation of 3,600 ft. The heavy snowfall and the snowslides, which occur regularly each winter between Rocky Bar and the Middle Fork of the Boise River, close the road from November to June of the following year, require the storing of all supplies necessary for the winter operations, and prevent the shipping of concentrate except during the summer.

Mail, passengers, and perishable supplies, such as meat, eggs, butter, fresh fruit, and vegetables, are delivered during the winter months by twice-a-week airplane service from Boise. This service, which was started in December, 1931, is the first Star Route aeroplane mail service established by the United States Post Office Department to an isolated mining camp. It was in part made possible by the company building, presenting, and maintaining the landing field at Atlanta. The aeroplanes in use have a carrying capacity of 1,675 lb., and have transported in emergencies machinery repair parts weighing more than 800 lb.

The Atlanta lode is a shear zone varying in width from 50 to 120 ft. It starts at Montezuma Gulch—a fault contact of two granites of entirely separate ages—and strikes S. 17° W. with a lineal extent of approximately 2½ miles to the Yuba River, where it ends on another fault contact of two different granites. The lode is wholly confined to the older rock and does not enter the younger at either end. Going west from the east end for 3,000 ft., it dips at an angle of 73° to the north. The dip then commences to change to the vertical, through which it continues to a final dip of 75° to the south. The matrix consists of unreplaced granite, quartz, calcite, and possibly barytes. The valuable metal content of the ore is gold, most of which is associated with arsenopyrite, and argentite. Pyrite is present in abundance, and assays of the concentrate show the presence of lead, copper, bismuth, and antimony minerals in small quantities. The pyrite, which is barren, occurs mostly as cubical disseminations in the matrix. The gold occurs as particles, varying from coarse to fine, scattered through a dense black ground-mass. The gold is seldom visible to the naked eye, although occasionally bunches of high-grade ore are encountered in which it can be seen in streaks more than $\frac{1}{16}$ in. in thickness. Seventy per cent is recovered as bullion and the remainder is recovered in the concentrate.

The ore occurs as lenses varying from 4 to 12 ft. wide, generally near the centre of the lode and dipping toward the foot-wall, but never reaching it. There is no line of demarcation between ore and waste and all mining is done to produce a mill feed averaging ½ an ounce gold, as economic conditions do not permit mining it to a lower gold content. The General Pettit ore-shoot has been continuous from the surface to No. 6 tunnel, a vertical distance of more than 800 ft. As yet, No. 9 tunnel has not been advanced far enough to intersect it and mining has not progressed far enough to prove the extent of the other two ore-shoots, all mentioned later. The ground in the lode is exceedingly heavy and swells so rapidly that it is almost impossible to keep an entry open for any length of time. As a consequence all permanent tunnels and rises are driven in the hanging-wall, and all stopes are kept filled to the working face.

Three groups of mining claims cover the extent of the lode. Starting at Montezuma Gulch going west is the Boise-Rochester, with a length of about 2,700 ft. ; next the Monarch, covering approximately 1,800 ft. ; and then the Atlanta. The first and last named groups are owned by the St. Joseph Lead Co. and all operations are confined to the former.

Ore-bodies. — The ore-bodies are confined to different parts of the lode. Three, from east to west, known as the Old Chunk, Central, and General Pettit ore-shoots, occur in the Boise-Rochester group. The Old Chunk is about 1,000 ft. long, the Central 400 ft. long, and the General Pettit 500 ft. long ; the three are separated from each other by 250 and 350 ft. of barren lode matrix.

The Monarch group is opened by a 600-ft. vertical shaft. In the early days the General Pettit ore-shoot was opened and operated through a 100-ft. vertical shaft. No 2, or General Pettit, tunnel was then driven and connected with this shaft by a 300-ft. vertical rise, in which were four intermediate levels ; the mine was operated through this tunnel for many years. Later operators drove No. 6 tunnel, a cross-cut, which intersected the lode 2,200 ft. east of the General Pettit shaft and 430 ft. below No. 2 tunnel. Old Chunk ore-shoot is located near the point where No. 6 tunnel intersected the lode. It and the Central ore-shoot were both unknown until encountered by this tunnel about 1915. After the St. Joseph Lead Co. acquired the mine, No. 6 tunnel was driven in the hanging-wall of the lode to the west end line of the Boise-Rochester group, a distance of 2,500 ft. and then later extended a distance of 1,900 ft. to a connexion with the 400-ft. level of the Monarch shaft. No. 9 tunnel, a 1,900-ft. cross-cut, situated 280 ft. vertically below No. 6 tunnel, was then completed to a point beneath the Old Chunk ore-shoot, and the two were later connected by a two-compartment 70° inclined rise. These connexions provide an excellent natural ventilation throughout the mine.

Underground Transport.—When the mine was placed in operation in February, 1932, stoping started in No. 6 tunnel, on General Pettit, and Central ore-shoots and since then has progressed steadily upward. A 1½-ton Mancha storage battery locomotive and side-dump mine cars of 2,000 lb. capacity are used to gather the ore, which is then dumped into the rise and drawn out in No. 9 tunnel. This latter tunnel is level with the top of the crude bin in the mill, and the cars are dumped directly into it. The ore is transported from the rise to the mill by a locomotive and cars similar to those in No. 6 tunnel, each train being composed of from 10 to 15 cars. An extra set of batteries is supplied for each locomotive, so that one set can be charged while the other is in use. The motor-generator set for charging the batteries is located in the engine room, and the direct current is taken to the charging stations, which are located near the portals of the two tunnels. All track underground consists of 12-lb. rails laid to a gauge of 18 in.

Stoping.—The horizontal cut-and-fill method of mining is used in both stopes. The stope rises are spaced 46 ft. centre to centre and are carried up periodically as stoping progresses. All rises have two compartments, chute, and manway, each being 2½ ft. by 3 ft. in the clear. The tight-crib type of timbering is used in all rises, and both compartments are lined with 2-in. plank. The manway side is provided with straight ladders and a timber slide. This style of timbering has proved to be quite advantageous, as it permits flexibility when a change in the dip or offsetting of the ore is encountered. A trap door provided with control chains and constructed of 3-in. plank is maintained over the manway sides at all times, and the chutes are kept partly covered with loose plank to a hole so small that the danger of a man falling down them is almost negligible.

The stope is advanced upward horizontally as a single face, in 50 to 100 ft. sections. Selective blasting is practised, but this does not produce sufficient waste for filling, so it is necessary to mine waste for the back fill. This is done by carrying a cross-sectional cut about 5 ft. wide, across the width of the lode. These cuts are staggered from foot to hanging-wall at intervals corresponding to the centre of the rises (46 ft.) and progress upward with the stope as the ore is mined. Sufficient surplus waste is broken in these cuts to keep them always back filled to a point slightly higher than the floor of the stope. In addition to furnishing waste for filling, they make a complete vertical cross-sectional cut of the lode for its entire width, thus prospecting it for any overlapping or unknown ore-shoots which may be parallel to ore being mined.

The fill is carried to within 6 ft. of the face, or breast. Before blasting the ore the fill is levelled and covered with 3-in. plank 8 and 10 in. wide and 5 ft. in length. After blasting, waste sorted from the ore is thrown to one side, and the ore is shovelled directly into the chutes.

Power.—All machinery is driven by electricity obtained from two sources, a small hydro-electric plant and a Diesel engine, the former being located on the Middle Fork of the Boise River about 2½ miles from the mine. It is a low-head plant and during the high-water season generates about 125 h.p. ; during the low-water period and in freezing weather, the output is reduced to about 25 h.p. The other plant is housed in a building adjoining the mill and consists of a 360-h.p. M. A. N. 8-cylinder Diesel engine, direct connected to a 3-phase 480-volt 375 k.v.a. generator. Both plants are synchronized, and all switchboards and synchronizing apparatus are located in the engine room. The fuel oil is stored in two 50,000-gallon tanks located outside of the building, and the exhaust from the engine is utilized to heat the mill building. A 987-cu. ft. 2-stage I-R compressor, direct connected to 1 175-h.p. motor, furnishes all the compressed air needed for the mine, drill sharpener, and for operating the hoist at the rise in No. 9 tunnel.

Water is flumed from Flint Creek, a tributary of the Yuba River, over a low divide, to the Montezuma Creek side, and thence around the mountain into a series of 18 by 22-ft. tanks at a point 150 ft. above the mill. These tanks are connected with two pipe-lines, one for general utility purposes, the other for fire protection. The fire line, which extends throughout the mill buildings and to all camp buildings, is provided with outlets and hose at all strategic points. An extensive fire protection sprinkler system has also been installed in the mill and hand fire extinguishers are placed in all the buildings.

Timber.—The region immediately adjoining Atlanta is forested with red fir, yellow pine, and lodge pole pine. All timber used in the mine is sawed in a mill owned by the company. The lumber and sawed timber are delivered to the timber-framing shed at the portal of No. 9 tunnel, where it is framed and sawed into size for use underground. It is then delivered to the rise in this tunnel and hoisted to No. 6 tunnel.

MILL.—(*a*) *Crushing.*—The ore is transported from the mine (No. 9 tunnel) by a $1\frac{1}{2}$-ton Mancha storage battery locomotive and delivered into an 850-ton crude-ore bin, from which it is drawn by a Stephens-Adamson feeder equipped with a 30-in. electromagnet into a 24 by 14 in. Blake crusher, which reduces it to pass a $1\frac{1}{2}$-in. ring. The crusher discharges directly into a set of gear-driven crushing rolls, 36 by 14 in., which are gauged to grind to $\frac{1}{8}$ in. The rolls discharge into a 32-ft. bucket elevator, with 12 by 6 in. buckets, spaced 2 ft. apart, which discharges onto a St. Joe vibrating screen equipped with $\frac{3}{8}$-in. mesh screen. The oversize from this screen goes to a second and similar set of crushing rolls, which discharge into the elevator, and the undersize goes directly into a 600-ton fine-ore bin. The crusher is driven by a 100-h.p. motor, belt connected with line shafts and pulleys.

(*b*) *Grinding.*—The fine-ore bin is provided with three gates on the lower side and a fourth or central gate in the centre of the bottom. Each gate is equipped with an 18-in. belt feeder, which discharges into a main belt feeder, which in turn discharges into a gear-driven Geary sampler. After it passes the sampler soda ash in a ratio 2 to $3\frac{1}{2}$ lb. per ton of ore and water to give a pulp density of about 20% solids are added to the feed and it then passes directly into a 4 by 10-ft. Marathon rod-mill, where it is ground to 30 mesh. Equal weights of 3- and 4-in. drop-forged steel balls are used and a total ball load of approximately 16,000 lb. is maintained.

The screening is done by an 18 by 36-in. conical screen attached to the discharge end of the mill and integral with it. The undersize is distributed through launders to the amalgamation circuit and, after passing over the plates, it joins the oversize in a launder which carried both products to a No. 66 Marcy ball-mill, operating in closed circuit with a 30 by 6-ft. Dorr duplex classifier, grinding to 80% minus 200 mesh. Approximately equal weights of $2\frac{1}{2}$- and 3-in. drop-forged steel balls are used and a total ball load of about 9,000 lb. is maintained.

The total ball consumption for both mills averages $3\frac{1}{2}$ lb. per ton of ore ground. Both mills are driven by a single 240-h.p. motor with Tex-rope drive, and the classifier is driven by an individual 10-h.p. motor.

(*c*) *Flotation.*—The overflow from the Dorr classifier, averaging 20 to 23% solids, passes directly to the intake of a 3-in. Wilfley pump. This pump discharges into the intake of another similar pump, which discharges into the rougher cell. The reagents, which are added by means of Denver wet reagent feeders, are fed into the intake of the second pump. Each pump is driven by a direct-connected 10-h.p. motor.

The rougher cell is a 40-ft. St. Joe flotation machine equipped with 38 drop pipes. The tailing from this machine goes to waste and the overflow into launders and thence to the cleaner cell, a 4-ft. St. Joe machine with five drop pipes. The tails from this machine are returned to the rougher cell, and the overflow goes into the launders, where additional reagents may or may not be added; thence to the recleaner cell, a 2-ft. St. Joe machine with three drop pipes. The tails from this machine are returned to the cleaner cell and the overflow is washed down a launder to a 6-ft. American filter.

All three machines are set in tandem, and the air is delivered to them through a single 16-in. header pipe from which it is taken off by a 3-in. feeder or drop pipes drawn down to $\frac{1}{4}$-in. vent slots at the lower ends. A centrifugal blower, with a rated air pressure of $\frac{3}{4}$ lb. which furnishes the air for all three machines, is located at the head end of the rougher cell and driven by a 27-h.p. motor.

The cake from the filter drops directly onto a hot plate, the heat for which is derived from the exhaust of the Diesel engine. After drying it is shovelled into sacks for shipment to the smelter.

The reagent consumption in lb. per ton of ore milled is as follows: Cresylic acid, 0·15 lb.; pine oil, 0·15 lb.; xanthate, 0·12 lb; potassium cyanide, 0·002 lb.

(*d*) *Amalgamation.*—All amalgamation is done on outside stationary plates. The pulp passing the screen on the Marathon mill passes to launders, which distribute it to three 9-ft. by 42-in. and four 6-ft. by 42-in. copper plates set at an inclination of $3\frac{1}{4}$ in. per foot. An amalgam trap consisting of a wooden box of length equal to the width of the plates and of a depth of 8 in. is attached to each plate. The pulp flows from these traps into a gathering launder, where it joins the oversize from the screen and is carried into the classifier. This launder is equipped with an amalgam trap, consisting of a wood box 12 in. deep by 2 ft. long. The total plate area is 178·5 sq. ft. which gives an approximate average of one sq. ft. of plate per ton of ore milled per day. All plates are made of copper and weigh approximately 5 lb. per sq. ft.

The plates are cleaned and dressed each morning, the amalgam being removed with a hard rubber scraper. After scraping the plates are scrubbed and washed with a whisk broom and a weak solution of lye. This operation is then similarly followed with a weak solution of sal ammoniac, after which they are flushed with clean water; mercury is then sprinkled on them and rubbed in with a whisk broom. Following the application of the mercury, small chunks of clean gold-amalgam are added and thoroughly rubbed in with a whisk broom. The plates are then ready for 24 hours' operation although occasionally it is necessary for each following eight-hour shift to dress some of the plates. The cleaning and conditioning of the plates requires about $1\frac{1}{2}$ hours. The amalgam is ground and cleaned in a small laboratory ball-mill and is then ready for periodical retorting and melting. After melting it is poured into bricks and shipped to the United States Assay Office at Boise.

(*e*) *Classifier Clean-up.*—After the mill had been in operation a short period it was discovered that a large percentage of coarse gold was accumulating under the rakes and in the trap of the Dorr classifier. Experiments proved that this gold should be removed twice a week. So the mill is shut down for three-quarters of an hour and the classifier is thoroughly cleaned. This material is then put over a Wilfley table, which makes three products: a tailing, which is returned to the classifier; a middling, which is sacked for shipment to the smelter; and a concentrate which is roasted and then melted into bullion.

(*f*) *Products.*—

Average Assays of Mill Feed and Products.

	Gold Oz.	Silver Oz.
Mill Feed	0·38 to 0·67	1·70
Flotation Heads.	0·20	1·20 to 1·50
Flotation Cons ..	20·00 to 25·00	100·00 to 125·00
Flotation tails ..	0·03 to 0·04	0·25 to 0·35

Tons Milled .... Averages	180 per 24 hours.
Ratio of Concentration ...	90 to 120 : 1
Total recovery	92 to 93% gold
Total recovery	82 to 84% silver
Per cent gold recovered by amalgamation	70
Per cent gold recovered by flotation	30

Fineness of bullion averages about 550 parts gold, 443 parts silver, and 7 parts base metals.

Assay of Average Flotation Concentrate.

Gold	22·50 oz.
Silver	112·50 oz.
Lead	0·30%
Copper	0·30%
Arsenic	6·0%
Iron	38·0%
Insoluble	8·5%
Bismuth	Trace
Antimony	Trace
Moisture ....Approx.	4·0%

(*g*) *Tailing Disposal.*—The tailing is conveyed in a launder for a distance of 500 ft. from the mill and dumped into a ditch 1,000 ft. in length, which leads to three impounding ponds build in tandem in Montezuma Gulch. The ditch and ponds are so arranged that but one pond at a time is in use. The overflow from these ponds goes to a 2,000-ft. ditch, which empties into a settling or clarifying pond with an area of approximately 300 sq. yd. On leaving this pond the water is almost clear; it is then run into Montezuma Creek and finally reaches the Middle Fork of the Boise River. The impounding dams are started by laying three or four rows of logs, tied together by cross logs, across the bottom of the gulch; when these are filled the sand is then shovelled against the top log and carried upward in alternate steps with a stope or batter of 45° on the down hill slope. Each dam is provided with a decanting launder at the top.

Labour.—(*a*) *Mill.*—The mill and power plants are operated 24 hours per day. There are three men to a shift in the mill, one to a shift in the Diesel engine plant, and one continuously at the hydro-electric plant. The crusher is operated two shifts with one man to a shift. Additional men on day shift are: Mill superintendent, bullion clean-up man, roustabout, mechanic, and a man on the tailing ponds; 19 in all.

(*b*) *Mine.*—The mine is operated in two 8-hour shifts with 40 men to a shift; additional men on day shift are: One electrician, two timber framers, two blacksmiths, one warehouseman, and one truck-driver.

Other employees are: Manager, book-keeper, engineer, and assayer, two night watchmen, and boarding-house help.

TREATMENT OF ASBESTOS

In the *Engineering and Mining Journal* for June W. A. RuKeyser gives an account of the general methods used in the dressing of asbestos and describes a method of mechanically cobbing out the crude grades. The author, dealing with occurrences, says that the two major types of occurrence of chrysotile asbestos are (1) deposits derived from peridotite-pyroxenite and (2) those derived from limestone (dolomite) intruded by diabase. The first type is the source of the bulk of commercial asbestos, which is produced in Quebec, Vermont, the Urals, and Rhodesia. From the second type is derived the important long-fibre, iron-free product of Arizona, Minusinsk (Siberia), and Carolina (South Africa). In both types the first product of mineralization is serpentine. From this, in situ, by simply the addition of water of crystallization, is derived the chrysotile. Thus the amorphous serpentine is practically always the surrounding gangue from which the valuable asbestos must be freed in the commercial exploitation of either type of deposit.

Inasmuch as the specific gravity of the asbestos is for all practical purposes the same as that of the serpentine enclosing it, this physical property cannot be utilized in any separation process. Likewise as the chemical composition of the two minerals differs practically only in the water content, no method of commercial extraction is suggested by that property. So, in the past, the technique which has been involved in the milling of asbestos rock utilizes the fact that the asbestos is amenable to fiberization, whereas the serpentine is not. This, in effect, is simply lightening the specific gravity of the asbestos by "beating" air into it, or increasing its volume in relation to the dense, massive, crude form in which it occurs in the veins. The asbestos, thus fiberized, can be separated from the gangue by air-suction (the method by which the bulk of the commercial production has been effected), or by tailing, or by some such wet process where the fluid is water instead of air.

The disadvantages of air-suction separation, utilized first, and in all the mills in Quebec, are many, to wit:—(1) The crude grades, which are desired with a minimum of fiberization, have to be hand-cobbed from the rock before milling. The effect of this on the cost of large-scale mining operations is obvious. (2) The mill feed must be practically bone dry. (3) Special types of fine-grinding machines had to be developed to fiberize the asbestos during the comminution of the rock particles. (4) The longer the fibre the greater the commercial value. Since the standard practice involves dry milling, a serious breaking down of fibre-length results during the fine-crushing stages required to liberate the asbestos from the gangue, at the same time fiberizing it sufficiently to make it amenable to the air-suction. (5) The dust problem thus becomes a serious one and results not only in increased plant cost, if the health of the workmen is to be considered, but also in the necessity of cleaning and recleaning stages in the flow-sheet to rid the fibre from dust and rock particles beaten into it during the "opening-up" process. (6) Maintenance and energy costs are relatively high. (7) A great amount of headroom is required.

These considerations led the author several years ago into a study of some other property of asbestos that might possibly be utilized in its separation from the gangue, the primary object at that time being to devise some mechanical method for the cobbing out of the crude grades. A study of hand cobbing showed that the impact of the hammer actually exerted a straight squeeze that resulted in the splintering of the rock while merely flattening the asbestos fibres somewhat. An obvious conclusion was that the process of hand cobbing and hand cleaning of the crudes in reality utilized the following cardinal difference between the gangue and the asbestos :—the former is extremely friable, whereas the latter has a high tensile strength. Two necessary features of any mechanical separation process that was to utilize this difference in properties soon became apparent. First, that method of crushing which would result in a minimum of fiberization and most nearly approximate a straight squeeze action must be used. Second, inasmuch as the value of the asbestos depended upon fibre-length—that is, its longest dimension irrespective of the cross-section of the rod-like masses or "bundles"—all types of screens then in vogue would up-end the fibre masses, discarding them along with the gangue, according to cross-section area and not according to length. The so-called RuKeyser process thus resulted, which is covered by U.S. Patent No. 1,875,890 (September, 1932), protecting the entire method ; similar protection is also provided in Canadian parents granted in December, 1932. (Additional parents are pending in all asbestos-producing countries.)

Rolls, with the shells running at the same speed, were found to produce the crushing action most desired, with a minimum of attrition and negligible fiberization of the asbestos. The rock, being friable, is reduced to sand. The asbestos, having tensile strength, comes through the rolls unbroken with the formerly adhering gangue particles, for all practical purposes, completely broken away. Rolls are thus an integral part of the process and their inclusion in the flow-sheet is an essential part of the patent. The screen motion which was developed permits the asbestos at all times to lie flat on the screening surface and/or in parallel planes to it. That means, in other words, that the asbestos does not up-end and can be graded according to fibre-length. The process thus accomplishes a separation, a cleaning, and a grading operation all in one step, as contrasted to many stages in the so-called standard Canadian technique. The results noted are accomplished by a head motion different from the known types of asbestos screens formerly on the market. The horizontal movement of the screen surface is not effected in the usual manner through an eccentric movement, but is brought about by the action of a horn cam that operates through a series of levers, only 60 to 75 r.p.m. being required. The fact that the screen surface is inclined against the direction of flow, coupled with the further fact that its forward motion is stopped suddenly by the impact of its block against a bumper, gives the rock its flow along the screen surface entirely by inertia. The asbestos, after crushing by rolls that have reduced the enclosing rock to sand, flows up along the screen to the discharge end. This flow is accomplished by what is commonly called "momentum." The asbestos always remains flat on the screen or in planes parallel to it. On the return motion the screen surface falls away from the mass of material on it, providing greater capacity, yet in no way permitting the asbestos to up-end. The load thus progresses forward on the screen and remains practically in one plane. The screen surface coming up to meet the load accomplishes the screening out of the sand at the head end and the grading of the cleaned asbestos in the middle sections and over the discharge end. Then the screen surface falls away again from the load after it has progressed along and on the screen by inertia after the bump. The screen is shown in one of the accompanying illustrations.

The first commercial installation of the process was in the mill of the Regal Asbestos Mines, Inc., 52 miles from Rice, Ariz., in the Globe-Salt River-valley district. This plant, which the author designed and supervised during construction, was started in the late fall of 1928, test runs being made during February and March, 1929. The accompanying flow-sheet shows the adaptation of the process. The mill was originally built to rework an accumulation of material on the mine dumps from which most of the No. 1 and No. 2 crude, particularly the softer, more-silky fibre, had already been cobbed by hand over a period of almost ten years. Inasmuch as the rainy season in that section of Arizona lasts about two months in the winter and as the process in question does not have to have bone-dry feed, no drying installation was necessary. Furthermore, the rock taken direct from underground in the mine was dry, permitting the mill operation to utilize such material during the rainy season.

Arizona asbestos deposits, as exemplified at the Regal mine, occur in limestone-dolomite strata that have a dip of but 5° from the horizontal. In the major producing horizon are two bands of serpentine, each of which varies in thickness from a fraction of an inch to a maximum of 3 ft. They are separated by an average of 4 ft. of extremely hard, compact, dense limestone, which grades locally into dolomite. A combination of the long-wall and room-and-pillar methods of mining is used. Only the serpentine bearing the asbestos veins is sent to the mill, the dry rock being used as backfill. The percentage content of valuable mineral varies considerably, an average of 10% being a conservative estimate of the result of past operations. The dump material, which had already been hand-cobbed, yielded about 7% additional fibre of all grades during the mill operations that I witnessed from March to June, 1929.

A surprising amount of No. 1 and No. 2 crude resulted from this reworking of the dumps through the mill. One reason for this yield of grades supposedly already robbed from the ore by hand-cobbing is the fact that so many of the veins are wedge-shaped, tapering from a fraction of an inch in thickness at one end up to one and a half or two inches for No. 1 crude at the other. To hand-cob such wedge-shaped veins would be exceedingly difficult, if not, in a practical sense, impossible. Furthermore, as this work is nearly always done on a contract, po[illegible]ndage basis, the men would throw out such [illegible]ial in favour of ore-bearing veins more eas[illegible] This indicates another and extremely important advantage to the process of mechanical cobbing. From full-sized tests run at the James' Laboratories, in Newark, N.J., where the mechanical features of the screen itself were developed, a conclusion reached during the working out of the flowsheet for the mill was that extraction of grades of asbestos shorter than crudes Nos. 1, 2, and 3 would be commercially feasible. Then, too, a certain amount of fiberization was effected in the coarse-crushing stages. Inasmuch as the process under consideration was so radically new and different, the original plan had called for a mill along strictly conventional Canadian lines. But, owing to the results of the preliminary tests made on ore shipped from Arizona, a decision was made to replace the " jumbos " originally intended for the tail end of the mill by rolls and a re-design of the flow-sheet was made to include the RuKeyser process in conjunction with air suction. The results of actual full-scale operation of the mill brought to light additional advantages which were not at first suspected.

In the first place the fiberized material sucked up into the collector by the fan constituted seldom more than 20% of the total product. This " opened " material, having been fluffed up entirely by the action of jaw crushers showed a minimum of attrition and a minimum of breaking down of fibre-length. Second, as this material was run over the first standard Thetford-type shaking screen tables equipped with suction hoods, along with rock of 1 in. size, the collector being directly adjacent and on the same level as these two tables, little energy was required by the suction fan. Third, and this appears to be most important, the material collected by the fan was practically free of grit and dust.

As can be seen from the flow-sheet, the asbestos ran by gravity directly from the collector through a series of four trommels. These were of slow speed (12 to 16 r.p.m.), not of special construction (standard Allis-Chalmers), but so arranged that the oversize of each represented a finished grade, the undersize going to the next trommel and the first and uppermost trommel bearing the largest openings and producing the longest fibre. The final " throughs " from the fourth and last trommels were ultimately run over a Colorado Iron Works impact screen (borrowed from another operation and not shown on the flow-sheet), which produced an excellent paper stock, the rejects being run to waste. Definite proof was thus obtained that, by accomplishing what fiberization must result during coarse-crushing by means of jaw crushers and that by eliminating the attrition required by the fine-grinding stages in the standard Canadian technique, the asbestos could be sucked into a primary collector and then graded without further cleaning and recleaning. When the proper screen sizes were finally determined by experimentation, the " drops " from all grades rarely exceeded one ounce, and the No. 1 spinning fibre, which ran as high as 10 oz. on the first box of the standard Thetford testing screen, nearly constituted, for practical purposes, an opened crude.

Coming now to the lower part of the flow-sheet, the first set of rolls was adjusted to produce a ½-in. discharge which constituted the feed to the second stage of standard Thetford-type screening. Little fibre was picked off of this table by the suction hoods. Oversize from this shaking table went to the second stage of rolls, which were set close. Discharge from the second and last set of rolls constituted the feed to the special screen already mentioned as being an integral part of the patented process. The first section of this screen at the feed end being of smallest opening eliminated more than 80% of the gangue, which, after passing through the second rolls, was 96% minus 6 mesh material. The next section of the screen toward the discharge end had surface of larger opening and produced a middling material constituting the remainder of the gangue. Sand from the discharge end was free of asbestos longer than " cement " or possibly than a poor paper stock and, when separated out by hand, gave no test on the standard testing machine because of its unfiberized state. The middlings section was later split in half, the discharge from the first and smaller openings having no commercial value at that time in Arizona, though, were the process installed, say, in Canada, this material would be excellent " jumbo " feed for the production of some paper and cement stock, in addition to that produced from the head end of the mill through the suction system. The latter half of the middlings were re-run for such few " rods " of No. 3 crude as still remained. After passing this section of the screen, the load was entirely freed of gangue ; the No. 3 crude fell through the next section, the No. 2 through the last ; and the No. 1 passed over the end as oversize. After the usual experimentation with screen sizes, a perfectly clean No. 3 was produced, with no practical loss of any valuable fibre through the middling sections. The No. 2 and No. 1 grades were entirely clean, no rock particles were left adhering to the asbestos and the mineral was graded as to length within limits not feasible by hand methods.

Operation of this mill, as was substantiated by commercial-scale tests when the process was installed in one of the Soviet mills in the Urals in 1930, demonstrated that :—(1) Run-of-mine rock crushed by easy stages (reduction of not over 3 to 1 in any stage) in jaw crushers to a size suitable for roll-feed produced fiberized asbestos with the least resultant breaking down of values owing to attrition. (2) This fiberized material could be passed immediately from primary collectors to graders of the type mentioned to produce a clean, finished product without cleaning or recleaning stages. (3) " Crudes," as such, are produced cleaner and graded better than by hand-cobbing and by a 100% mechanical process. (4) The addition of suction to the screen used in the process increases the screen's capacity and improves the product. (5) This so-called RuKeyser process can be used in itself, without suction, to produce all crude, spinning, and possibly shingle grades. (6) The rejects from this screen can, if desired, then be fed to a " jumbo " or similar machine, discharging on to the standard type of shaking-screen table equipped with suction to produce paper stocks and shorts. As the rock is already crushed, the work done by the " jumbo " would consist primarily and merely in the fiberization of the shorts to permit separation by air suction. (7) The use of this process produces asbestos of which the degree of fiberization is always under control. Remembering that the buyer of crude asbestos for spinning purposes must clean his hand-cobbed crudes under " chasers " (a " chaser " being a Chilean type of mill), which operation results in a real loss to him in the dollars and cents represented by the rock still adhering to the, by necessity, imperfectly cleaned hand-cobbed material, and then must open this fibre after he has " chased " it, to provide feed for the carding machines, the advantages of the mechanically cobbed material become obvious. Certain sales were made at a substantial premium over the "hand-cobbed" owing to lesser or no loss in the subsequent manufacturing operations. Should "crudish" fibre, as desired by some markets, be the objective, this advantage in the use of this process over the Canadian technique is emphasized. If opened material is desired, the asbestos, after separation and no longer in contact with the rock particles producing attrition, can be opened by one simple additional stage in the flow-sheet to any degree desired and under full control of the operator. (8) The connected motor horse-power load of this mill, including the suction system, was about ⅜ h.p. per ton of rock, 20-hr. capacity. This compares with more than twice that figure in one of the newest Canadian mills, despite its tremendously larger capacity, which should bring down the relative horse-power per ton-rock capacity.

SEPARATION TECHNIQUE IN THE CHEMICAL INDUSTRY

Chemical and Metallurgical Engineering for May contains a symposium on progress in unit operations. Dealing with separation it says that under this head developments in filtration, screening, centrifugal separation, air separation, thickening and classifying, and magnetic separation are discussed. In not all of these fields have improvements been equally numerous. Filtration, perhaps, has been especially fortunate in that a considerable number of organizations have been active in sounding out its possibilities. One important development of the period is the use of cake-compacting means on rotary vacuum filters. A belt weighted with rollers is employed by Filtration Engineers, Inc., and Arthur Wright, Inc., while Oliver United Filters uses a roll.

Filtration.—A number of interesting filter applications have recently been made in the paper industry. Oliver-United has developed a new ground-wood decker, a rotary vacuum filter which operates with 80% submergence and is said to increase decker capacity by some 20%. Rotaries have also been applied in place of the diffusion pans in the washing of brown stock in kraft and soda-pulp mills. Still another application is in high-density bleaching where the pulp is thickened on the filter to 6% pulp content, then squeezed by means of a roll to 78% water content. Another of the recent developments of Oliver-United is the top-feed filter, a vacuum type in which no tank is used, the slurry being spread on the filtering surface by means of a feed trough placed above the drum. Rotation of the drum carries the cake under an air heater where the moisture content is brought as low as 0·5%. This compares with a final moisture content of 3–5% in older equipment.

Two further developments are the Oliver-Beatty clarifier and the Oliver-Campbell cachaza filter. The former is a vacuum clarifier for liquids containing not over about 1% of solids. It consists of a vertical, cylindrical tank containing a vertical shaft from which filter leaves radiate. Discharge is accomplished by sluicing. The cachaza filter is used in cane sugar mills for the filtration of hot, defecated cane juice. It resembles the standard Oliver in some ways, although it differs markedly in others. It employs a metallic cloth and a submergence of only 15%. By the use of a double liquor port in the valve chamber the first filtrate drawn as each section is submerged is separated for return to the filter.

Another vacuum filter of very different type is the new Bartlett-Hayward Genter filter which is formed from a vertical spider carrying a number of tubular filter elements, the lower ones of which are immersed in a feed tank. Motion of the spider is reciprocating and intermittent so that there is a shorter return motion for each forward movement, serving to agitate the slurry and give quick submergence.

One definitely new piece of equipment combines the characteristics of filtration and thickening. The Laughlin clarifier, which has been applied to the separation of sewage sludge in the Dearborn, Michigan, municipal sewage plant, resembles a Dorr thickener in that it uses a circular concrete tank, a sludge rake and central sludge discharge for settled solids, a centre feed well, and a circumferential overflow for clarified effluent. Here, however, the resemblance ceases. Through an annular filter-bed of magnetite particles, supported inside the overflow, liquid is forced upward by the hydrostatic pressure of the feed. A magnetic cleaner, moved by the sludge rake, rides over, agitates, and cleans the filter bed continuously.

Screening.—Among mechanically shaken screens, the most noticeable development is the diversity of mechanisms that have appeared. Cams, ratchets, unbalanced rotors, electrical vibrators, and centrifugal force are all employed. The Blutergess sifter, introduced by the Abbé Engineering Co., is a mechanical screen which differs from all others. Instead of a shaking or vibrating action this device hurls the material to be sifted against the inside of a screen drum. The hurling mechanism consists of a turbine-type feeder which throws the particles outward by centrifugal force. Its capacity, in proportion to the space occupied by the Blutergess, is said to be much higher than in any other method.

Centrifugal Separation.—So far as is known only one centrifugal introduced in the United States during the depression period was radically different from all previous equipment. This is the Sharples Rotojector, a high-speed clarifying centrifuge which provides for semi-automatic discharge of separated solids while the bowl is rotating at full speed. An inner bowl slides within a casing so as to uncover an annular slot when solids have accumulated to sufficient extent. This movement is accomplished by the centrifugal pressure of water admitted to a special space in the bowl, which pressure works against a piston and opens the bowl against spring pressure.

The slow-speed centrifugal has been applied to a number of continuous clarifying problems. A number of types with imperforate baskets have been used in cleaning paper stock. Customarily, some of the stock is trapped behind a baffle, so that solids which are heavier than the pulp are driven into the mat of trapped stock and prevented from passing over the dam.

Air Separation.—Progress in air separation has been made in three directions. Fan-operated equipment has been redesigned for closer separations; cyclones have shrunk to small-diameter devices, used in multiple; while what is called the dynamic separator—a centrifugal fan combined with a dust-skimming arrangement—has appeared on the market.

The small-diameter, multiple cyclone has been exploited by two concerns, the Western Precipitation Co. and the PratDaniel Corp. It has been found that the separation factor for a cyclone of small diameter is very much greater than for a large one. In commercial units a collection efficiency of over 99% has been obtained where the particle size averaged about 5 microns. As examples of use the collection of boiler fly ash and of milk powder may be cited.

The third type of air separator mentioned above was introduced a few months ago by the American Air Filter Co. under the name of Turbo-Clone. Dust is sucked into the centre of an impeller where it is deflected toward the periphery by a cone. It passes through a large number of hyperboloid blades, after which, as the stream follows the curved outline of the casing, the dust is skimmed off into an annular passage while the air continues on into a volute. On some dusts the collection efficiency is said to be as high as 99·5%.

Thickening.—Sedimentation practice has benefited in a number of particulars. One of the earlier developments of the period was a thickener brought out by the Dorr Co. for use with fluccolent precipitates. It was noted that a gentle stirring action made for uniform flocs and hastened sedimentation. A cross-flow, circular basin which employs a number of vertical stirring bars mounted on the rake mechanism was, therefore, brought out to accomplish the desired result.

A still newer sedimentation unit is the Dorr Sifeed clarifier, a type of construction that can be applied both to the square traction clarifier and the round, central-drive clarifier. The outstanding feature of this new method is the introduction of the influent through a central inverted siphon. In the central concrete pier is a vertical conduit, flared out at the top where it joins a feed-diffusing casting. This casting supports the clarifier mechanism. It is provided with a turntable top which, in the central drive type shown in the illustration, carries the driving mechanism. In the traction type, it carries the inner end of the oscillating drive truss. It also supports a large, circular baffle and the rake mechanism.

The siphon feed is said to give minimum turbulence and disturbance within the settling zone. Further than this it is said to improve feed distribution. Other savings are in pumping cost for the feed and, sometimes, in the cost of the tank. In some settling problems, the new construction is said to have shown 30 to 40% higher capacity than equal settling area in other types of equipment.

This company recently developed a combination reaction and settling device, comprising in itself a complete C.C.D. unit. This equipment consists of a vertical tank, in the upper part of which are four built-in reaction agitators equipped with turbine-type mixers and below these are two to four thickener compartments for washing and decantation. On top of the tank are mounted a feeder for solid material and another for liquids. The unit has been employed for small-scale recausticizing and in the manufacture of alum solution. In the latter connexion, the equipment is completely rubber lined and is capable of producing 5 tons of equivalent 17% alum per day. Bauxite and acid are continuously fed to the first reaction compartment, overflowing in turn to the other three. From the last the slurry passes through the washing and decantation sections. In smaller sizes, the entire unit may be shipped assembled, ready for immediate installation and operation.

Classification.—With the increasing use of closed-circuit grinding, classifiers of the Dorr rake type have become increasingly important. As a result, about two years ago, the Dorr Co. redesigned its Type D classifier bringing out the F model. This eliminated the cam and roller mechanism for operating the rake by substituting eccentrics, cranks, and linkages which give a much simpler design with about 22% fewer moving parts. Very recently a similar rake mechanism has been applied in the F X classifier, the largest ever built. This permits a circulation as high as ten to one in closed-circuit grinding, with a capacity for the classifier of about three times that heretofore attempted.

Electrical Separation.—Probably the most important recent development in the application of electricity to separation processes is the advent of the high-intensity magnetic separator. The first installation of one of these machines was made in 1930 at the plant of the Tennessee Mineral Products Corp. at Spruce Pine, N.C. It was used in the production of ground felspar for the manufacture of glass, a product which must be free from even very faintly magnetic materials. This machine employed a number of laminated rotors revolving under the pole pieces of two large electro magnets. Materials to be separated were connected in a thin, uniform stream over each of the rotors, one after another, giving them five stages of separation.

Since the development of the first machine several concerns have adopted a similar principle. In each case a number of separation stages is employed, the magnetic element being two or more laminated rotors in which the magnetism is induced. More highly magnetic materials cling to the rotors a fraction of a second longer than the values, which causes them to drop into the tailings chute. It is stated that there are some forty materials sufficiently magnetic to be separated by this means.

Floatability of Gold.—A paper by G. L. Oldright and R. E. Head, of the Intermountain Experiment Station of the United States Bureau of Mines, concerning the influence of mill grinding on the floatability of gold appears in the *Engineering and Mining Journal* for June. The authors give the result of an investigation by microscopic methods, the following conclusion being based upon a study of the various products from a flotation mill treating a complex lead-zinc ore:

(1) The normal gold in place is bright and clean. In the earliest stage of grinding comparatively little deformation of the original particles takes place.

(2) As grinding continues the larger particles are flattened and deformed into many irregular shapes. These first deformations, however, are confined largely to flattening and folding and relatively little shearing and puncturing of the particles is in evidence.

(3) Continued grinding of these flattened particles and the attrition and pounding in contact with hard material result in shearing the flat particles into numerous smaller pieces.

(4) Constant grinding in the presence of fine

material, such as metallic and non-metallic slime, has the effect of rubbing and embedding this fine material into the already roughened surfaces of gold.

(5) The contaminants on the surfaces of the gold are built up to such a degree by constant exposure to slimed material and pounding between the balls in the mill that some of the gold is entirely coated and totally obscured. Such gold particles then have the characteristics of the material which constitutes the coating on the surface and they therefore do not float. Seemingly, the gold selects fine non-metallic slime and where a coating has been started the evidence indicates that it continues to build up.

(6) Extremely fine particles of sulphide material have been found in the gold in the lead concentrate. The possibility exists therefore, in some instances, that gold, although slightly tarnished and contaminated, floated because of the presence of a sufficient amount of sulphide material on its surface.

(7) The practice of grinding in closed circuit causes the heavy minerals to be ground preferentially. Particles of a metal as heavy as gold cannot overflow a classifier without being associated with a lighter mineral or being exceedingly fine or both.

(8) Indications are that means should exist for "bleeding" the classifier circuit, so that the gold should be recovered while it is still relatively coarse. The material bled could be treated by gravity concentration—for example, tabling—or by flotation. The use of such devices as blankets in tailing launders may be tried as a last resource.

SHORT NOTICES

Shaft Sinking by Freezing.—W. L. Lowe-Brown in the *Engineer* for May 26 last describes the sinking of shafts in connexion with the Swansea power station by the freezing process.

Tanna Tunnel, Central Japan.—Progress in the driving of the Tanna tunnel in Central Japan, which will be 4·86 miles long when completed, is described by W. H. Clarke in the *Far Eastern Review* for May.

Sand Filling.—In *Glückauf* for April 1 and 8 last Dr. K. Bax surveys the use of hand and machine methods of sand stowing.

Open-Pit Blasting.—Blasting work on a large scale, carried out at the Flin Flon mine, Manitoba, is described by M. A. Roche in the *Canadian Mining Journal* for June.

Yieldable Mine Props.—R. D. Parks describes a new yieldable mine prop in Contribution No. 44 (Class A, Metal Mining) to the American Institute of Mining and Metallurgical Engineers.

Ventilation.—In Contribution No. 54 to the Metal Mining Division, American Institute of Mining and Metallurgical Engineers, W. S. Weeks, C. H. Guest, and T. H. McClelland give the results of a study of the splitting of an air current.

Scraper Loading.—An article on scraper loading and conveying by J. B. Keast appears in the *Canadian Mining and Metallurgical Bulletin* for June.

Air Compressing.—L. Eaton discusses efficient air compressing in the *Engineering and Mining Journal* for June.

Dust in Mines.—The health hazard from dust in mines and other industries of the United States is surveyed by M. van Siden in Contribution No. 45 to the American Institute of Mining and Metallurgical Engineers for May, 1933.

Detonating Explosive.— In *Industrial and Engineering Chemistry* for June L. V. Clark gives an account of an investigation into the properties of diazodinitrophenol, which, it is expected, may replace the fulminate mixtures for the detonation of certain explosives, such as the dynamites.

Power-Shovel Work.—J. E. Bosland describes the protection of the power-shovel equipment against overheating in the *Engineering and Mining Journal* for June and shows how this cuts maintenance costs.

Fine Grinding.—The technique of fine grinding for flotation work is discussed by M. Gratacap in *Revue de l'Industrie Minérale* for June 15.

Gravity Concentration.—F. J. Tolonen describes gravity concentration tests on Michigan iron formations in Contribution No. 46 to the American Institute of Mining and Metallurgical Engineers for May last.

Tellurides and Cyanide.—W. E. Johnston discusses the solubility of gold tellurides in cyanide in the *Canadian Mining and Metallurgical Bulletin* for June.

Canadian Metallurgy.—In the *Canadian Mining Journal* for June H. Hanson reviews progress in the metallurgy of Porcupine and Kirkland Lake ores.

Magnetic Surveys.—In a paper read before the Institute of Mine Surveyors at Cannock on April 8 last T. G. Bannock discusses the selection of a date for magnetic needle observations.

Potash Determination.—J. E. Schneler and R. P. Thomas discuss the determination of potassium by sodium cobaltinitrite in *Industrial and Engineering Chemistry* (Analytical Edition) for May 15.

Zinc Separation.—The quantitative separation of small amounts of zinc from iron-rich material is described by F. G. Hills in *Industrial and Engineering Chemistry* (Analytical Edition) for May 15 last.

Quartz Spectrography.—In *Economic Geology* for June–July M. H. Haycock describes the application of the quartz spectrograph to the study of opaque minerals.

Manganese in the United States.—In a report issued by the A.I.M.E. sub-committee on manganese the metal is dealt with as an element in the problem of national defence.

RECENT PATENTS PUBLISHED

☛ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2, with a note of the number and year of the patent.*

28,729 of 1931 (391,136). D. TYRER and IMPERIAL CHEMICAL INDUSTRIES, LTD., London. Improved roasting of pyrite is found to result if SO_2 or an SO_2-containing gas is fed into the combustion zone.

30,843 of 1931 (392,532). EXOTON COMPANY, New York. An improved magnetic separator.

31,451 of 1931 (391,514). H. E. COLEY, London. Metallic zinc is vaporized in a rotary chamber in the presence of carbonaceous material, oxidation being completed in an adjoining rotary furnace.

31,994 of 1931 (392,578). G. RAW, Low Fell, Durham. A pneumatic separating table or deck for mineral concentration processes.

32,145 of 1931 (392,585). W. SINGLETON, W. HULME, B. JONES, and GOODLASS WALL AND LEAD

INDUSTRIES, LTD., London. Alloys of lead and tellurium.

34,808 of 1931 (392,640). E. WYDLER, Thurgan, Switzerland. Silicates are mixed with aluminium and sulphur and roasted to yield metallic sulphides and massive silicon.

2,208 of 1932 (392,664). ALUMINIUM, LTD., Toronto. Froth flotation process for the concentration of fluorspar.

15,151 of 1932 (392,361). NEW JERSEY ZINC COMPANY, New York. Zinc vapour is freed from metallic contaminants by refluxing part of the zinc in molten form back towards the vapour source, the vapour being thereby purified.

27,316 of 1932 (392,809). FRIED. KRUPP GRUSONWERK A.-G., G. ULLRICH, and R. SIEBERT, Magdeburg, Germany. Magnetic separators for dressing dredged material.

28,635 of 1932 (391,369). BERYLLIUM DEVELOPMENT CORPORATION, New York. Beryllium and other metals are recovered from their ores by a process which first results in the formation of a double fluoride of the metal, from which it may be recovered in the usual way.

NEW BOOKS, PAMPHLETS, Etc.

Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London, E.C. 2.

Prospecting and Operating Small Gold Placers. By WILLIAM F. BOERICKE. Cloth, octavo, 136 pages, illustrated. Price 9s. 6d. London: Chapman and Hall.

Angewandte Geophysik für Bergleute und Geologen. By HERMANN REICH. Paper covers, 151 pages, illustrated. Price RM. 12·60. Leipzig: Akademische Verlagsgesellschaft. G.m.b.H.

Die Primare Erzverteilung, auf den Erzlagerstätten und ihre geologischen Ursachen. By Dr. F. WERNICKE. Paper covers, 173 pages, illustrated. Price RM. 7·50. Halle (Saale): Wilhelm Knapp.

The Technical Man Sells his Services. By EDWARD HURST. Cloth, octavo, 239 pages. Price 12s. London: McGraw-Hill Publishing Co.

Lead. Imperial Institute Monograph on the Mineral Industry of the British Empire and Foreign Countries. 2nd edition. Paper covers, 253 pages. Price 4s. London: H.M. Stationery Office.

Explosion-Proof Electrical Switch-Gear. "What every Mining Man should Know," No. 5. Paper covers, 27 pages, illustrated. Price 3d. London: H.M. Stationery Office.

Electrical Signalling Systems and Telephones in Mines. Mines Department Safety Pamphlet No. 8. Paper covers, 11 pages, illustrated. Price 3d. London: H.M. Stationery Office.

Reports of H.M. Inspectors of Mines, 1932. 2.—Northern Division. By T. GREENLAND DAVIES. 3.—Yorkshire Division. By E. H. FRAZER. 4.—North-Midland Division. By J. R. FELTON. 5.—North-Western Division. By W. J. CHARLTON. 6.—Cardiff and Forest of Dean Division. By J. MACLEOD CAREY. 8.—Midland and Southern Division. By W. E. T. HARTLEY. Each part in paper covers, price 1s. London: H. M. Stationery Office.

Canadian Limestones for Building Purposes. Canadian Mines Branch Publication No. 733. By M. F. GOUDGE. Paper covers, 196 pages, illustrated. Price 30 cents. Ottawa: Department of Mines.

Canadian Geological Survey, Summary Report, 1932. Part A I: Placer and Vein Gold Deposits of Barkerville, B.C., by W. A. JOHNSTON and W. L. UGLOW; Geology and Placer Deposits of Quesnel Forks Area, B.C., W. E. COCKFIELD and J. F. WALKER. Part A II: Mining Industry of Yukon, 1932, H. S. BOSTOCK; Whitewater Gold Belt, B.C., F. A. KERR; Zeballos River Area, B.C., H. C. GUNNING; Quadra Island, B.C., H. V. ELLSWORTH and H. C. GUNNING; Cadwallader Creek, B.C., W. E. COCKFIELD and J. F. WALKER. Part B: Waterton Lakes, Flathead Area, G. S. HUME; Crowsnest Pass Area, B. R. MACKAY; Birch Ridge Structure, Alberta, G. S. HUME. Part C: Great Bear Lake Area, D. F. KIDD; Great Slave Lake-Coppermine River Area, C. H. STOCKWELL; Maguse River, L. J. WEEKS; Amisk Lake Area, Saskatchewan, J. F. WRIGHT. Part D: Michipicoten River Area, A. F. MATHESON; Palmarolle and Taschereau Map Areas, Quebec, A. H. LANG; Waswanipi Lake Area, A. H. LANG; Middle River Gold Field, Nova Scotia, F. J. ALCOCK. Each part in paper covers, illustrated. Ottawa: Department of Mines.

Studies of Geophysical Methods, 1930. Canadian Geological Survey Memoir 170. Paper covers, 118 pages, illustrated. Price 20 cents. Ottawa: Department of Mines.

Quebec: Bureau of Mines Report, 1931. Part D: Chromite Deposits of the Eastern Townships. By B. T. DENIS. Paper covers, 106 pages, with map. Quebec: Bureau of Mines.

Southern Rhodesia. Geology of Central Part of Mazoe Valley Gold Belt. Geological Survey Bulletin No. 22. By R. TYNDALL-BISCOE. Paper covers, 120 pages, illustrated. Price 3s. 9d. Salisbury: Geological Survey.

Gold Coast Colony. Map showing positions of gold and diamond properties, revised to June 12, 1933. Price 2s. 6d. London: C. D. Syndicate, Ltd.

Uganda. Geological Survey Department Report, 1932. Paper covers, 58 pages, with map. Price Shs. 3. Entebbe: Geological Survey Department.

Tanganyika Territory. Limestones Deposits. Geological Survey Department Bulletin No. 4. By FRANK OATES. Paper covers, 120 pages, with map. Price 5s. Dodoma: Geological Survey Department.

Malaya: F.M.S. Chamber of Mines Year Book, 1932. Paper boards, 333 pages, with tables. Ipoh: Chamber of Mines.

British Guiana: Mineral Resources of the North-West District, Mazaruni and Puruni Districts, and the Potaro-Essequibo District. Paper covers, 64 pages. London: Crown Agents for the Colonies.

Alaska: Mineral Industry in 1931, by P. S. SMITH; Mineral Investigations in the Railroad Belt, by S. R. CAPPS. United States Geological Survey Bulletin 844-A and B. Paper covers, illustrated. Washington: Superintendent of Documents.

COMPANY REPORTS

Transvaal Gold Mining Estates.—This company, formed in 1895, operates gold-mining properties in the Lydenburg district of the Transvaal. The report for the year to March 31 last shows that 227,400 tons of ore was milled, as compared with 197,100 tons in the previous year, the yield amounting to 65,467 oz., against 61,385 oz. The total revenue amounted to £317,922, while expenditure was £242,848, leaving a working profit of £75,074, equal to 6s. 7·2d. per ton milled. A dividend paid during the year absorbed £35,749, equal to 6¼%. The ore reserves at the end of the year, calculated on the standard value for gold, were estimated to be 391,000 tons, averaging 7·1 dwt. in value over 18 in., of which amount 334,000 tons are in the Central mines. The reserves at the end of the previous year totalled 386,000 tons, averaging 7·9 dwt. in value.

Taquah and Abosso.—Formed in 1927, this company works gold properties in the Wassau district of the Gold Coast Colony. The report for the year to March 31 last shows that 122,043 tons of ore was treated, the gold recovered, at standard price, being worth £169,208, the premium realized being £69,006. After providing for depreciation and other items the accounts show a profit of £67,165, making, with the balance brought in, an available total of £79,084. Dividends equal to 28½% were declared for the year, absorbing £50,625, leaving a balance of £28,459 to be carried forward. The ore reserves at the end of the year were estimated to be 339,700 tons, averaging 31s. 10d. per ton in value. The Cinnamon Bippo property has been unwatered and is being sampled, while the reopening of the Adjah Bippo shaft is said to be making good progress.

Bisichi Tin.—This company was formed in 1910 and works alluvial tin properties in Northern Nigeria. The report for 1932 shows that 268½ tons of tin concentrates was produced, against 469 tons in the previous year, the amount realized per ton being £94 16s. 3d., against £86 15s. 10d. The accounts show a profit of £6,371, increasing the sum brought in to £13,203. A dividend equal to 3½% has been declared and this will absorb £12,075, leaving a balance of £1,128 to be carried forward. The proved reserves of ore at the end of the year amount to 9,308 tons of concentrates, all situated on areas that are not at present being worked.

Kagera (Uganda) Tinfields.—Formed in 1926, this company operates the Mwirasandu mines in Uganda. The report for 1932 shows that 308 tons of tin concentrates was produced and this realized £32,325, equal to £104 19s. per ton. The working profit was £6,623, allowance for sundry items reducing this to £6,532, which reduced the debit balance brought in to £5,720. The reserves at the Mwirasandu mine at the end of the year were estimated to be 1,307 tons, of which 685 tons are in the mine and 622 tons detrital ore.

Great Boulder Proprietary.—This company was formed in 1894 and operates gold-mining properties in the East Coolgardie district of Western Australia. The report for 1932 shows that 106,641 tons of ore was treated, the gold yield amounting to 77,919 oz., worth £269,556, 1,267 oz. having been recovered from old tailings. The royalty from tribute operations was £28,985, while £6,532 was received as revenue from the Boulder Perseverance for ore treated at their plant. The accounts show a profit for the year of £70,950, increasing the sum brought in to £78,771. Australian taxes amounted to £10,708 and two interim dividends, each of 12½%, absorbed £43,750, leaving a balance of £24,313 to be carried forward, from which an interim dividend equal to 12½% has been declared for the current year. The ore reserves at the end of the year were estimated to be 204,792 tons, averaging 7·99 dwt. in value, as compared with 132,139 tons, averaging 8·13 dwt., at the end of the previous year, while the probable reserves are estimated to provide an additional 333,208 tons.

Sons of Gwalia.—Formed in 1898, this company operates a gold-mining property in the North Coolgardie goldfield, Western Australia. The report for 1932 shows that during the year the mill treated 143,202 tons of ore and 6,888 tons of accumulated slimes for a recovery of 43,568 oz. of gold, which realized, including the gold bonus, £260,224. The profit for the year was £101,118, as compared with £57,697 for the previous year, the total sum available after making various allowances being £117,042. Of this amount £50,000 has been placed to reserve and £24,000 absorbed in taxes, while £16,575 was absorbed as a dividend, equal to 1s. per share. After making other allowances, a sum of £12,680 was carried forward. Development work has resulted in a further increase in the ore reserves, which are now estimated as equivalent to three years' supply for the mill, having a grade of 30s. per ton with gold at 85s.

South Kalgurli.—This company was formed in 1913 and works gold-mining properties in the East Coolgardie goldfield, Western Australia. The report for the year to March 31 last shows that 112,637 tons of ore, including ore from tributes and purchased ore, was treated for a gross value of £288,394, of which £105,061 represents exchange premium. The profit for the year was £93,668, making with the sum brought in an available total of £95,056. Dividends equal to 2s. 6d. per share absorbed £31,250, while the same amount has been distributed as a bonus and, after allowing £26,000 for depreciation, there was £6,555 to be carried forward. The ore reserves at the end of the year were estimated to be 201,000 tons blocked out, averaging 7·91 dwt. in value, and 76,000 tons of probable ore, averaging 5·76 dwt. Options on two leases adjoining the Croesus Proprietary mine were acquired during the year and prospecting is being carried out.

Ipoh Tin.—This company was formed in 1913 and works alluvial tin properties in the State of Perak, F.M.S. The report for the year to March 31 last shows that owing to restriction conditions Nos. 1 and 2 dredges were closed down during the year, while No. 3 (the Ayer Etam) worked for eight months, producing 550 tons of ore from 883,400 cu. yd. dredged. The accounts show a profit of £26,586, giving with the sum brought in an available total of £34,822. Of this amount £5,561 has been allowed for income tax, £14,912 written off the Ayer Etam property and dredge, and £7,500 absorbed in the payment of a dividend, equal to 1s. per share, leaving £6,848 to be carried forward.

Lahat Mines.—Formed in 1906, this company owns alluvial tin properties at Lahat, F.M.S. The report for 1932 shows that 141 tons of tin concentrates was produced by the tributor, the company's revenue from this source amounting to £2,007, the accounts showing a loss for the year of £509, reducing the balance brought in to £3,007.

Tronoh Mines.—This company was formed in 1901 and operates alluvial tin properties in the Kinta district, Perak, F.M.S. The report for 1932 shows that under restriction conditions the output of tin concentrates amounted to 678 tons, which realized an average of £85 per ton, as compared with £72 12s. 2d. per ton for the 1,488 tons produced in the previous year. Operations resulted in a profit of £17,908, increasing the balance brought in to £67,514, of which £15,000 has been absorbed as a dividend, equal to 5%, leaving £52,514 to be carried forward.

Southern Tronoh.—This company, formed in 1927, works an alluvial tin property in Perak, F.M.S. The report for 1932 shows that the 202 tons of concentrates produced realized an average price of £83 19s. 4d. per ton, as against £71 6s. 8d. obtained in the previous year. The profit for the year was £376, increasing the sum brought in to £3,888. Of this amount £1,273 has been written off for depreciation, leaving the sum of £2,115 to be carried forward.

Tavoy Tin Dredging.—Formed in 1923, this company operates alluvial tin properties in the Tavoy district of Lower Burma. The report for 1932 shows that 3,250,000 cu. yd. of ground was treated for a recovery of 735½ tons of concentrates, while 84 tons was produced on tribute, the average net price realized amounting to £137 per ton of metal. The accounts show an operating profit of £26,725, this being reduced after allowing for all expenses and interest charges to a loss of £6,601, which increases the debit balance brought in to £39,663.

Siamese Tin.—This company was formed in 1906 and works alluvial tin properties in the Renong and Takuapa districts, Siam, and on Puket island. The report for 1932 shows that 2,236,600 cu. yd. treated on the Ngow property yielded 758¾ tons of concentrates, while the 1,869,400 cu. yd. treated at Kopah yielded 451¼ tons. The accounts show a profit of £10,726, increasing the sum brought in to £22,634, of which £15,000 has been distributed as a dividend, equal to 10%, leaving £7,634 to be carried forward.

Bangrin Tin.—This company, formed in 1920, operates an alluvial tin property in the Renong district, Siam. The report for 1932 shows that 1,338,000 cu. yd. was treated by the three dredges, 546·37 tons of tin concentrates being recovered. The profit for the year was £1,869, increasing the sum brought in to £21,767, which has been carried forward.

Chosen Corporation.—This company was formed in 1923 and controls gold-mining companies operating in Korea. The report for the year to June 30 shows that 120,290 tons of ore, averaging 7·75 dwt. in value, was treated at the Great Nurupi mine, the yield amounting to 790,930 dwt. of gold and 26,226 oz. of silver. The profit of mining operations was 930,941 yen. The reserves at this mine at March 31 last were estimated to be 123,227 tons, averaging 6·16 dwt. in value, in addition to 22,166 tons, averaging 3·15 dwt. Intensive prospecting is in progress on several other properties, some of which have provided ore for the mill during the year, the work on the East Nurupi mine being expected to lead to economic results in the near future. The accounts show a distributable profit of £49,756, of which £23,437 has been distributed as dividends, the balance carried forward, after making other allowances, being £13,319.

East Pool and Agar.—This company was formed in 1913 and works lode-tin properties at Illogan, Cornwall. The report for 1932 shows that 34,016 tons of ore was crushed, of which 26,975 tons came from the Rogers lode, 6,530 tons from the Moreing lode, and 511 tons from other sources. The production of black tin amounted to 577·62 tons, while 53 tons of refined arsenic were also produced. The accounts show a loss for the year of £4,716, increasing the debit balance brought in to £22,137.

DIVIDENDS DECLARED

Anglo American Corporation.—Pref. 3%, less tax, payable August 17.
Apex Mines.—4½d., free of tax, payable August 17.
Ayer Hitam.—1½d., less tax, payable June 29.
Balaghat.—Ord. 1s., Pref. 6d. (return of capital).
Bechuanaland Exploration.—6d., less tax, payable June 13.
Bisichi Tin.—3½%, less tax, payable July 12.
Blackwater.—1s. 6d., free of tax, payable June 30.
British South Africa.—6d., less tax.
Cam and Motor.—4s., less tax.
Chosen Corporation.—6d., less tax, payable July 1.
Consolidated Gold Fields of New Zealand.—9d., free of tax, payable June 30.
Gopeng Consolidated.—3d., less tax, payable July 7.
Great Boulder.—3d., less tax, payable July 14.
H.E. Proprietary.—9d., less tax, payable July 8.
Henderson's Transvaal Estates.—3d., less tax.
Ipoh Tin.—1s., less tax, payable July 8.
Kamunting Tin.—3d., less tax, payable July 14.
Kinta Tin.—3d., less tax, payable June 28.
Komata Reefs.—3d., free of tax, payable July 14.
Lake View and Star.—6d., less tax, payable August 10.
Lonely Reef.—6d., less tax, payable July 29.
New Era.—4½d., less tax, payable August 17.
Pangnga River.—4%, less tax, payable July 15.
Pari Tin.—3d., less tax, payable June 28.
Rand Mines.—3s. 3d., less tax, payable August 17.
Renong.—Pref. 1s. 6d., less tax, payable June 30.
Rezende.—2s. 6d., less tax.
Rooiberg Minerals.—1s., free of tax, payable August 17.
Sherwood Starr.—6d., less tax.
Siamese Tin Syndicate.—6d., less tax, payable June 22.
Sons of Gwalia.—1s., less tax, payable July 22.
South Kalgurli.—4s., less tax, payable July 25.
Taquah and Abosso.—9d., less tax, payable July 14.
Tronoh.—1½d., less tax, payable June 30.

NEW COMPANIES REGISTERED

Mount Magnet Gold Mines.—Capital: £110,000 (50,000 £1 seven per cent cumulative participating preference and 480,000 2s. ordinary). Objects: To acquire mineral and other rights. Directors: Sir Cyril K. Butler, and Hon. Lionel Holland.

Tano Alluvials.—Capital: £25,000 in £1 shares. Objects: To carry on the business of mine owners, metallurgists, etc. Office: Lloyds Bank Buildings, 55-61, Moorgate, E.C. 2.