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EDITORIAL

A GEOLOGICAL survey of Kenya will certainly fill a long-felt want, the lack of such a body being referred to elsewhere in this issue. It is welcome news, therefore, to learn that Sir Albert E. Kitson left last month for Kenya to inaugurate this much-needed survey. He has as his assistant Mr. R. Murray-Hughes, who will carry on the work on the return of Sir Albert in about six months' time.

THIS year the Institution has decided to award two gold medals, one to Sir H. C. Harold Carpenter, in recognition of his eminent services to metallurgy, and a second to Dr. T. A. Rickard, in recognition of his work in the advancement of mining engineering. The Consolidated Gold Fields of South Africa gold medal goes to Mr. P. J. Crowle for his work on ground movement and methods of support on the Kolar goldfield, and the same company's premium to Prof. B. W. Holman for his research on flotation reagents. The William Frecheville students' prize is awarded to Mr. G. F. Hatch for his paper on "Check Sampling of Diamond Drill Holes at the Trepca Mines, Yugoslavia."

IN the MAGAZINE for December last our Ipoh correspondent drew attention to proposals which were then on foot in Malaya favouring a policy of decentralization. Further reference to this matter is made in this month's letter and it is felt that such far-reaching changes as are apparently contemplated should receive wider attention. In effect, it would seem that local government for each of the States in the Federation is proposed in order that differences between administrative methods in the Federated and Unfederated States may be lessened, the seat of government being removed to Singapore. The removal of the Mines Department from the principal mining district can hardly be regarded as helping the industry.

THE intention to erect a statue to the memory of Richard Trevithick, the inventor of the steam locomotive and pioneer in the use of high-pressure steam, was announced in our Camborne column in May, 1929. The memorial is to have a two-fold character, the erection of the statue and the establishment of a scholarship fund to provide free instruction at the Camborne School of Metalliferous Mining. A representative gathering is anticipated at the unveiling ceremony by Prince George at Camborne on May 17, when the Institution will be represented by the president, Mr. Pellew-Harvey. It might be added that an interesting paper by J. Harvey Trevethick on the life and inventions of his great-grandfather was summarized in THE MINING MAGAZINE of October, 1920.

Testing Alluvial Deposits

A paper by Mr. W. R. Rumbold presented before the Institution of Mining and Metallurgy early in 1928 created a great deal of interest among those engaged in alluvial mining, the discussion revealing such a diversity of views on certain important aspects of this branch of the profession that it was finally decided by the council to set up a committee to examine and report on the conditions under which alluvial areas were tested. The subject was again brought to the fore at the April meeting of the Institution by the first paper to be read—"Systematic Sampling of Alluvial Deposits by the Banka Drill," by Mr. P. R. Lake. The scope of Mr. Lake's thesis is examined here, while a more detailed summary appears elsewhere in this issue. The attendance at the meeting was, perhaps, equally attracted by the prospect of hearing the views of the committee referred to, and those present could hardly have been disappointed, the discussion on Mr. Lake's paper being keen and to the point, while Mr. C. B. Brodigan reviewed the work of the committee.

It will be recalled that one of the most contentious points raised by Mr. Rumbold's paper was the determination of the number of bores to be put down in a given area, or, as it might be called, the holes-per-acre question. The many differing views apparently held by those well qualified to express an opinion were certainly calculated to create uneasiness among junior members, who felt that their first task might involve a decision on such a point. It may be said, however, that a study of Mr. Lake's paper reveals a scheme of boring which should be of great assistance to those undertaking the

examination of an alluvial area for the first time and in this respect at least is of considerable value. The author's scheme may be described, in his own words, as a system of uniformly-decreasing squares, wherein every hole is given equal weight and bears the same responsibility, by which, it is claimed, the sampling of alluvial deposits is simplified, there being at the same time a gain in economy and accuracy. Briefly, the various stages in the scheme are as follows: First, a series of scout bores at the corners of 8-chain squares, whereby the economic boundaries within the property are roughly defined, the series involving one hole per 6·4 acres; secondly, normal bores at the corners of 4-chain squares, equal to one hole per 1·6 acre, workable boundaries being thus fixed to within two chains; thirdly, check bores at the corners of 2-chain squares —one hole per 0·4 acre—proving up the property; and, lastly, the delineation of patchy areas by close boring, sinking holes at the corners of 1-chain squares—that is, a density of 10 holes per acre. The stage to which it may be considered necessary to follow this plan will depend, of course, on the uniformity of the results obtained, but the author claims that the system will eliminate to a large extent the errors that are constantly occurring in the mineral valuation of such deposits. The paper also deals with the Banka drill and its use and with the recording of results, concluding with a description of the method by which mineral values are computed. After a brief introduction of his paper by the author, the discussion was opened by Mr. E. T. McCarthy, who had something to say on the dangers of the standardization of drilling methods, a point stressed by several of the later speakers, many of whom were of opinion that certain deposits—such as those along well-defined valleys—would be sampled better by bores set out on lines laid at right angles to the stream course. In addition to Mr. Brodigan, whose remarks are dealt with in the following paragraph, those members joining in the discussion included Messrs. Morgans, Bolt, Inder —who called attention to the importance of correct estimations of gravel sizes and to the correlation of drilling results with actual winnings—Naish, Hatton, Rumbold, and Underwood-Jarvis, the last-named, since so many had referred especially to the sampling of alluvial tin deposits, dealing with gold placer work. Members found many points in the paper where they were at variance with the author, but there can be little doubt that the presentation of a clearly-defined scheme of this nature should be of the greatest value, especially, as already indicated, to junior members of the profession.

The remarks of Mr. Brodigan during the discussion were of more than usual importance, embodying as they did the conclusions of the committee on alluvial valuations set up by the council. This committee, which comprised Messrs. Rumbold, Inder, Scrutton, Trewartha-James, Pawle, Thorne, and Brodigan, the last named acting as chairman, has progressed sufficiently far in its labours to offer certain tentative conclusions for consideration. The speaker emphasized that in the course of its work—which, it must be remembered, was in part an attempt to raise the status of the alluvial side of the profession—it had been realized that the present haphazard fashion in which reports on alluvial areas were sometimes presented to the public was detrimental, and it was, therefore, of the utmost importance that members interested should respond to the committee's request for comment and criticism of the provisional conclusions. The following notes summarize briefly the committee's findings, which are given under seven headings: First, two holes per acre is considered a useful number of bores on which to report, unless the engineer in charge has sound reasons for taking a different course, while the check afforded by calculating values on the samples from alternate bores is recommended; secondly, the manner in which bore samples are measured should be stated in the report; thirdly, sampling results should not be stated in terms of mineral alone, other facts, such as yardage, depth of ground, and weight of concentrate, should be given, while, in addition, prices on which values are based should be clearly stated, as well as factors which may affect subsequent working; fourthly, widely differing sample values should be treated carefully; fifthly, British units are recommended; sixthly, "ore" should not be used in referring to alluvial deposits, "wash" being considered a better term; and, finally, reserves should not be given in reports unless the manner in which they have been determined is also given. It will be seen, therefore, that whatever be the outcome of the discussion on these recommendations, they would, if they became standardized, afford a useful skeleton on which sound reports might be built and

the course of discussion upon them will be closely followed. Meanwhile many members of the profession cannot but feel that the formulation of such a scheme as Mr. Lake's, together with the guiding recommendations of the committee, go a long way towards placing alluvial valuation on a surer basis.

Gold in Kenya and Uganda

The gold-producing potentialities of the West Coast of Africa were examined in the January issue of the MAGAZINE, owing to the stimulus afforded to prospecting by the premium created when this country left the gold standard. It is only fair, therefore, that the possibilities for precious metal discoveries in East Africa should receive equal attention, particularly as regards Kenya and Uganda, and we are indebted to Dr. A. W. Groves, formerly of the Uganda Geological Survey, for much of the material incorporated in this article. Elsewhere in this issue the results of reconnaissance work in Kenya are given and they form interesting reading. For many years it has been customary to regard Kenya as a colony devoid of any mineral wealth beyond the soda deposits of Lake Magadi, as perhaps was only to be expected in a country generally overlain by volcanic rocks of comparatively late geological age. There are, however, large areas which, even if not altogether free from the late volcanics, afford ample opportunity for the study of the older rocks of the country and it is clearly to these that the prospector must turn. In particular those parts of the colony bordering on Lake Victoria, between the Nandi Escarpment and the Kenya–Uganda border south of Mount Elgon, as well as the country southwards from the Kavirondo Gulf to the Tanganyika-Kenya border are beginning to yield material evidence of their potentiality to produce gold. Only recently the colony experienced its first gold rush at Kakamega, although if a well-equipped geological survey had been in existence in Kenya some years ago it is reasonable to suppose that this discovery would have been made earlier. Kenya has not been without her share of prospectors, but their investigations have been hampered by the lack of a Geological Survey Department, although the need of such a department must have been recognized, a member of the Geological Survey of Uganda having on two occasions been lent to the Kenya Government to do reconnaissance work in that colony. It is satisfactory to learn, therefore, that the inauguration of an official survey is now well in hand.

Kakamega, the centre of the recent gold rush in Kenya, lies about 25 miles north of Kisumu, the terminus of the old main line of the Kenya and Uganda Railway, on the shore of the Kavirondo Gulf of Lake Victoria. With regard to its location, it will be recalled that Mr. Wayland pointed out in the course of an article in the March issue of the MAGAZINE that " the remarkably sharp turn of the Nile below Nimule and the continuation of that line in a south-easterly direction by the Aswa River is strikingly brought out on the map. By projecting that line, which along the Nile and the Aswa is known to be a fault or shatter zone with crushing, it will be found to run under the south-western part of Mount Elgon, and to run into the fault of the Nandi Escarpment." Kakamega is only about 15 miles to the west of the foot of the Nandi Escarpment and on theoretical grounds, therefore, it appears very probable that the mode and period of mineralization at Kakamega will turn out to be comparable with that of the earlier discovered gold-producing area to the south of the Kavirondo Gulf.

As regards Uganda, the protectorate has been more fortunate than Kenya in having a Geological Survey Department, which, commencing with a sole member in 1919, grew to six during 1929 and 1930. Prior to 1919 geological knowledge of Uganda was extraordinarily meagre, much more so than that of Kenya at that time. The discoveries of economic importance in Uganda have all been made in the last ten years or so, but progress is of necessity comparatively slow on account of the nature of the country. Gold has been found in small quantities in widely different parts of the protectorate, in the alluvials of the River Kafu, the streams of the West Nile district, the Nile Valley in the East Madi, in the Bugishu district near Mount Elgon, the shore sands of Lake Albert, and in the Kigezi district. The occurrence in the alluvials of the River Kafu has been fully investigated by the Geological Survey, the river now forming a classical example of the difficulty which is experienced in prospecting quite a good proportion, though not all, of the Uganda rivers in that it has suffered reversal, with the result that " the best chance of discovery of placer deposits in mineralized areas is in pre-reversal gravels, in what is now a downstream direction."

This also applies, of course, to much of the prospecting for cassiterite. The source of the gold in each of these districts, as well as in Bugishu, is obscure, but it certainly appears to have come from the ancient gneisses of the Basement Complex, together with its later igneous intrusions. Promising discoveries of gold have recently been made by a prospector in streams in the forest of Lubugole, known as the "Impenetrable Forest," in the Kigezi district and north-west of Kabale. The locality is at an altitude of over 7,000 feet in difficult country, with juvenile streams, heavy rainfall, and mists. The alluvial gold is coarse, shows little sign of attrition, and is clearly near to its source. Nuggets as heavy as half a gramme have been found. A peculiar feature of the gold in this district is that it is frequently accompanied by native copper and that when this is the case a large proportion of the gold grains are then coated with a deposit of metallic copper. Only a fraction of the gold in such concentrates is visible until the sample has been leached in hot nitric acid, when many grains which originally appeared to be copper prove to be gold. It is apparent, therefore, that these two East African colonies possess important potentialities as gold producers and it is to be hoped that in any survey of Imperial mineral resources they will not be ignored. The world may go off a gold basis—some day; at present, all that can be produced is badly needed.

Ore Deposition

In August last, in the course of a review of proceedings at one of the discussions in the geological section of the British Association's centenary meeting, the state of research on ore-genesis was examined in these columns, the views of practical mining men and of economic geologists on this question being compared. The geologist's view—with which, it is felt, there is substantial agreement among technical men—was then expressed as one of alarm at "the indifference of many mining companies towards research on their chief asset—the ore-body." This indifference, it was stated, "is, in fact, a disservice to themselves, the hasty removal, for 'economic' reasons, of the first of their finds often destroying much valuable evidence that might have been applied to the search for new prospects." It will readily be granted, of course, that researches on ore-genesis are often conducted at a serious disadvantage, so many factors having to be assumed. Nevertheless, the use of new lines of attack may often prove fruitful and on these grounds it is possible to welcome the efforts of Dr. H. C. Boydell, who has in the past endeavoured to apply physico-chemical data in the interpretation of geological phenomena. In the second paper read at the April meeting of the Institution Dr. Boydell once more returns to this type of subject, his paper on the "Temperature of an Epi-Thermal Ore-Deposit" involving a mathematical study of certain factors affecting the formation of the Camp Bird vein in the San Juan region of Colorado. At the meeting the paper was, in the absence of the author, ably introduced by Professor Cullis, who infused general interest into a paper which not only appeared terrifying to the ordinary reader, but with which he was himself in certain fundamental respects in disagreement. Discussion was limited, so much time having been taken by a previous paper, but it is hoped that written discussions may prove helpful to Dr. Boydell and to others engaged in similar studies.

The description of the Camp Bird deposit has been carried out by experienced authorities on ore geology, the work of Ransome, Purington, and Spurr being well known, and for a general description of the deposit readers may be referred to their papers. It will, however, be recalled, no doubt, that after Spurr's description of the Camp Bird "Compound Vein Dyke" a controversy ensued between the author and Dr. Boydell over the importance of certain operative factors, in the course of which Mr. Spurr expressed the view "that in centres of active vulcanism, where ore-injection was in many cases preceded and followed by lava eruptions," the temperature must have been greater than 150° down to a depth of several thousand feet. By the use of mathematical data, based on the work of Ingersoll and Zobel, Dr. Boydell, using Fourier's series as a mechanism, has endeavoured to disprove this contention of Spurr's, his work showing that the temperature rise in a basement rock due to the emplacement of hot lava upon it reaches nothing like 150°. It will be felt, of course, that Dr. Boydell's work only touches on part of the question, heat in an area of active vulcanism having so many other sources than the one examined, although the novel treatment of the subject may possibly throw new light on a controversial matter.

REVIEW OF MINING

Introduction.—The major event of the past month has, of course, been the introduction of the Budget, followed by protective measures of a more definite character than those hitherto in force. The Budget, which has been aptly described as a "nothing-for-anybody" measure, represents, in effect, a continuation of the severe economies imposed last Autumn, while the duties evidence the sincere desire of the Government to redress the adverse balance in trade.

Transvaal.—The output of gold on the Rand for April was 901,894 oz. and in outside districts 47,902 oz., making a total of 949,796 oz., as compared with 960,035 oz. in March. The number of natives employed on the gold mines at the end of the month totalled 214,334, as compared with 214,024 at the end of March.

The reports of the Anglo American group of mines for 1931 were issued during the past month. The Brakpan Mines accounts show a profit of £556,426, which, added to the sum of £50,377 brought in, gave an available total of £606,803. Of this amount £408,000 was absorbed as dividends, equal to 40%, and after making other allowances a balance of £55,331 was carried forward. The ore reserves at the end of the year were estimated to be 2,520,890 tons, averaging 7·78 dwt. over a width of 51·59 in., a slight decrease when compared with the figures for the previous year. The tonnage milled during 1931 was 1,138,500, 414,537 oz. of gold being recovered, worth £1,759,321.

The results of Springs Mines show the profit to have been £839,971, the total sum available being £901,150. Dividends absorbed £581,250, equal to 38¾%, the amount carried forward, after making other allowances, being £73,106. The ore reserves at the end of the year show an increase of 141,613 tons over the previous year's figures, the amount being 3,452,983 tons, averaging 9·14 dwt. over a stoping width of 48·4 in. During the year 843,300 tons of ore was milled, 413,688 oz. of gold being recovered for a revenue of £1,755,808.

During 1931 West Springs made a profit of £165,944, the total sum available being £257,565. Dividends paid absorbed £134,475, equal to 7½%, and, after making other allowances, there was a balance of £103,849 to be carried forward. The ore reserve position shows little change when compared with the previous year, the figures being 2,737,020 tons, averaging 5·85 dwt. over a stoping width of 53·15 in. The tonnage milled was 851,800 and the gold recovered 210,496 oz. worth £892,942. Developments in the southern area of the property have improved, recent bore-holes showing considerably larger reef widths and better values than were exposed above the faults in this area.

The reduction plant at Daggafontein Mines was brought into operation on the last day of the year under review—1931—having been finished well on time. No. 3 shaft was completed and in a report for the first three months of 1932, issued subsequently, it is noted that the erection of headgear, winder, and boiler at No. 2 shaft, preparatory to the commencement of unwatering operations, is proceeding satisfactorily.

The report of the Sub Nigel for the three months to March 31 shows that the company has tendered to the Government for the lease of that area of the farm Grootfontein situated along the eastern boundary of the present holdings of the mine. If this tender is accepted the mining area held will be increased to over 6,580 claims.

A pressure burst in the No. 3 vertical shaft of Geldenhuis Deep placed it out of commission for some days, affecting the monthly output considerably.

It was announced towards the end of last month that the board of the Central Mining and Investment Corporation had decided to resume the payment of dividends and at the annual meeting to be held this month the payment of a dividend of 6s. per share, less tax, will be recommended.

The profit of the Anglo American Corporation of South Africa, Ltd., for 1931 was £113,303, to which must be added the sum of £204,884 brought in from the last account. In addition £1,240,000 has been transferred from reserve, giving an available total of £1,558,187, of which £1,059,589 has been written off the value of shares, investments, and diamond and other interests and £400,000 placed at general reserve, leaving £98,598 to be carried forward. The diamond and base-metal investments of the corporation have suffered severely during the year under review and this mainly accounts for the considerable falling off in the revenue. In Rhodesia the work of the Victoria

Prospecting Company was continued, but, in spite of evidence of widespread mineralization, no important discoveries have been made and work will be stopped in this area when the grant expires on June 30 next.

During 1931 the Anglo-French Exploration Company made a profit of £11,373, which, added to the sum of £16,503 brought in, gave an available total of £27,876, which was carried forward. Working expenses have been substantially reduced, although the full effect of economies carried out cannot be felt until the end of the current year.

The report of Rooiberg Minerals Development Co., Ltd., for the three months ended March 31 last shows that 19,101 short tons of ground was treated, 29·8 long tons of concentrates being recovered. The alluvial plant ran satisfactorily during the quarter, but operations were conducted at a total estimated loss of £1,530.

Diamonds.—The report of the Consolidated Diamond Mines of South-West Africa, Ltd., for 1931 shows a mining loss of £28,669, as compared with a profit of £366,530 in the previous year. The unappropriated balance brought in was £348,243 and, after adding £500,000 from general reserve, £168,000 from preference dividend reserve and making various allowances, £525,427 was written off diamond stocks, leaving them valued at £1, the balance of £372,196 being carried forward. Operations during the year were on a limited scale only, the Elisabeth Bay plant being closed down in April, 1931, while, as announced in the March issue, all operations have now been suspended.

During 1931 the New Vaal River Diamond and Exploration Company suffered a loss of £1,590, the credit balance being reduced to £4,022 during the year. The year's output of diamonds totalled 5,173¾ carats, realizing £23,237, or an average of £4 9s. 9d. per carat, against £6 11s. 1d. per carat the previous year. In addition 1,376 carats were produced on the Pniel Estate holding and this realized £4,496, equal to £3 5s. 4d. per carat.

Southern Rhodesia.—The output of gold from Southern Rhodesia during March was 47,239 oz., as compared with 45,032 oz. for the previous month and 42,278 oz. in March, 1931. Other outputs for March last were : Silver, 7,938 oz. ; coal, 45,972 tons ; chrome ore, 1,823 tons ; asbestos, 1,000 tons ; copper, 3 tons.

Northern Rhodesia.—Shareholders of Luiri Gold Areas, Ltd., have been informed of certain developments on their property. On the old Dun Robin reef it is stated that difficulty has been found in following the body on the third level, while the new Dun Robin ore-body is said to have greatly improved on the same level. Development has been started on the Eclipse lode, some favourable assays being reported from the first level. At Chitaba development has also been commenced, the lode having been exposed in the shaft before operations were held up by surface water. A trial run on ore from the new Dun Robin body is to be conducted during the present month.

The report of the Selukwe Gold Mining and Finance Company for the year ended March 31 last shows a profit of £368, increasing the credit balance carried forward to £1,358. The company is, through the Kafue Copper Development Company, still investigating the gold occurrence in Burma mentioned in the March issue of the MAGAZINE.

Gold Coast.—The return of the Ashanti Goldfields Corporation for April is accompanied by news of some interesting developments, cross-cut No. 22 N.E. on the 24th level showing a reef width of 17 ft., the values averaging 110 dwt. On No. 16 level cross-cut No. 25 N.E. shows the Ashanti reef to have a width of 13 ft. at that point, the values averaging only 2 dwt. The sinking of the main shaft was advanced 21 ft. during the month.

A circular to shareholders of Ariston Gold Mines (1929), Ltd., embodies a report from the consulting engineers, Messrs. C. B. Brodigan and Frank B. Powell, on the mine, in which they state that given a continuance of width and value in the main ore shoot below the 17th level, of which there is every indication, the next twelve months should show a decided increase in reserves and allow for increase of output. The report concludes with a note to the effect that with an additional £20,000 at the disposal of the management development could be much expedited and the board has decided to make an issue of £20,000 in 12½% Notes, the units being 2s. 6d., in order to raise this.

Australia.—Developments on the No. 2 West Lode on the property of the Wiluna Gold Corporation have, in the opinion of the board, provided ample evidence for regarding the new ore-body as of major importance. It has now been proved on the 290-ft., 450-ft., and 625-ft. levels and has an apparent lateral extent of at least 1,700 ft. In view of this the management at the mine has

recently acquired, by pegging, additional ground to the west and south of their existing mining area, in order to cover extensions of this and other ore-bodies which may be disclosed by further exploration.

A recalculation of the ore reserves of the South Kalgurli mine shows 40,000 tons blocked out on the Australia lode having an average value of 9·5 dwt., together with 174,000 tons proved elsewhere averaging 8·25 dwt. The probable reserves give an extra 94,700 tons of an average value of about 6 dwt.

Malaya.—The report of Idris Hydraulic Tin, Ltd., for 1931 shows a profit of £15,273, which gave, after deducting the debit balance of £1,992 brought in, an available total of £13,281. Of this amount £3,000 has been transferred to reserve, leaving £10,281 to be carried forward. The output of tin ore for the year was 312 tons, as compared with 353 tons for 1930. The amount realized from the sale of ore was £21,402, an average price of £68 11s. 4d. per ton, against £80 1s. 8d. the previous year.

Brazil.—The report of the St. John D'el Rey Mining Company for 1931 shows a profit of £142,292, giving, with the balance of £41,369 brought in, a sum of £183,661 to be disposed of. Dividends for the year absorbed £83,970, equal to 10% on the ordinary shares, while £60,000 has been transferred to capital works account, leaving £39,691 to be carried forward. During the year 221,800 tons of ore was crushed, yielding 115,473 oz. of gold, worth, at par value, £488,429, a yield lower by 7s. 6½d. per ton when compared with the previous year. This decline was mainly due to the policy adopted of milling ore which would be unpayable with gold at par. The ore reserves in the Morro Velho mine at December 31 last were estimated to be 1,522,271 tons, averaging over 4 oitavas per ton, an increase of 244,108 tons over the 1930 figures. This amount is exclusive of much ore which will be payable with gold at a premium. Good progress has been made with the new power scheme and it is hoped that the supply necessary for the extension of mining operations will be available towards the end of the current year.

In a circular to shareholders of the Itabira Iron Ore Company issued last month it was stated that prolonged negotiations with the Brazilian Government over the renewal of the company's concessions had brought the company's resources to the verge of exhaustion. It is estimated that unless funds can be found immediately the company may be forced into liquidation.

Colombia.—A report from the consulting engineer of Viborita Gold Mines issued last month stated that an ore-body carrying gold values had been discovered during the driving of the deep débris tunnel, which remained in lode for over 100 ft. Sampling is in progress, but meanwhile the driving of the tunnel is being carried on.

Yugoslavia.—During the three months ended March 31 the working surplus of Trepca Mines, Ltd., was estimated at £21,291, equal to 5s. 2d. per metric ton milled. The tonnage treated was 82,151, averaging 10·63% lead, 8·51% zinc, and 4·05 oz. of silver per ton, which yielded 10,845 tons of lead concentrates, averaging 77·57% lead and 27·9 oz. silver per ton, together with 11,725 tons of zinc concentrates, averaging 49·99% zinc.

London Tin Corporation.—The accounts of the London Tin Corporation for the year ended September 30 last show a loss of £1,777, while £800,000 was transferred from reserves, largely to cover depreciation in investments. These now stand in the company's books at £3,097,575, the schedule accompanying the report showing that the Nigerian investments are slightly greater than those in Eastern companies, while the Cornish interests have been written down to £1,396.

National Mining Corporation.—During 1931 the National Mining Corporation suffered a loss of £7,186, increasing the debit balance brought in to £110,277. No new business was undertaken during the year and general conditions have prevented any important realization of the corporation's holdings.

Tin.—At a meeting of the International Tin Committee held in Paris last month it was decided unanimously to recommend a further cut in production at the rate of 20,000 tons a year, to be effective from June 1 next. Subsequently it was announced that the Tin Producers' Association had approved a still more drastic scheme for curtailing output, involving a complete cessation of operations for two months. If this proposal is adopted production would be resumed at the rate of 40% of capacity until the price of tin metal remains at £200 for one calendar month, when the quota would be raised to 50%. Under this scheme the Pool would not be permitted to release its holdings below £200 per ton.

DAGGAFONTEIN MINES

INTRODUCTION

This article deals with Daggafontein Mines, Ltd., a company holding a considerable mining area on the Far East Rand, and which commenced milling early in January, 1932. The company's predecessor, the Daggafontein Gold Mining Company, Ltd., was one of the oldest on the Far East Rand. Shaft sinking was commenced over 20 years ago in the eastern part of the farm, but the ore which is now being stoped is drawn from the north-western area of the property. The company has had many vicissitudes; operations were suspended twice for lack of funds, and there were two financial reconstructions. The area was originally 1,437 claims, and is now 3,737 claims.

The history of what is now Daggafontein Mines, Ltd., is a record of struggles against adverse natural conditions, setbacks due to lack of suitable equipment, complicated by disinclination to put funds into mining investments during times of unrest and strife. But it is also a record of faith in the property, which is well situated in the line of the Far East Rand ore shoots, an advantage which will outweigh disappointments caused by difficulties in the past. It is proposed to trace the development of the company from the commencement of operations down to the present time. This will be done in the first part of this article, and will give an opportunity of touching on South African Mining Laws, a subject of which readers outside the Union of South Africa may have only a cursory knowledge, and for a description of the mining work. The growth of the company, the increases of capital, and appeals made to shareholders for the raising of further funds, which provide a fine example of mining finance, will also be dealt with. This is contributed by F. A. Unger, consulting engineer to the Anglo American Corporation of South Africa.

A description of the surface plant is given in the second part of the article by Messrs. S. E. T. Ewing (consulting mechanical and electrical engineer) and J. L. Willey (consulting metallurgist), of the Anglo American Corporation of South Africa, Ltd. The reduction plant, while following in the main the layout of the West Springs plant, presents certain new features. The mechanical equipment on the surface follows the practice established by the later developments on the Anglo American Corporation's mines and notes on this subject are also given by the authors.

I.—HISTORY, DEVELOPMENT, AND EQUIPMENT OF THE PROPERTY

By F. A. UNGER

Transvaal Mining Laws.—Under the Transvaal Gold Law of 1908 the right to mine for precious metals is vested in the Crown. If a farm has been proved to be gold-bearing, either by prospecting or by drilling, the Government may give notice of its intention to proclaim this farm. The freehold owner of the farm has certain mineral rights under this Act; he can dispose of these rights while retaining the ownership of the surface. The owner of these mineral rights is entitled to select one-fifth of the farm (or, to be exact, one-fifth of the area proclaimed) as his mynpacht. The discoverer of the precious metal, who may or may not be the owner of the mineral rights, is also entitled to compensation for his efforts. His reward takes the form of a number of claims (varying from a minimum of 10 to a maximum of 50) in proportion to the size of the farm, but if the reef is discovered by shaft sinking or boring deeper than 1,000 ft., he may acquire a maximum of 50 claims for every 1,000 ft. vertical depth below the surface that the discovery is made. The mining rights over the balance of the farm belong to the State.

In the Transvaal the size of a farm is expressed in "morgen." A morgen is 86,400 sq. Cape ft. (1 Cape ft. = 1·033 English ft.). A claim measures 60,000 sq. Cape ft. A morgen is thus 1·44 claims. Expressed in acres, a morgen is equivalent to 2·1165 acres, while a claim measures 1·47 acres. An example will illustrate the rights of owners and discoverers. Suppose that on a farm 3,000 morgen in extent, the reef has been found by diamond drilling to a vertical depth of 3,500 ft. The owner of the mining rights would be entitled to one-fifth of this farm for his mynpacht, viz. 600 morgen or 864 claims, while the

discoverer is entitled to 175 claims. If the owner and discoverer are the same person, his total mining area would thus be 1,039 claims. On the Central Rand, and in the early days of outcrop propositions, this provided an ample mining area.

On the Far East Rand there is, as a rule, only one workable reef, often thin, and only payable in parts. On the earlier Central Rand mines, where both the Main Reef Leader and South Reef were generally payable, the conglomerate beds well developed, and where the Main Reef was sometimes mined, as much as 70,000 tons per claim might be milled. On the Far East Rand there are large areas where the mill tonnage is less than 5,000 tons per claim. Nevertheless, these areas may constitute very attractive mining propositions provided they are of sufficient size and, further, that the workable portions of the conglomerate bed carry sufficient gold. It follows, however, that a mining area of, say, 1,000 claims, may under certain conditions be insufficient to justify the large capital expenditure required to bring it to production. This was realized by the Mines Department and the Government, and in 1918 an Act was passed, known as the Mining Leases Act, which provided for the leasing of ground from the Government. The condition on which the owner could secure this ground was by giving the Government a participation in profits according to certain minimum terms, contained in a schedule to the Act. These minimum terms are in the form of a sliding scale, the Government's participation in profits increasing according to the richness of the ore. This object was obtained by basing the scale on the ratio between profit and yield, the percentage of profits payable to the Government increasing with this ratio. On the Witwatersrand this ratio is generally referred to as " x." With a yield of 30s. and working costs of 20s. per ton, the ratio of profit to recovery would be $\frac{10}{30}$, in other words, x expressed as a percentage would be $33\frac{1}{3}$. The Government's participation is generally referred to as " y."

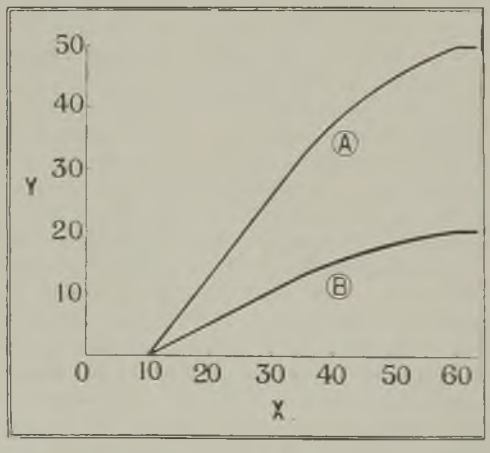


FIG. 1.—RELATION OF PROFITS TO THE GOVERNMENT PERCENTAGE.

The minimum terms on which the owner of a mynpacht can obtain additional ground are as follows :—

Profits expressed as a percentage of revenue. Ratio " x."	*Percentage of profits payable to Government. Ratio " y."*
10% or under.	Nil
12%	2·6%
15%	6·4%
20%	12·9%
25%	19·3%
30%	25·7%
35%	32·2%
40%	37·5%
45%	41·7%
50%	45·0%
55%	47·7%
60% or over.	50·0%

If this sliding scale is plotted, it will be noted that the first part of the scale is represented by a straight line, and the second part by a curve. The equation for the straight line is approximately $y = 1{\cdot}28x - 12{\cdot}8$; the equation for the curve is $y = 75 - \frac{1500}{x}$.

If the area acquired from the Government under this arrangement were to represent, say, 40% of the total combined area, then the Government's participation in profits would be 40% of this scale, and the curve part would thus be represented by the formula $y = 30 - \frac{600}{x}$. This is practically the formula applying in the case of Daggafontein, and the various steps in the Company's history leading to this arrangement will be dealt with later.

In practice this law has not proved a great success, due to the fact that the Government's share of profits under the minimum terms is very high. The Mines Department itself has realized this state of affairs and legislation will shortly be introduced which will do away with the mynpacht, but give the owner the right to take up an area, not less than half the size of the farm, on a lease from the Government.

Amortization Allowance.—The taxation of gold mines and the Government's

participation in profits are calculated on the net profits. Mining companies are not taxed on that part of the profit which represents a return of capital, and the same principle applies in the case of participation in profits. The companies are allowed to set aside a sum each year, which, accumulated over the life of the mine, will total the capital expenditure incurred on shaft sinking, development, plant, and equipment. This sum is referred to as the "amortization allowance," and the net or taxable profit is the gross profit minus this amortization allowance. The amortization allowance, for the purpose of calculating the Government's participation in profits, is the equivalent of a sinking fund, which, compounded at 3% interest over the life of the mine, will return the capital expenditure.

In regard to Income Tax, which is 15% on gold mining profits, the amortization allowance is calculated by dividing the total capital expenditure by the estimated life of the mine. When Daggafontein Mines started producing, the capital expenditure incurred by the present company and its predecessor, and ranking for amortization, amounted to over £2,800,000. The present shareholders will reap the benefit of this expenditure in the shape of a large amortization allowance; in other words, the allowable deduction from the working profits will be very considerable.

Early History. — Daggafontein was a comparatively large farm, being over 4,960 morgen, or 10,500 acres, in extent. A triangular portion in the northern corner of the farm, measuring about 600 morgen, had been disposed of in the early days and coal mining conducted thereon. The remaining portion of the farm, viz., 4,367 morgen, was the property of the Daggafontein Gold Mining Company, Ltd., which was registered in London as early as 1902. After information as to the depth of the reef on this farm had been obtained by boring, shaft sinking was commenced in 1910. No. 1 Shaft, of 7 compartments, was located on the eastern portion of the farm, some 7,000 ft. from the eastern boundary. The reef was encountered early in September, 1914, at a depth of 3,580 ft. Sampling results gave an average of 317 inch-dwt., approximately 40 dwt. over 8 inches. Owing, however, to lack of funds and the impossibility of raising fresh money due to the outpreak of the European War, operations had to be abandoned and the shaft allowed to fill with water.

First Reconstruction.—In 1916, under the aegis of the Consolidated Mines Selection Company, Ltd., the Daggafontein company was reconstructed and given the new title of "Daggafontein Mines, Ltd." Funds were raised for the dewatering of No. 1 Shaft and for the commencement of development operations. The dewatering of the shaft was quickly accomplished, and haulages were started in four directions, viz., north, south, east and west. The reef disclosed in the north, east and south haulages was narrow, but in many cases of good value, while the western haulage on the whole exposed a wider reef.

The amount of cash raised in the first instance was comparatively small, as it was the intention to proceed with development work on a limited scale, until further funds became available from the exercise of certain options to subscribe for shares. An influential section of the shareholders, however, was in favour of commencing a second shaft at the earliest possible date so as to hasten forward the time of production. No. 2 Shaft was therefore located 6,000 ft. west of No. 1, and by the end of 1916 the shaft was sunk 178 ft.

In 1917 a period of difficulties commenced. Water was encountered in the workings of No. 1 Shaft; the station was lost, development workings flooded, and hoisting accidents in the shafts, due to the continuous baling, added to the troubles. Heavy rains interfered with the transport of coal and put a stop to baling. It was then decided to instal a pumping plant at No. 1 Shaft; a station was cut on the reef horizon and an intermediate station 2,000 ft. below the surface. In No. 2 Shaft also, water was encountered; here the cementation process was applied. It should be explained that, at that time, owing to the exigencies of the War, no equipment could be imported for non-producing mines, and Daggafontein had therefore to carry on as best it could with second-hand material. It was not until 1919 that development work in No. 1 Shaft could be resumed. No. 2 Shaft at the end of 1918 had only reached a depth of 1,028 ft. below the surface. In 1919 this shaft was sunk 1,941 ft., and in August, 1920 the reef was exposed at a depth of 3,951 ft. The average value of the reef was 26·1 dwt. over 14·5 in., or 378 inch-dwt. In April, 1921, the connexion between the two shafts was made. The reef exposures

around No. 2 Shaft, supplemented by diamond drilling, gave, for a total length of 750 ft. east and west from the shaft, a value of 23·9 dwt. over 16·2 in., or 388 inch-dwt.

Long before this, however, the new Company's funds had become exhausted. The Consolidated Mines Selection Company had come to the rescue and, assisted by others, had advanced the Daggafontein Company no less than £450,000. In June, 1921, operations were suspended, and the workings and shafts once more filled with water.

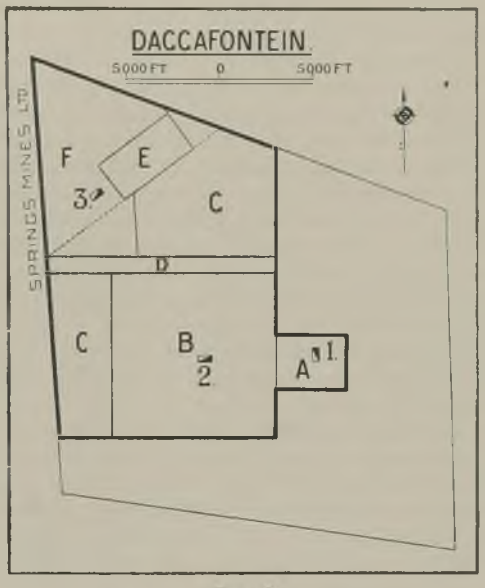


Fig. 2.

The suspension of operations at that time may seem difficult to understand, in the light of what is known to-day, but it must be remembered that in 1920 and 1921 the position of the gold mines of the Witwatersrand had become very difficult. Working costs had risen to the high average of 25s. 8d. per ton milled, labour troubles were threatening, and the post-war depression had set in. In those days stoping was done by means of heavy reciprocating machines, and stoping widths of 60 in. and over were common practice. It followed, therefore, that the development results quoted were not sufficiently attractive if considered in conjunction with the high level of working costs, and a stoping width of 60 in. The change of conditions and the improvement in mining practice which have taken place during the last 10 years, however, have put a completely different complexion on the value of the earlier disclosures. Since 1924 working costs for the Witwatersrand as a whole have been under 20s. per ton, and the stoping width has considerably decreased. Various Far East Rand properties are working a width of less than 50 in. For example, during the last 4 years the width of the stopes in Springs Mines, which adjoins Daggafontein Mines, has averaged less than 43 in., and this figure is the actual width based on tonnage hoisted.

During this second active period, which lasted from 1916 until 1921, the company first located its 179 discoverers' claims around No. 1 Shaft and selected its mynpacht of 1,258 claims. Somewhat later, it acquired a further 173 claims, to the north of its mynpacht, from the Consolidated Mines Selection Company, and leased an area of 449 claims from the Government, which extended the property to the joint Daggafontein-Springs Mines boundary. Its holdings thus totalled 2,059 claims, as follows :—

A.	Discoverers' claims . .	179 claims
B.	Mynpacht area . . .	1,258 ,,
C.	Leased from the Government .	449 ,,
D.	Acquired by purchase . .	173 ,,
		2,059 claims

The delimitation of these areas may be seen on the plan (Fig. 2).

Second Reconstruction.—After closing down in 1921, no work was done for 6 years, but the possibility of raising funds and resuming operations was always kept in mind. The opportunity came in 1927, when certain development faces in the eastern part of Springs Mines were approaching the Daggafontein boundary. This rendered possible the 1927 reconstruction. One difficulty had first to be overcome, viz., while Springs Mines development headings were proceeding towards the Daggafontein border, they were not approaching that part of the farm Daggafontein then held by Daggafontein Mines, Ltd. The Government was therefore asked to lease to the company a further area situated between the eastern boundary of Springs Mines and a line drawn parallel thereto at a distance of 5,000 ft. further east. The company submitted a reconstruction scheme under which sufficient funds would be raised to inaugurate development work from Springs Mines into the area to be acquired.

As already stated, the northern portion of the farm Daggafontein did not belong to the

original Daggafontein Gold Mining Company, Ltd. This portion of approximately 600 morgen was held by different owners, who, some years previously, had been granted a mynpacht of 172·9 claims, but had not commenced active operations. Part of this mynpacht fell within the 5,000 ft. strip, and after negotiations was acquired for shares in the reconstructed company. (Area E, Fig. 2.) The proposals met with the approval of the Government, and the company thus acquired its second lease (Area F, Fig. 2), which measured 778·2 claims, also the mynpacht just referred to of 172·9 claims, making its total area 3,009·4 claims.

The financial reconstruction was as follows:—273,580 shares were issued to old shareholders and in satisfaction of loans and interest owed by the company. An amount of £205,185 was raised for working capital by the issue of 3 shares at par for every 4 shares held in the reconstructed Company. The mynpacht of 172·9 claims (Area E, Fig. 2) was acquired for 40,000 shares, bringing the total issued capital to 518,765 shares. In addition, options to take up further shares at par were given to shareholders in the reconstructed company.

Progress of Work.—It was not until the end of 1927 that development operations were actually started, and at first only one haulage from Springs Mines had entered the property, with the result that 1927 saw the accomplishment of only 472 ft. of development. In the following year 2,162 ft. of development work was done, three haulages then having crossed the border. Progress in one of these three haulages was impeded by its encountering a water-bearing fissure, which resulted in the flooding of the face. The amount of development work done at the end of 1928 was less than 3,000 ft., but the conditions as to the reef width in the payable areas, and the trend and extent of the payable shoots, were similar to those in Springs Mines, and a forward policy thus appeared justified.

Two problems now confronted those in control, namely, the policy to be pursued to bring the company to the producing stage in the shortest possible time, and the best means of raising the money necessary to achieve this end. As regards the first, there appeared to be two methods of procedure. One way was to equip and dewater Nos. 1 and 2 Shafts, while the other way was to sink a new shaft to serve the area where development work from Springs Mines was progressing, and where prospects of disclosing an appreciable tonnage in a comparatively short time were favourable. Either course involved heavy capital expenditure, and delay was unavoidable, owing to the fact that it takes nearly a year from the date of ordering heavy equipment, such as a large hoist, before it can be put into commission. After due consideration, it was recommended to sink a new shaft in the area adjoining Springs Mines, at a distance of 3,000 ft. from the joint border. The location of this shaft (No. 3) is shown in Fig. 2.

As regards the question of finance, the Anglo American Corporation of South Africa, Limited, the successor to the Consolidated Mines Selection, came to the company's assistance. An issue of one new share (at 22s. 6d.) for every two shares held, involving a total of 259,441 shares, was made to the shareholders and underwritten by the Anglo American Corporation, while the corporation subscribed for a further 49,552 shares at the same price. This issue brought the capital of the company to a total of 827,945 shares while there were, in addition, options outstanding to take up 622,055 shares at par, to November 24, 1930, which, if exercised, would increase the capital to a total of £1,450,000. The issue of 308,993 shares at 22s. 6d. provided £347,617, sufficient for the programme contemplated.

Description of No. 3 Shaft.— The sinking of No. 3 Shaft was commenced in 1929. A 5-compartment shaft was decided on, each compartment measuring 6 ft. by 9 ft. inside timbers. The earlier shafts sunk by the Consolidated Mines Selection/Anglo American Group generally had 7 compartments, and the shaft section was of the long and narrow type. No. 4 Shaft, Springs Mines, was a departure from this, as it had 5 compartments each 5 ft. by 10 ft. This provides room on all sides of the skip for filling during the shaft sinking stage, an advantage which clearly showed up in the footages accomplished. In 1928 this shaft was sunk from 1,165 ft. to 4,023 ft. in less than 11½ months, a total distance of 2,858 ft. and an average of 250 ft. per month. Daggafontein No. 3 Shaft with its 6 ft. by 9 ft. compartments was considered to be a further improvement in the type of shaft. Its larger cross section and wider compartments are advantages in ventilation. The 9 ft. width gives a stronger divider than in the case of a 10 ft. shaft, and the useful width of skips and cages is

considerably increased. With a 5ft. compartment, the internal width of a skip is only 3 ft. 6 in. ; the extra foot width allows this dimension to be 4 ft. 6 in., an increase of 29%. The timber used in this shaft is 9 in. by 9 in. pitch pine, and the sets in normal ground are 7 ft. 6 in. apart. Guides are 8 in. by 4 in., and are cut in 30 ft. lengths. The dimensions of the shaft outside the timber are, approximately, 36 ft. by 11 ft. 9 in. Sinking is done on three shifts of 8 hours per day, permission being granted to work on Sundays. The labour force at the bottom of the shaft consists in normal circumstances of about 45 natives per shift, under the supervision of a white sinker and his helper. These " boys " load the broken

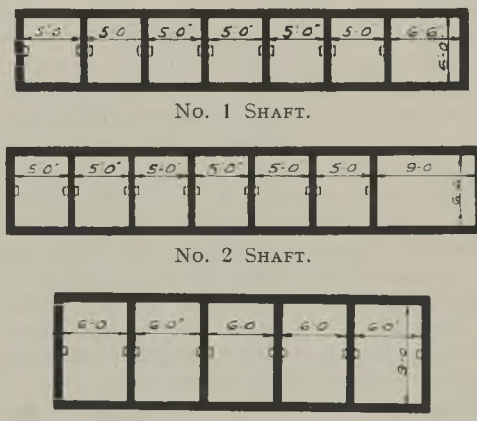


Fig. 3.

rock, and when the shaft bottom is clean, some 25 natives proceed to the surface, leaving 20 for drilling. On this work 10 heavy jackhammers are employed, manned by 2 boys each. The cycle of cleaning, drilling and blasting is completed in 8 hours, and the average rate of advance is about 2 ft. 6 in. per shift, or, say, 7 ft. 6 in. to 8 ft. per day. The best footage done in any individual month was 292 ft. sunk in March. For the six months January/June, 1931, a total distance of 1,436 ft. was sunk, an average of 239 ft. per month, involving an expenditure of nearly £8,000 per month.

Water encountered at times interfered with the progress in No. 3 Shaft. In sinking a 4,000 ft. shaft, conditions change according to the strata intersected, and for a proper understanding of the problems of sinking a short reference to the geology of the district may not be amiss.

Geology.—On the Far East Rand, the Main Reef Series form practically a complete basin. The Main Reef actually outcrops along the north-western rim of the basin where the New Kleinfontein, Van Ryn Estates and New Modder Gold Mines are operating. The series then take a northward bend before turning to the east, and on this northern portion and on the eastern side, they are covered by coal measures and dolomite. The reef outcrops again in the south on the holdings of the Nigel Gold Mining Company. The dip here is, of course, to the north, and the strike, in places, east and west. The outcrop then continues towards the south, and gradually assumes a south-western trend. The length of the outcrop from the workings of the Kleinfontein, along the Modder group and the eastern rim of the basin to the Nigel, is about 45 miles, while a straight line from the Kleinfontein to the Nigel workings is just over 16 miles long. The greatest distance from north to south across the basin is 19 miles. The position of the farm Daggafontein is quite near the middle of the basin. The centre of Daggafontein is about 6 miles from the eastern sub-outcrop, about 12 miles from the northern outcrop, and about 10 miles from the southern outcrop.

The geology of this part of the Witwatersrand is simple. Coal measures, about 200 ft. thick, are the uppermost formation, followed by dolomite, which is underlain by the Black Reef Series, the base of the Transvaal System. The thickness of dolomite is generally less than 1,000 ft. Then follow Upper Witwatersrand Series in which the Kimberley reefs are found. These conglomerates occur above the Kimberley shales, the only shale bed in these Upper Series. Below the Kimberley shales the Upper Witwatersrand Series continue, and contain the so-called " amygdaloidal diabase " (an interbedded sheet and an important " marker ") below which one or more thin and insignificant conglomerate beds occur, amongst them being the Bird Reef. Then follows the Main Reef, the usual name on the Far East Rand for the extension of the Main Reef Leader of the Central and East Rand. The Main Reef rests on a shale footwall, and the shafts generally bottom in this shale.

From a sinking point of view, the conditions in these strata are as follows: The coal measures are usually decomposed, and near the surface a concrete lining of the shafts is often advisable. The dolomite is

the water-bearing formation, and in this series progress as a rule is rather slow, due to water difficulties. In this formation also occurs the so-called "Green Dyke," a sill of ultra basic igneous rock, which disintegrates on exposure to air. This Green Dyke may be 80 or 90 ft. thick, and this section of the shafts is also generally concreted.

In No. 1 Shaft, Daggafontein, decomposed coal measures were found from the collar of the shaft to a depth of 72 ft. The dolomite, containing various sills, continued to a depth of 764 ft. In No. 2 Shaft, the first 175 ft. were in coal measures, then followed dolomite to a depth of 870 ft.

In No. 3 Shaft dolomite was encountered at a depth of 40 ft. and continued to 957 ft. The contact of Black Reef with Upper Witwatersrand quartzites was at 968 ft. Over 500,000 gallons of water were handled per 24 hours. Baling is the usual practice when sinking through the dolomite. A permanent station to deal with the dolomite water is cut as soon as solid quartzites below the Black Reef are reached. This dolomite water is pure and of good quality; it is pumped separately to the surface and used for boilers and other purposes. In the Upper Witwatersrand quartzites, sinking conditions improve. Progress after the dolomite pumping station has been cut is generally satisfactory, but sometimes layers of a dense glassy quartzite, hard to drill, slow down the rate of advance.

In the Kimberley shales, which are easy to drill, good footages are often accomplished. Some 300 ft. per month has been done when shafts were passing through this formation. The record for a rectangular shaft is held by the Sub-Nigel where, in August, 1928, the Betty shaft was sunk from 857–1,177 or a distance of 320 ft., in quartzite.

Kimberley Reefs.—These conglomerate beds, which may be of very considerable thickness, occur below the dolomite and above the Kimberley shales. No. 3 Shaft, Daggafontein, exposed over 30 of these reefs, the widest of which was 156 in. Between depths of 1,700 and 2,300 ft., 25 of these reefs were exposed and sampled; generally they did not contain any gold, sometimes "trace" was returned, but there was one exception. In January, 1931, when the shaft had reached a depth of 2,264 ft., values were encountered in one of the Kimberley reefs then exposed. This reef was sampled at 10 different points around the shaft circumference, the results averaging 10 dwt. over a width of 51 in. One sample returned a very high value, but the remaining nine sections still averaged 7·34 dwt. over 50 in. This was the first instance of payable values being encountered in the Kimberley reef in shaft sinking on the Far East Rand, and it was decided to do a limited amount of prospecting work on this reef as long as shaft sinking operations were not interfered with. A small station was cut, and a cross-cut to the reef commenced. Owing to faulting, the work was not as simple as it might otherwise have been. Nevertheless, 107 ft. of rising was accomplished, of which 55 ft. on reef were sampled, giving an average of 7·6 dwt. over 37·8 in. In addition, 28 ft. of winzing was done, which disclosed 6·55 dwt. over 52 in. As, however, time was limited, the early completion of the shaft and the pump stations was of primary importance, and it therefore became necessary at this stage to stop work on the Kimberley Reef horizon. This suspension will, of course, be only temporary, as the results so far obtained have been sufficiently encouraging to raise the hope that this reef will at some future date contribute its quota of tonnage to the mill.

Development Work.—Returning now to the account of the development and shaft sinking progress, during 1929 another haulage from Springs Mines crossed the border, making a total of four. One lateral haulage was started towards the position of the new shaft and in that year the development footage was increased to 4,775 ft., while No. 3 Shaft was sunk by means of temporary equipment to a depth of 286 ft. In 1930 No. 3 Shaft was sunk 1,905 ft., making the depth of the shaft at the end of that year 2,191 ft. In addition to sinking, the permanent pump station in No. 3 Shaft to deal with the water from the dolomite formation, was cut at a depth of 1,001 ft. below the surface and equipped with sump capacity sufficient to store half a million gallons of water. At a depth of 1,997 ft. below the collar of the shaft the intermediate pump station was cut, and a commencement was made with the excavations to store 250,000 gallons of water. The development footage accomplished in 1930 was 17,324 ft., as against 4,775 ft. in the previous year, the introduction of night-shift work in the Daggafontein headings being largely responsible for the increased footage.

Springs Mines works on a single shift basis, the broken ore in the development

ends being cleaned out during the early part of the day shift. The natives and their white supervisors engaged on this work, go down at 5 a.m. The miners in charge of the development work go down at 7.15 a.m. to start drilling operations soon after reaching the face. The advantages of day shift work are obvious and are not confined to mining operations only. On the other hand, under the system in vogue at Springs Mines, no spectacular footages can be obtained in any individual working places. On account of the increasing distances from the Springs Mines shafts, the delay in getting started in the Daggafontein workings was becoming more and more serious. Rounds were lost, and as every heading was then on a down gradient, water was also a constant difficulty. In order to expedite the work, the night shift cleaning of the development ends in Daggafontein was inaugurated, this company, of course, paying for operating those haulages in Springs Mines which had to be in commission during the night.

Long steel was introduced in order to get longer rounds. Drilling was done with S-70 Ingersoll-Rand drills and in certain important headings good progress was made, especially when considering the local difficulties and the distances from the Springs Mines shafts (in many cases approximately 2 miles). It was necessary, for instance, in a number of development faces to drill pilot holes 10 ft. long as a precaution against unexpected water. The best footage during this period was accomplished in the south face of Collecting Haulage No. 1, a heading approximately 16 ft. wide by 7 ft. to 8 ft. high, which was advanced 834 ft. during the period January to May, 1930. During the latter month, the advance was 195 ft. The north face of the same haulage was driven 722 ft. during this period of 5 months. While the rate of development was improved, the cost of this work greatly increased; fortunately the results obtained were encouraging.

At the end of October, 1930, the company was able to show an ore reserve of over 800,000 tons, averaging 8·55 dwt. over 45 in., in the area adjoining Springs Mines. At the end of December, this tonnage had increased to just over one million tons, averaging 8·22 dwt. over 46 in. This was the outcome of 24,733 ft. of development work, and the satisfactory nature of this result will be clear from a comparison with the results in Springs Mines for the same year. This latter company during 1930 did 33,958 ft. of development, while the tonnage of payable ore developed was 949,075 tons. Daggafontein therefore developed a slightly larger tonnage, with its 25,000 ft. of development, than Springs Mines did with its 34,000 ft. The records in the old Nos. 1 and 2 areas had also been investigated and it was found possible to include 227,700 tons averaging 8·98 dwt. over 36·66 in. in this area. Most of this tonnage was located around No. 1 Shaft, where the reef is narrow, being less than 6 in. in the majority of the exposures. This latter tonnage, of course, will not become available until the shafts are dewatered.

At the end of November, 1930, in spite of the difficult financial conditions existing at that time, the holders of the options again showed their faith in the prospects of the company, and Daggafontein Mines obtained £622,000 of additional funds. The amount previously raised was just sufficient to carry on until the end of 1930, the new capital being required for completing No. 3 Shaft, continuing development work, and at a later date for the reduction plant. It was soon apparent, however, that the available funds would not be sufficient even for the modest programme then contemplated, which was to erect a 40,000 ton mill at No. 3 Shaft. The area around No. 2 Shaft was much more suitable for a reduction plant, while the existing housing and compound accommodation near the shaft was also an important consideration. Moreover, negotiations were proceeding with the Government for the lease of additional ground, which, if successful, would increase the area to be usefully served by No. 3 Shaft and also by No. 2. The possibility of dewatering Nos. 1 and 2 Shafts and making the older portion of the mine available for production at an early date, was also a factor in deciding the location of the reduction plant. There appeared to be an opportunity of bringing the company to its maximum crushing capacity very soon after the commencement of milling operations if equipment were ordered for the Nos. 1 and 2 shafts and this section brought into production. These possibilities, and also that of the Kimberley Reef, had to be borne in mind when laying out the plant, as they would call for extensions at an early date. Questions of foundations, suitability of site, and room for slime dams, were of even greater importance. Taking all these factors into

consideration, it was clear that the more desirable situation for the reduction plant was at No. 2 shaft.

In February, 1931, the successful outcome of negotiations with the Government added a further 729 claims to the holdings of Daggafontein. The area involved is that marked " G " on Fig. 2 and the advantages to the company of this acquisition were considerable, as the development layout was simplified, and the tonnage potentialities of the property were increased. The inclusion of this additional ground increased the company's mining area to its present total of 3,737 claims made up as follows :—

A.	Discoverers' claims	179	claims
B.	Mynpacht No. 657	1,257·8	,,
	Leased from the Government—		
C.	First lease	448·9	,,
D.	Acquired by purchase	172·6	,,
E.	Cassel-Clydesdale mynpacht	172·9	,,
	Leased from the Government—		
F.	Second lease	778·2	,,
G.	Third lease	727·4	,,
		3,736·8	,,

An initial capacity of 50,000 tons for the reduction plant was then fixed and it was decided to make every effort to commence crushing early in 1932. Excavations for the plant were begun in March, 1931. Fig. 4 is a photograph taken on the site just after the start of the excavation work, while Fig. 5 shows the plant at the commencement of operations.

The company's finances, however, required further attention. The problem of meeting the anticipated shortage of funds when reaching the producing stage was easily solved, but advantage was taken of this final appeal to the shareholders to supply funds for a more ambitious programme. The increase in the company's capital aimed at providing for the permanent equipment of the Nos. 1 and 2 Shafts, preparatory to dewatering and making these shafts bear their quota of the tonnage, with a view to an early increase in the capacity of the reduction plant. An offer was made to shareholders to take up 145,000 shares at 37s. 6d. per share, on the basis of one new share for every ten held. The issue was guaranteed by the Rand Selection Corporation, Ltd., a company closely associated with the Anglo American Corporation. The Rand Selection Corporation, for guaranteeing this issue, was granted an option to take up 55,000 shares at 45s. per share until June 30, 1932. The issue was most successful, practically all shares on offer being applied for and the company thus received £271,875, while the options at 45s., if exercised, would bring in a further £123,750. The company would then be provided with additional funds totalling £395,625. This sum was estimated to be sufficient to bring the company to the producing stage on the 50,000 ton basis, and for the provision of permanent equipment at Nos. 1 and 2 Shafts including the necessary pumping plant. The proposed extension to the reduction plant from 50,000 to 70,000 tons per month will not involve any great expenditure. Extensions to the compound, station work, and the cutting of the necessary ore and waste bins at No. 2 Shaft, will bring the total amount required to a figure slightly in excess of the funds provided, but this expenditure will not have to be incurred until after dewatering. Provided there are no undue delays in delivery of plant,

Fig. 4.—Start of Excavation Work: The Plant Site in April, 1931.

dewatering should commence towards the end of May, and work on the permanent underground equipment for No. 2 Shaft should be taken in hand during the second half of this year.

THE FINAL STAGE.—Early in August, 1931, the Main Reef was intersected in the shaft at an average depth of 3,887 ft. A few feet below the reef a large sill was encountered, which proved to be over 200 ft thick. This rock was not only hard to drill, but caused considerable trouble through " scaling off " and " air blasting." The shaft had to be sunk to its final depth in this formation, while the main station, the ore and waste bins, and the conveyor cross-cut from the loading pockets to these bins, all had to be cut in the same rock. The greater part of the station roadways, which were being driven from Springs Mines, was also in this sill. The hardness of the rock accentuated various difficulties such as the drop of pressure in the air mains due to the long distance from the Springs Mines shafts. During these last months, adverse natural conditions once more made their full weight felt, the work being not only difficult and slow, but also dangerous.

After the middle of December, however, the end of a very strenuous period was in sight. On the 18th of that month the shaft was connected with the workings from Springs Mines, and before the end of the year the ore bin was available, the necessary connexions were made and the loading arrangements in the shaft were completed. By the middle of December the reduction plant was ready for work, but the first ore was not hoisted until the 30th, and crushing started on December 31. On January 2 there was sufficient ore in the mill bins to put the tube-mills into commission. During the year 1931 development work was continued at a satisfactory rate in order to provide a sufficient number of stope faces and to strengthen the ore reserve position.

Mining is now getting into its stride. In January 2,000 fathoms were broken, and in February over 3,000. Stoping is being done with jackhammers and scrapers are used for the removal of the broken ore. Mining work follows the usual practice of this particular area of the Witwatersrand and there is thus no need for any further description.

This concludes the first part of this article and provides a good opportunity for reviewing the position. Development operations from Springs Mines commenced late in 1927. Shaft sinking was started in 1929 and the reef was intersected early in August, 1931, at a depth of about 3,890 ft. Excavations for the reduction plant were begun late in March, 1931. The plant was completed by the middle of December, 1931, and crushing commenced on the last day of the year. In these four years the holdings of the company had increased from 2,059 to 3,737 claims.

II.—SURFACE EQUIPMENT AND REDUCTION PLANT

By S. E. T. EWING and J. L. WILLEY

The power requirements of the mine as regards winding and compressing air are supplied from steam plants, whilst power for the reduction plant, pumping, and underground requirements is provided by the Victoria Falls and Transvaal Power Co. at 3,300 volts and 500 volts from their 40,000 volt distribution system.

NO. 3 SHAFT—SURFACE EQUIPMENT.—The reduction plant is supplied with ore from this shaft alone until such times as Nos. 1 and 2 Shafts are brought into commission. The surface equipment at No. 3 Shaft is as follows :—

Boiler Plant.—Coal is supplied by rail, the track extending directly over the bunkers. The initial equipment, based on staggering the winding and compressor shifts, comprises four Babcock and Wilcox boilers equipped with mechanical stokers and superheaters, each having a capacity of 12,000 lb. steam per hour at a working pressure of 160 lb. per sq. in. A 240-tube Green's economizer is installed together with a direct-coupled induced draught fan at the base of smoke stack. The whole plant is so arranged that extensions can be readily made.

Winding Plant.—The two direct acting main engines, both of which have been in commission since the early stages of sinking the shaft, were manufactured by Messrs. Fraser and Chalmers of Erith. The cylinder dimensions of the man hoist are 30 in. by 60 in. stroke, and of the rock hoist, which is a duplex tandem compound, 25 in. and 40 in. by 60 in. stroke. The drums on both engines are 11 ft. diameter by 8 ft. 3 in.

FIG. 5.—THE PLANT COMPLETED—JANUARY, 1932.

wide, and are spirally grooved for 1½ in. diameter ropes. The Whitmore overwind device and standard brake and clutch interlocking gear form part of the equipment on each hoist. The condensing plant used in conjunction with the rock hoist comprises a Hick Hargreaves jet condenser with steam ejector and motor driven rotary extraction pump. In addition to the above two main engines a 16½ in. by 33 in. Robey geared hoist is installed for the handling of material, such as electric cables and pipe columns in the No. 5 compartment.

Headgear, Skips, and Cages.—The headgear is of steel construction, 105 ft. high and mounted with 14 ft. diameter rope sheaves of the built-up type. 5-ton skips and two-deck cages, the latter holding 40 men, are attached to the rope with Humble hooks. Facilities for rapid changing over from skips to cages and vice versa are provided.

Waste Rock Bin.—This bin of steel construction and 300 tons' capacity, is offset from the shaft and is fed by chutes running parallel to the long axis of the shaft, the waste rock doors at the tipping point in the headgear being opened and thus discharging into the above chutes, when hoisting waste rock.

Air Compressor Plant.—There are three horizontal reciprocating steam-driven compressors located at No. 3 Shaft. The first, which was already in commission during the shaft sinking stage, is of Pokorny Wittekind manufacture, having a capacity of 5,000 cu. ft. per minute at 80 lb. pressure. The other two have a capacity of 10,000 cu. ft.

FIG. 6.—ERECTION OF HEADGEAR AT NO. 2 SHAFT.

per minute each, and are built by Messrs. Walker Brothers, of Wigan. Each of them is provided with a Hick Hargreaves jet condenser similar to that mentioned as installed for the rock winder.

Cooling Pond.—The cooling pond is of large area and is equipped with 18 Yarway sprays. All piping is of reinforced concrete made locally and supplied by the Hume Pipe Company of South Africa, Ltd.

Ore Storage and Transport.—The supply of ore is drawn from No. 3 Shaft where the ore storage capacity is 2,500 tons, this being in the form of a dump on to which the skips tip direct from the headgear. In a tunnel beneath the dump the ore is discharged into 50-ton hopper trucks, the latter being hauled on a 3 ft. 6 in. gauge track by a steam locomotive a distance of 2·71 miles to the reduction plant site at No. 2 Shaft. Here, the trucks discharge the ore into the 1,500 ton capacity "railway ore bin," under which is installed a 36 in. conveyor, the ore being fed on to the conveyor by means of an automatic travelling shaking feeder. This conveyor is extended under the 2,000 ton ore dump at No. 2 Shaft, which will be formed at a later date in the same manner as that at No. 3 Shaft.

Washing Plant and Crusher Station.—The ore is fed to this plant from the storage bin and dump by the above-mentioned 36 in. conveyor belt and is delivered on to a "Disc-ring" grizzley having 4½ in. apertures. The oversize from this grizzley is fed by means of a Ross chain feeder on to a 36 in. sorting belt and, after washing, to enable the waste to be sorted out, the balance is conveyed by a further belt to the tube-mill pebble storage bin having a capacity of 250 tons, and thence trammed to storage bins situated at the feed end of each of the primary tube-mills. Any surplus coarse rock over that required for pebbles, also pieces too large for this purpose, are passed to a bin feeding a No. 6N Allis Chalmers gyratory crusher. The undersize of the 4½ in. disc grizzley is fed to a Robins cataract grizzley with 1¼ in. spacings, the oversize from which is fed on to a 60 in. washing and draining belt, where, after washing, it is delivered to two 36 in. sorting belts and after the waste rock has been hand sorted, the remainder is delivered to bins of 80 tons capacity, from which it is fed to two 7 in. Newhouse crushers. The undersize from the 1⅛ in. grizzley gravitates directly to a 30 in. incline belt and is taken to the main tube-mill storage bin.

The washings from all the sorting belts and the main washing belt are gravitated to a 6 ft. wide by 18 ft. 3 in. long rake classifier, the de-watered grit being delivered on to the 30 in. main incline belt above mentioned. To minimize the trouble usually experienced when conveying wet material on belts, the dry crushed product from the gyratory crushers forms the bottom layer on the main incline belt on top of which is placed the raked product from the classifier, and on top of this again is fed the undersize from the 1⅛ in. grizzley. The slime overflow from the rake classifier is pumped to a 50 ft. diameter conical-bottom collecting tank, the clear water overflowing being collected in a 50 ft. diameter storage tank and again used for washing purposes, whilst the settled slime is periodically pumped to the main pump sump in the tube-mill house. Tramp iron is removed from the ore flow by an Allenwest rectangular lifting magnet situated at the head of the 60 in. washing belt.

The reject pebbles from the tube-mill plant are transported by belts to a storage bin of 200 tons' capacity, placed at the side of the washing plant. From this bin the rejects are fed on to a 30 in. sorting belt, the waste pebbles being hand sorted into the waste bin, whilst the remainder are fed to a sizing trommel having 1¼ in. round holes, the oversize from which is passed to a storage bin of 20 tons' capacity, and thence conveyed by an incline belt to a storage bin adjacent to the main storage bin for tube-mill pebbles and thence hand-trammed to small storage bins situated at the feed end of the secondary and tertiary tube-mills. Alternatively, the trommel oversize can be fed to one of the 7 in. Newhouse crushers or to the two 24 in. Symons disc crushers. The undersize from the trommel passes directly into a storage bin and is fed to the two 24 in. Symons disc crushers, the discharge from which is delivered on to the belt transporting the crushed product from the gyratory crushers to the main incline belt. All discharge chutes from the three gyratory and the two disc crushers are encased and connected to a dust flue to which a fan is connected, the exhaust from which is led to a dust collecting chamber fitted with canvas bags, the settled dust being periodically removed.

The bottom of the waste bin is formed by

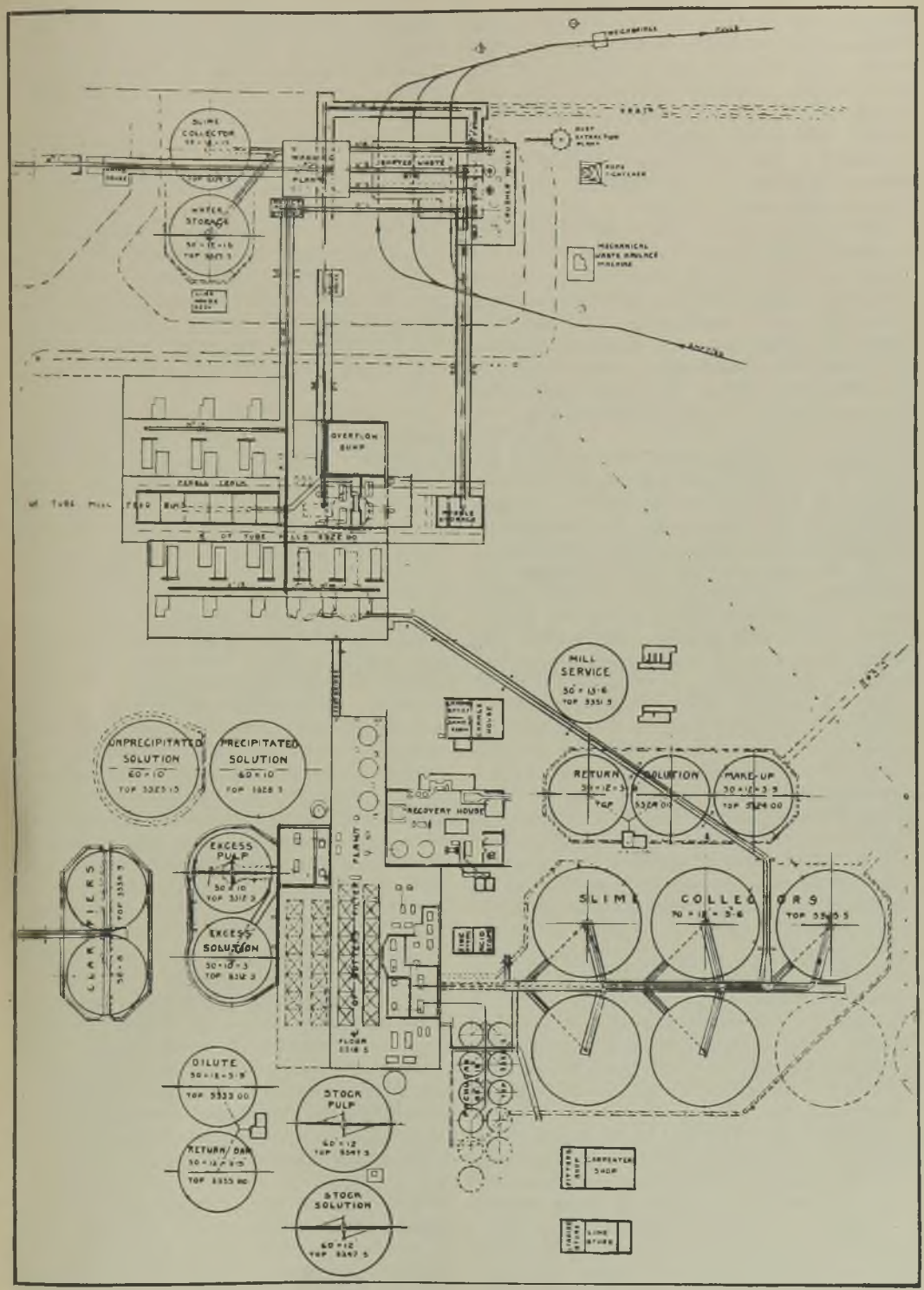


FIG. 7.—LAYOUT OF THE TREATMENT PLANT.

the natural ground, whilst the ends and sides are supported on a rectangular concrete wall. This bin has an available capacity of 1,200 tons and the waste is discharged by three lines of chutes into side-tipping trucks of 20 cu. ft. capacity, which are hand trammed to an endless-rope haulage. All waste discarded is automatically weighed before going to the dump.

Tube-Mill Plant.—This plant consists of nine tube-mills, each 20 ft. long by 6 ft. 6 in. diameter driven by 250 h.p. motors through David Brown reduction gears. The estimated capacity of the tube-mill plant is 50,000 tons for a 26-day month. Grinding and classification are carried out in three stages and as the economic number of units required in each stage can be best determined while the plant is in operation, special attention has been given in the layout so as to obtain the maximum interchangeability of the tube-mills for the various stages and for this reason it was decided to have all the tube-mills of the same size.

At the start of operations, there are 6 primary, 2 secondary, and 1 tertiary tube-mill. The primary mills are laid out on the back-to-back arrangement, the storage bin being of saw tooth shape, permitting the mills on opposite sides of the building being staggered on 30 ft. centres, thus giving ample space and daylight, and at the same time allowing the bins to be self-emptying. The ore from the storage bin is delivered to the primary tube-mill by means of a belt feeder, arrangements being made for regulating the rate of feed over a wide margin. The grinding pebbles are hand fed from the 14-ton storage bin situated at the feed end of each mill; the pulp discharge passes through a trommel fixed at the discharge end of the mill, having $\frac{3}{4}$ in. square holes. The oversize, called "reject pebbles," drops on to a 14 in. conveyor belt and is transported to the storage bin situated near the washing plant. The trommel undersize gravitates to a small concrete sump, from which it is elevated to an 8 ft. wide by 14 ft. 8 in. long rake classifier, the rake product being returned to the tube-mill, whilst the overflow (which is the final product of the primary circuit) gravitates to the main pulp launder, which is situated in the ground underneath the main storage bin, thence to a 10 in. pulp pump by which it is elevated to two 20 ft. diameter Dorr bowl classifiers, the rake compartment being 8 ft. wide by 34 ft. 3 in. long. The rake product from these two bowl classifiers gravitates to the two secondary mills and, after passing through these, the ground pulp gravitates to an 8 in. pump and is elevated to another Dorr bowl classifier of the same dimensions as the two previously mentioned. The rake product from this bowl classifier gravitates to the tertiary tube-mill and, after being ground therein, is again elevated to this bowl classifier; the overflow from this bowl gravitates to the two primary bowl classifiers, the overflow from which constitutes the final pulp and gravitates to the slime collecting plant. The grinding media used in the secondary and tertiary mills are the plus $1\frac{1}{4}$ in. reject pebbles obtained from the primary tube-mills.

An overflow sump of large capacity is placed adjacent to the two pulp pumps to prevent spillage in the event of sudden "shut downs." Provision has been made in the layout of this section of the plant for any future capacity increase up to double the initial tonnage.

Slime Collecting and Treatment Plant.—The final pulp from the tube-mill plant gravitates to 5 slime collecting tanks, each 70 ft. diameter by 12 ft. vertical height and having conical bottoms. The clear solution overflowing gravitates to two 50 ft. diameter return-solution storage tanks, from which it is elevated to the main tube-mill solution storage tank, provision being made to send any desired quantity of solution to the precipitation plant in order to maintain the gold contents of the crushing solution at the desired figure. After collection the slime is transferred by means of a 12 in. Robeson Davison pump to the top of 7 Pachuca tanks, each 45 ft. high by 15 ft. diameter, for treatment with air agitation, additional cyanide and lime being added as required.

Butters Filter Plant.—This is of standard design and of the "Full Gravity" type, consisting of two filter boxes each containing 7 hoppers with facilities for adding a further hopper at the end of each. In addition, arrangements have been made for further extensions if required, up to doubling the original capacity.

Clarification and Precipitation Plant.—There are two 50 ft. diameter tanks for clarifying the solution prior to precipitation. After clarification the solution gravitates to a 60 ft. diameter storage tank from which it is pumped to a Crowe vacuum receiver and thence

to the precipitation tanks of the Merrill vacuum type. There are three of these tanks each 11 ft. 2 in. diameter by 11 ft. 0 in. to 13 ft. 6 in. cone bottom equipped with 36 filter leaves. The solution after precipitation is pumped to a 60 ft. diameter precipitated storage tank and thence to the Butters Plant. When the clean up takes place the precipitated gold slime is pumped direct to the acid vats situated in the recovery house, thus obviating any handling of this product. The Butters filter and precipitation plants are placed under the same roof and have a common operating floor, thereby concentrating the operating of these two sections under the same shiftsman.

Recovery Plant.—This section of the plant is attached to the Butters filter and precipitation plants in order to facilitate general supervision, and all gold recovery operations take place therein. There are two acid vats each 10 ft. diameter by 8 ft. deep for the treatment of the gold slime from the Merrill precipitation plant. The acid treated slime gravitates to a 30 in. Johnson filter-press and after washing is transferred to a calcining furnace. After calcination it is mixed with the necessary fluxes and smelted in No. 100 pots in a reverberatory furnace capable of holding 30 of these pots. This furnace is equipped with a Mansell fire grate, which from past experience, improves the smelting conditions and gives appreciable operating economies as compared with the ordinary grate with stationary fire bars. An amalgam barrel and concentrating table is provided for the recovery of gold and osmiridium from the concentrates obtained from the tube-mills when they are relined. All bullion obtained is periodically sent to the Rand Refinery at Germiston for final refining and marketing.

A ball-mill of the Krupp type is installed in which slags, old pots, liners, etc., are ground. "Metallics" in these products are removed by concentration and the tailings are sent to the Witwatersrand Co-operative Smelting Works for final treatment.

SOME EXPERIENCES IN ECUADOR

By BERNARD BERINGER, A.I.M.M.

The author describes a prospecting trip in the Province of Esmeraldas.

The following description of how the author and another engineer fared at free-lance prospecting in the Republic of Ecuador, although containing nothing new from a technical standpoint, may be of interest in adding some more information to that which has already appeared in the Magazine on general conditions in the Republic ; it may also help to elucidate the few advantages and the many handicaps of free-lance prospecting.

Ecuador lies between latitudes 2° N. and 6° S. Its boundaries are Colombia to the north, the Pacific Ocean to the west, and Perú to the south. The Cordillera de los Andes runs roughly north and south, and in Ecuador it consists of two ranges with an elevated plateau between ; this plateau, known as the Páramo, is some 300 miles long and 30 miles wide. The settled population of the country is to be found in the coastal section, between the foothills of the Andes and the ocean, with, perhaps, the bulk on the plateau. The trans-Andean country to the east of the Cordillera is little known (marked *poco conocida* on the maps), is inhabited by Indians still in their uncivilized state, and is reported as possessing a somewhat hot climate.

On arrival in Guayaquil, in October last, the first thing done by the author and his companion was to probe every possible source for information. It might be mentioned in this respect that the British Consulate spared neither time nor trouble to help, and one of the two engineers seeking information was an American. Knowing that operations would have to be limited to a matter of weeks on account of the approaching rainy season and also that, owing to the large area of the Eastern Province, an expensive equipment would be necessary for there, with the added cost of armed guides, etc., it was decided to concentrate on one definite area of the coastal section. The province of Esmeraldas was chosen because of the reported unhealthiness of the climate and lack of communications, as it was desired to do pioneer work in virgin country.

Ecuador possesses a diversity of climatic and topographical characteristics. When traversing the inter-Andean plateau by train the author was impressed by the almost European scenery and climate and in the

towns and villages with their pavé streets, stone houses, and tiled roofs, etc., the likeness was even more apparent. Quito, the capital, was made the starting-off point of the expedition. This city, most old-world in every respect, is about 10,000 ft. above sea level and possesses a healthy climate. The inhabitants are for the most part whites and mestizos. Indians from neighbouring villages sell their wares in the streets and market places—the author saw no negroes there.

In Guayaquil and in Quito a definite friendliness towards strangers was encountered from all classes. There was certainly no visible anti-gringo spirit, such as is so common in some other parts of South America, Perú in particular. The feeling that one was welcome became intensified by further acquaintance with the country and the people. The Under-Secretary of Public Works assisted by providing an open letter of introduction to all Government officials in the province of Esmeraldas; he emphasized, also, that foreigners have the same rights in Ecuador as the inhabitants except, of course, politically. The mining laws of this republic are very fair to the prospector and miner and the author will willingly lend a copy of the laws (in Spanish) to anyone interested.

In Ecuador, as in many parts of Latin America, pioneer work has been neglected by the inhabitants since the Spaniards left and foreigners, who now do most of the prospecting, usually equip themselves before leaving their own country. Hence there is a dearth of field equipment in Quito, and this caused a delay of eleven days in that city. As an example of the difficulties encountered it can be said that it occupied eight hours of continuous search to obtain two water-bottles.

The first objective of the author's party was Santo Domingo de los Colorados, 100 kms. from the railway. This distance was covered on foot with three small pack animals carrying the kit. For most of the way the going was fair, but awkward at times when passing other laden animals on the narrow mountain trail. Although on the first day 36 kms. was covered, it was found impossible to repeat the effort—loading the animals and readjustments of packs during the march, made slow travel. Mounted on two hired horses with, say, two muleteers to look after a better pack-train, although costing more money would have trebled the distance covered daily—if the question of speed were of importance.

The Andés slope fairly steeply towards the foothills, and a drop of 6,000 ft. was accomplished in the first two days. The hill scenery was impressive—possibly as beautiful as the Himalayas near Simla and even more massive. On the fifth day Santo Domingo was reached; named de los Colorados as the neighbouring Indians paint themselves in bright colours. This place looks rather large on the map, but in reality it consists of some twenty houses-on-stilts occupied by mestizos, with a few nearby haciendas (small farms.) The inhabitants were very interested in the arrival of two foreigners, as their only normal novelty is the fortnightly postman with news from the outer world. Santo Domingo is in the coastal plain, having an altitude of some 600 ft.

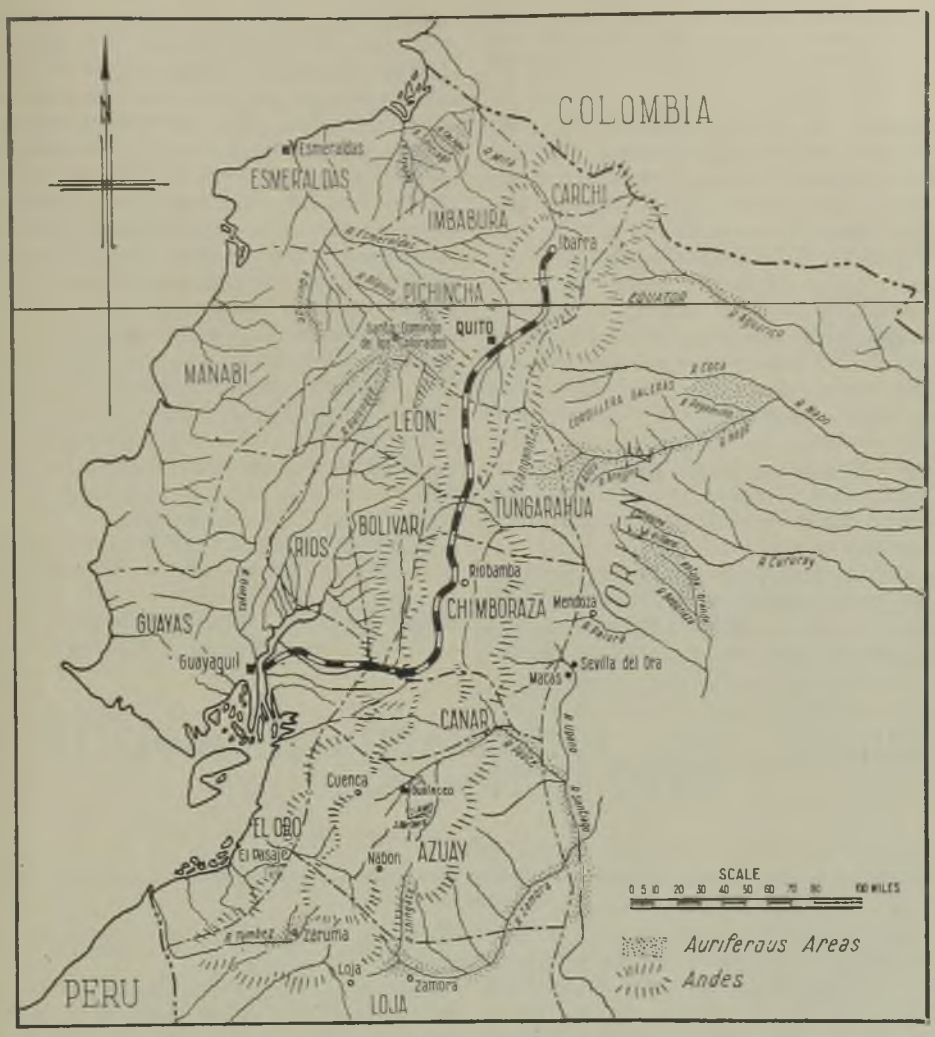
The next objective was Quinindé, a village situated at the confluence of the Rio Blanco and the Quinindé River, 91 kms. from Santo Domingo, and about 150 ft. above sea level. This second stage of the trek occupied five days. The trail traversed completely virgin forest land, where the tropical trees grown to a great height, and the brush on either side is so thick as to be impassable without a way being cut, as had been the trail, at great expense. Some difficulty was encountered as one of the pack animals had developed a pack sore and had to be left at a Government post (Tambo). The following extracts from the writer's diary may explain why the going was slow:—

Nov. 20, 1931.—At the Tambo at 80 kms from S. Domingo. The two donkeys were now done in, having three loads in two, and the way was boggy and heavy going. My pack itself weighed nearly fifty pounds. (The writer's companion carried a pack considerably heavier.)

Nov. 23.—I am writing this in Quinindé, a village about 120 miles by mule track from Quito, our nearest town, and about fifty miles from the small seaport of Esmeraldas, reached by canoe in two days at present, and in one day during the rains. On the way here yesterday one donkey fell into a stream and then later became bogged; we had plenty of trouble with packs, of course.

The Rio Blanco is one of many rivers in the coastal plain, and it has a number of tributaries. It was decided to prospect one of these and the streams running into it. All inquiries made received the answer that no foreign engineers had prospected this particular part of the province before.

The population here is wholly negroid and lives in small houses-on-stilts alongside the rivers, very little attempt having been



Sketch Map of Ecuador.

made to clear the tropical forests—the bush is yet to be reclaimed. These negroes excel as rivermen, but otherwise are rather lazy. They are a most hospitable, friendly, honest, and law-abiding people. It is doubtful if a small colony of any other race could live in such an isolated spot with less dissension. Their speech is a poor Spanish, but their tone and mannerisms, especially their ejaculations, are distinctly West African. A few more extracts from the writer's diary may elucidate the chief pre-occupations of the prospecting phase of the trip :—

Dec. 1.—We are still here at X camp. We are living chiefly on fried bananas, with a soup in the evenings of onions, potatoes and beans. The onions will last only a few days more and the potatoes about ten days. Rice we have plenty and I was able to buy some more beans from a nigger woman in a canoe, also a pound of lard—this last was a stroke of luck. We have been practically vegetarian for weeks. We have only been able to get yucca (roots) once, and camotes (sweet potatoes) not at all, which is a pity. But we have three coconuts, which make a diversion. I find that cooking and preparing the food, without conveniences, takes a lot of time. It is funny being completely away from *all* news. We do not even know if Sanchez Cerro is president of Perú or anything. To-day it was really hot. The mosquitoes at night are vicious.

Dec. 8.—To-day we shifted camp to about one kilo farther upstream. The nigger who has been selling us bananas helped us up here. At one of the rapids we had to unload our canoe and manhandle the stuff some 150 yards over boulders, while the

nigger pushed and pulled the canoe through the rapids. This new camp is a delightful spot, but cronic with those small black flies that leave blood wherever they bite.

A number of pits was sunk in the flats at the river bends and elsewhere ; it was found too difficult to sink to more than about one foot below water level—timber was available, but there were no pumps. It was impossible to strip, owing to the flies, so that one's clothes became saturated with sweat. Natives, passing in canoes, showed surprise at seeing two white men doing manual labour. The pits were sampled and panned in the usual manner. The concentrate was invariably magnetite, and thus any gold could be detected by its colour and shape, and any platinum by its lustre and shape. Eventually the arrival of the rains and the consequent rising of the rivers, caused a stop —in January of this year.

In a matter of weeks two engineers, working without the assistance of labourers and appliances, can do some prospecting and come to some conclusions, but were one to consider the salary that either would represent were he working for a company, then the chief conclusion would be that this is a very expensive method of prospecting.

Living in Ecuador is cheap ; there are hotels in the towns where good board and lodging can be obtained for $1·00 a day or even less. In the bush, living cost about three pence each per day, but it might have been better to have gone to the extra expense of carrying tinned goods to supplement bananas, etc., because one's bodily appearance at the finish suggested that too much reserve tissue had been drawn upon. The writer's total expenses in Ecuador, including equipment, came to about $200·00, but what information that was gained of the people and of general and mining conditions, was perhaps a satisfactory return for the money and the discomfort.

The trip could not have been accomplished without a knowledge of the language and of tropical hygiene, which, quite possibly, would apply to a similar expedition in any of the South American republics.

TERRAIN AND TOPOGRAPHICAL EFFECTS IN GRAVIMETRIC SURVEYS

By W. G. G. COOPER

In this article the author suggests a method of computing terrain and topographical effects in survey work with the Eotvos torsion balance.

The method of computing terrain and topographical effects given in the following article suggested itself to the writer from lectures by Professor Rankine, who is in charge of the course in Applied Geophysics at the Royal College of Science, London, and from whose method it differs rather in detail than in principle. It is hoped that this account will be read by geophysicists engaged in fieldwork, who may have both the opportunity and inclination to put it to the test of experience. Professor Rankine points out that it is only by so doing that the method may be judged, and he has approved of its publication with this object in view.

The suggestion embodies the use of slide-rule, graphical work, and planimeter, and it is claimed that the accuracy of these instruments is equal to or greater than that of the assumptions made regarding density of material, etc. Levels are taken along radial lines (8 in normal country) at any convenient distances, giving a fair representation of the ground.

THEORY.—The writer is in favour of taking the centre of the instrument as Origin instead of the ground-level at the station as is the usual practice. This involves no extra work in levelling, and it has the advantage of leaving the application more pliable, no extra calculations being needed to change the height of the instrument. Furthermore, it is quite unnecessary for purposes of calculation to make any assumptions regarding the magnitude of the height of the instrument, or of the ground-levels, and the integration is simple. In the Schweydar method, which has been worked out so clearly for English units by Lancaster-Jones,[1] the integration of terrain effect is performed in concentric rings, but in the following method the integration is first

[1] *Vide* "The Principles and Practice of Geophysical Prospecting" Report of the I.G.E.S., by Edge & Laby.

performed radially and then summed in azimuth.

In Fig. 1, Ox, Oy, and Oz are the axes of reference, the origin O being at the centre of the instrument. Consider a small elementary prism of cross section $\rho . \delta\alpha \times \delta\rho$, and height $\delta\zeta$ at P, distance ρ from O, and OP making an angle α with OX. ζ is the vertical co-ordinate of $\delta\zeta$, and r the oblique distance OP.

(*a*) The *Gravity Gradient* at O due to this, is clearly $\delta R_\alpha = 3\gamma, \frac{\rho\zeta . \delta m}{r^3}$ where δm is its mass, and γ the gravity constant: or $\delta R_\alpha = \frac{3\sigma\gamma . \rho^2 . \zeta . \delta\alpha . \delta\rho . \delta\zeta}{r^4}$ along OP,

whence for the whole section, on substituting for $r = \sqrt{\rho^2 + \zeta^2}$

$$R_\alpha = 3\sigma\gamma . \delta\alpha . \int_{\rho=0}^{\rho=\infty} d\rho . \int_{\zeta=0}^{\zeta=\zeta} \frac{\rho^2\zeta \; d\zeta}{(\rho^2+\zeta^2)^{\frac{5}{2}}}$$

where ζ = height of ground at P, relative to O. Integrating with respect to ζ, we get (omitting limits) :—

$$R_\alpha = 3\sigma\gamma . \delta\alpha \int -\frac{1}{3\rho\left(1+\frac{\zeta}{\rho}\right)^{\frac{3}{2}}} . d\rho \text{ or}$$

$$3\sigma\gamma . \delta\alpha \int \frac{1}{3\rho\left[F_R\left(\frac{\zeta}{\rho}\right)\right]} . d\rho$$

where $F_R\left(\frac{\zeta}{\rho}\right) = \left(1+\frac{\zeta^2}{\rho^2}\right)^{\frac{3}{2}}$.

Referring now to the slide-rule shown in Fig. 2. This $F_R\left(\frac{\zeta}{\rho}\right)$ is plotted on scale E opposite the corresponding value of $\frac{\zeta}{\rho}$ on scale C, A, B, and C being the ordinary logarithmic scales. (In using the slide-rule, the value of $\left(\frac{\zeta}{\rho}\right)$ is automatically obtained on scale C by dividing the value of ρ on A B into

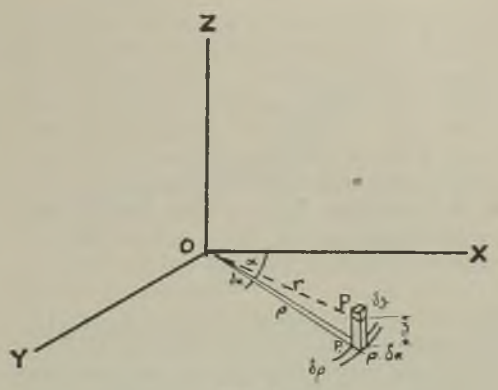


Fig. 1.

ζ on C, the same cursor position then giving the reading $F_R\left(\frac{\zeta}{\rho}\right)$ on E.)

The calculation of the Integrand is then completed on the slide-rule and the value plotted to suitable scale as ordinate against ρ as abcissa. This is repeated along the section OP at all points where levels are taken. Some such graph as shown in Fig. 3 will be obtained, which approaches the value of $\frac{1}{F_R\left(\frac{\zeta}{\rho}\right)} . \frac{1}{3\rho} = 0$ asymptotically. To obtain the integral of this with respect to ρ, we have merely to measure the area shown shaded by means of a planimeter. (It can be done arithmetically on squared paper if this is not available.) Calling this area S_R, we now have $R_\alpha = 3\sigma\gamma . S_R . \delta\alpha$, which is, of course, the gradient along OP due to a narrow sector $\delta\alpha$. The total gradient will therefore be $R = 3\sigma\gamma \sum_{\alpha=0}^{\alpha=2\pi} S_R . \delta\alpha$, namely the *Vector* sum of these sector gradients all round the station.

We now have to make some assumption, namely that over a certain angle of sector

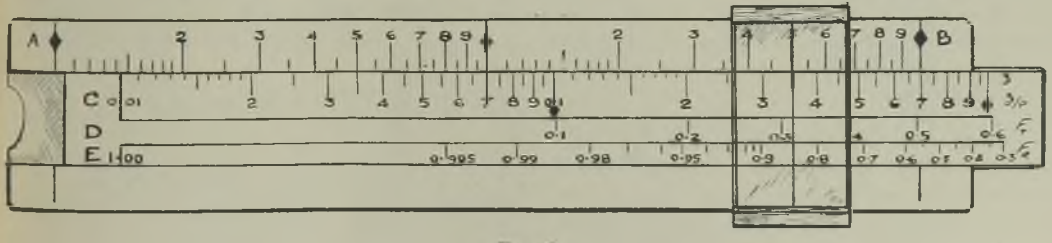


Fig. 2.

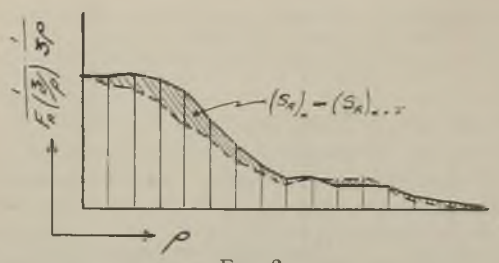


FIG. 3.

$\left(\alpha - \frac{\Delta\alpha}{2}\right)$ to $\left(\alpha + \frac{\Delta\alpha}{2}\right)$ the ground is uniform circumferentially, by which is meant that S_R is constant in amount (but not in direction). Suppose, as is the usual practice, we make $\Delta\alpha = \frac{\pi}{4}$. It will be noted that the vector for this will be curved, in fact part of a circle, commencing in direction $\left(\alpha - \frac{\pi}{8}\right)$ and ending in direction $\left(\alpha + \frac{\pi}{8}\right)$ (Fig. 4, MN.) Inspection shows that the resultant of this is the chord MN, whose length is $\frac{\text{Sin } \frac{\pi}{8}}{\frac{\pi}{8}}$ or 0·975 of the length of the arc. We may then either obtain the chord by taking $R = 3\sigma\gamma S_R \cdot \frac{\pi}{4} \times 0{\cdot}975$ for sector $\frac{\pi}{4}$, or, as suggested by Professor Rankine, plot the actual curve by compasses, which is, perhaps, rather prettier.

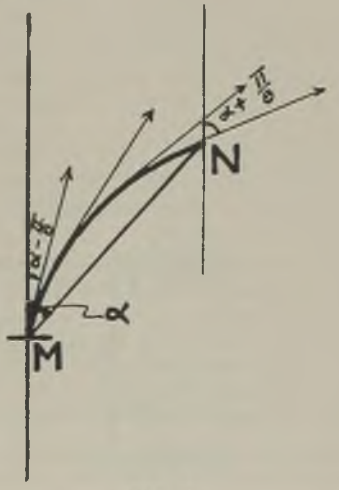


FIG. 4.

The Resultant vector (gradient) could then be obtained by plotting the 8 sections in the ordinary manner, but this is not necessary, since gradients making angles of π (or 180°) with each other may be subtracted algebraically, with due attention to sign. This can be done earlier, when plotting the elementary gradients as in Fig. 3 and measuring only the area lying between the two plotted curves for α and $\alpha + \pi$. Thus in the final vector diagram (Fig. 5) we have only four vectors to add. The Resultant gradient is given in amount and direction by the solid line R.

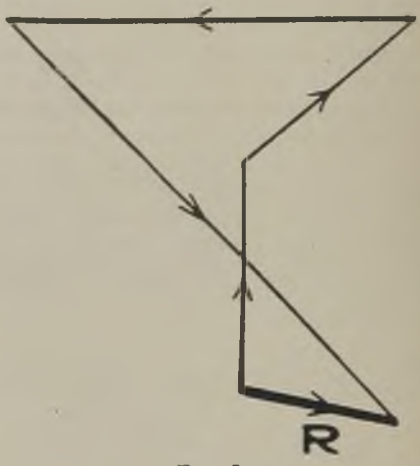


FIG. 5.

(*b*) *T*. (*Horizontal Directional Tendency.*) —It is unnecessary to explain the whole procedure again, since it is similar to that for R. For the small element

$$\delta T_\alpha = -3\sigma\gamma \cdot \frac{\delta\alpha \cdot \delta\rho \cdot \rho^3 \delta\zeta}{(\rho^2 + \zeta^2)^{\frac{3}{2}}}$$

which for the whole section OP becomes

$$T_\alpha = -3\sigma\gamma \cdot \delta\alpha \cdot \int_{\rho=0}^{\rho=\infty} d\rho \cdot \int_{\zeta=0}^{\zeta=\zeta} \frac{\rho^3 d\zeta}{(\rho^2 + \zeta^2)^{\frac{3}{2}}}$$

Integrating with respect to ζ, and keeping α and ρ constant, we get (omitting limits)

$$T_\alpha = -3\sigma\gamma \cdot \delta\alpha \cdot \int \frac{\left[1 + \frac{2}{3}\left(\frac{\zeta^2}{\rho^2}\right)\right]}{\left[1 + \left(\frac{\zeta^2}{\rho^2}\right)^{\frac{3}{2}}\right]} \left(\frac{\zeta}{\rho}\right) \frac{d\rho}{\rho}$$

which, say $= -3\sigma\gamma \cdot \delta\alpha \cdot \int F_T\left(\frac{\zeta}{\rho}\right) \times \frac{1}{\rho} \cdot d\rho$,

where $F_T\left(\frac{\zeta}{\rho}\right) = \frac{\left[1 + \frac{2}{3}\left(\frac{\zeta^2}{\rho^2}\right)\right]}{\left[1 + \left(\frac{\zeta^2}{\rho^2}\right)^{\frac{3}{2}}\right]} \left(\frac{\zeta}{\rho}\right)$, which

is plotted against $\left(\frac{3}{\rho}\right)$ on scale D of the slide-rule and is rapidly obtained therefrom at each point at which a level is taken. Notice how rapidly $F_T\left(\frac{3}{\rho}\right) \times \frac{1}{\rho}$ approaches 0 as ρ is increased. In plotting the Integrand for T (as done in case of R, Fig. 3) the operator would watch this, and cease his calculations when the desired degree of accuracy is reached.

It should be noted that T is not a true vector, but behaves as a vector in direction 2α in vector additions, where α is the direction of section, so that those at π (180°) should be added algebraically and those at angles $\frac{\pi}{2}$ subtracted algebraically, so that the whole may be reduced to only *two* vectors in final diagram, against four in the case of R. The vectors will still be curved, but in this case through twice the angle of sector, so that it should be remembered that the chord is, for example, $\frac{\text{Sin } \frac{\pi}{4}}{\frac{\pi}{4}}$ or

$0{\cdot}90 \times$ Arc. for a sector of $\frac{\pi}{4}$.

COMMENTS.—(1) Although the foregoing explanation is somewhat lengthy, the calculations can be made rapidly on the slide-rule as indicated, and it is believed with sufficient accuracy for practical purposes—that is as accurate as the density σ, for example, is known.

(2) The height of the instrument does not enter into the calculations (except in reduction of levels, for which it may be considered as a bench mark or datum), and so can be altered at will. All that is necessary is to read it when levelling.

(3) The whole process is visible throughout the calculations. Big arithmetical errors would be detected at once (but they should not be made on a slide-rule) and all the time one can see how far it is necessary to carry terrain corrections.

(4) The method is really flexible. σ may be altered locally (on any ordinate in Fig. 3); more sections (i.e. alterations of $\Delta\alpha$) may be taken with ease, particularly in any position where so desired, by nature of level of ground or its density, and it is not necessary to maintain symmetry in lines of levels.

(5) The method could be applied easily to distant topography. Even in the field, one has only to work out $\frac{3}{\rho}$ and $F_R\left(\frac{3}{\rho}\right)$ or $F_T\left(\frac{3}{\rho}\right)$ roughly on the slide rule, in order to see if it is necessary to consider any hill or rock or other object met with.

(6) $\left(\frac{3}{\rho}\right)$ and so F_R and $F_T\left(\frac{3}{\rho}\right)$ are all ratios independent of the units of measurement. The slide rule scales are therefore suitable for use with either English or Continental units.

Finally, since we are taught that the "proof of the pudding is in the eating", may I hope that some enterprising person will put it to the test—and let us know the result.

The I.M.M. Benevolent Fund

The following further subscriptions to the Benevolent Fund of the Institution have been received during the past month :—

Pato Mines (Colombia), Ltd.	£10	10s.	0d.
F. K. Borrow	£5	5s.	0d.
G. A. Denny	£5	5s.	0d.
Imperial Chemical Industries, Ltd.	£5	5s.	0d.
R. B. Woakes	£3	3s.	0d.
A. F. Dick-Cleland	£2	2s.	0d.
T. P. Grey	£2	2s.	0d.
R. Patterson	£1	1s.	0d.
D. A. Sutherland	£1	1s.	0d.
Previously acknowledged	£112	6s.	0d.
Total	£148	0s.	0d.

Institution of Mining Engineers' Summer Meeting.—The Summer Meeting of the Institution of Mining Engineers is to be held this year in Sheffield, on June 15, 16, and 17, by invitation of the president and council of the Midland Institution of Mining Engineers. The preliminary arrangements, which have just been announced, show that the first day will be set apart for the official receptions and for a technical session. During the other two days visits will be paid to various works in the district, while a dinner will be held at the Royal Victoria Hotel on the second day. Further details are to be issued in due course.

LETTER TO THE EDITOR

The Goldfields of Dutch West Borneo

SIR,—E. J. Vallentine's review of the prospects for gold in Dutch West Borneo in the MAGAZINE for February, 1932, is one of the few references available on that region and reminds me of my visit there in 1903. When at Kalgoorlie, Western Australia, the late E. Graham Price sent me with a portable sampling and assaying outfit to Singapore. There I met Messrs. Myhill and Ritchie, and we proceeded by one of the excellent oil-burning steamers of the Koninklijke Paketvaart Maatschappij (Dutch Packet Company) to Sambas, a native town up the Sambas River, Borneo, thence to Sinkawang down the west coast, where lives one of the Residents. After presenting our credentials we were given our *Toelatingskaart* or prospecting permits ; mine was number 4, 1903. Thence we sailed by prau to a small settlement at the mouth of the Sungei River. This we made a base of investigation. A Javanese boy did our cooking and other jobs, and we were friendly with the local chief and natives. We prospected around by digging test-pits and panning the ground excavated, also rock that we crushed, and creek sands and gravels. Many pans showed colours. But we were not in the right part of the country and decided to consult certain Dutch officials and others before doing further work. We had been led to believe that there were other deposits similar to those being worked by the Borneo Company in the Sambas district and in Sarawak. That material was being crushed coarsely and cyanided direct, yielding a profit of 5s. per ton. Apparently none has been found since, although, as Mr. Vallentine says, some may yet be uncovered. We learned that there were few if any worth-while gold areas available for working because much of the region had been granted to concessionaires, most of whom were not active, simply holding on. We then decided to abandon our prospecting and see what was being done elsewhere. From the Sungei River we walked through jungle to Pengkalen Batu, where Alluvia, Ltd., managed by Mr. Toby from Australia, and mentioned by Mr. Vallentine, was working steam-driven water and gravel pumps made at Castlemaine, Victoria. Many natives were employed and carried certain excavated gravel in baskets, the local practice. If I remember aright, the operation was not profitable when handling 100 cubic yards of 10-penny gravel an hour.

Mr. Vallentine's outline of the history of gold mining in Borneo up to 1903 agrees with what our party was told concerning Chinese operations and I am glad to learn more of what has happened since. We were unfavourably impressed with the prospects for any lodes or veins or blanket deposits in north-west Borneo, but we did believe that there should be good chances for dredges. Alluvia, Ltd., was recovering gold, and there were large areas of untouched alluvial deposits and others worked out and some being worked by Chinese. The latter had crude pumps, ditches, and women skilfully panning sand in wooden *dulongs*. However, our party was not interested in working placers. Probably Mr. Vallentine is correct, careful sampling might reveal large areas suitable for dredging by the latest equipment. Too much hope should not be held for pay gravel in the old Chinese workings and tailings, but the unworked flats might prove to be profitable at 10 to 15 pence per cubic yard.

With regard to general conditions, the mining laws of the Netherlands East Indies appear to be reasonable. They are available in concise form in Information Circular 6451, June, 1931, of the United States Bureau of Mines series of digests of foreign mining legislation. The climate is hot and moist, yet bearable if a man does not drink and become lazy and leaves the native women alone. Timber is abundant. Power would be a problem, although steam could be generated by wood fuel or perhaps by oil from Sumatra or eastern Borneo. Water power is said to be available in some parts of the island. Rainfall is heavy, up to 150 inches a year. Transport is not the best, although the rivers and perhaps some canals could be used. It has been customary to import Javanese coolies to work at some of the placer properties, but they are not good workers. Most of the mining and much of the cultivation of Borneo has been done by Chinese. It is important that mining men learn the Malay language which is spoken by Dutch, Chinese, Javanese, Malays, and others. The ordinary or bazaar Malay is rather easy to learn. Rice is grown in fairly large quantities, sago is made, and bananas, oranges, and coconuts are plentiful. Flour and certain foods must be protected against mould.

I believe that the foregoing notes are

substantially correct. Alluvial mining in north-west Borneo has not had a brilliant past, but I feel sure that if enough money is made available and extensive and reliable sampling is done, enough pay ground should be proved to keep several dredges at work.

M. W. von Bernewitz.

Washington, D.C.
March 24.

BOOK REVIEWS

Flotation. By A. M. Gaudin. Cloth, octavo, 532 pages, illustrated. Price 36s. London: McGraw-Hill.

In the old type of textbook the author expounded his subject to the best of his ability and gave facts, references, experience, and opinions to the fullest extent that space permitted. If an author is a competent technician, the value of such a book to the community is great, for, besides its educational value, it possesses value to those fellow technicians who earn their living by the practice of their profession. But such books give offence and arouse adverse criticism because they do not praise both the good and the bad, and because, even when they are praising the good, the apportionment of praise cannot please all equally. Many modern writers of textbooks avoid giving offence by avoiding personal opinions and by omitting personal references to their own experience. They adopt a definitely non-committal attitude towards the shortcomings and the virtues of the machines or processes they describe.

Professor Gaudin's many and able contributions to the literature of flotation and the exceptional opportunities he has enjoyed of acquainting himself with the practice of flotation should make any book by him on the subject a classic. Moreover the absence of any other recent textbook in English on flotation must assure his book a special place in the library of every mining engineer and every metallurgist interested in flotation. It seems a pity therefore that Professor Gaudin has adopted the more modern method of treating his subject, impartiality is carried to an extreme. For example, of flotation machines it is said (p. 401), "the difference between the various machines is small"; if one turns for information about the performance of the much discussed and novel South-Western flotation machine one reads "according to the maker, capacity ranges from 6 to 30 tons per foot of length," etc. The exceptional success of the machine, even as a cleaner in some cases, and its comparative failure in one or two instances is not commented on.

If, as a British engineer, one seeks the latest information about the application of flotation to tin, platinum, gold, or coal, one finds an equal caution with regard to the expression of adverse opinions. Of complex pyritic gold ores one reads (p. 327) that flotation has yielded high gold recoveries at a treatment cost which is but a fraction of the cost of roasting followed by cyanidation, but in Table 109 the highest grade of concentrate claimed is 1·60 oz. per ton—less than 0·01%. With regard to the application of flotation to English coals (p. 353) the reader has to be satisfied with the quotation of some optimistic tests from an article published in 1923. Some shareholders know otherwise.

Perhaps the same desire to please the majority accounts for the omission of the name of Elmore from the table (page 7) of those responsible for "Important Steps in the Evolution of Flotation." Even with regard to the minor subject of the use of terms the author maintains his attitude of detachment from all rancours and disputes. He uses the terms "agent" and "reagent" as synonymous, and dismisses the argument with regard to the use of "differential" and "selective" by the remark (page 6) that "it would seem as though there were no need for a qualifying adjective." On the subjects of adsorption and chemical action (p. 65, line 16) he is equally tactful.

In the treatment of his own special subject —flotation reagents— Professor Gaudin follows the popular method and endeavours to classify them according to their functions, although he admits that reagents "often have a manifold use." He gives five main classes and seven minor classes. His scheme is more a classification of functions than of reagents!

The principal feature of the book is its discussion and description of the treatment by flotation of the ores of copper, lead, and zinc. This occupies 163 pages, or rather more than one-third of the book. In addition, special chapters are devoted to the mechanical aspects of froth production (34 pages), liberation and particle size (35 pages), mill design (22 pages), costs (24 pages), choice of methods (31 pages), and testing and testing equipment (33 pages). Various

other subjects are dealt with to a lesser extent. With regard to the contents of the book as a whole it may justly be said that it presents in a convenient form "the scientific, technical, and economic aspects of flotation."

B. W. Holman.

Die Flotation. By W. Luyken and E. Bierbrauer. Cloth, octavo, 284 pages, illustrated. Price RM. 29. Berlin: Julius Springer.

Dr. Luyken, of the Kaiser-Wilhelm-Institute at Dusseldorf, and Professor Bierbrauer, of the charmingly-situated School of Mines at Leoben (Austria) have produced a book which is an interesting supplement to the more comprehensive and ambitious work by Professor Gaudin. Their work seeks to bring theory and practice closer together. The authors look forward to the time when a deeper theoretical knowledge will render blind testing (*blindes Probieren*) a thing of the past. They point out that at present, even in laboratory work, empirical testing and experience are the main essentials, but that with the increased use of chemical reagents a knowledge of related physics and chemistry is taking a definite rôle in the art of flotation.

Pages 19 to 60 deal with such theoretical matter and are followed by fifty-seven pages (pp. 61–108) on laboratory testing. Detailed consideration is given to the employment of laboratory grinding, sizing, and elutriating appliances. Testing with pneumatic and impeller flotation machines is considered in conjunction with the mineralogical examination of ores, measurements of surface tension and hydrogen ion concentration, float and sink tests, ratio of enrichment and recovery curves, and estimates of metallurgical efficiency.

The next section (pp. 109 to 187) deals with the working of the flotation process and is subdivided into sections dealing with the preparation of the ore, the preparation of the pulp, flotation machines, and the treatment of concentrates. In the section (35 pages) dealing with the preparation of the ore the types of crushing and grinding appliances, classifiers, ore feeders, pumps, and elevators met with in flotation plants are reviewed. The inclusion of this section has been criticized, but may be justified on the grounds that it is relevant, brief, and informative.

The next section (pp. 188-223) deals with the properties of those minerals which are recovered by flotation and the reagents employed for their recovery. The last section (pp. 223-215) giving examples of flow sheets and costs.

An excellent classified international list of references to recent literature on flotation occupies fourteen pages; this is followed by English-German and German-English vocabularies of about eight hundred names and terms employed in the text.

The matter throughout is treated from the point of view of the student or engineer who wishes to learn the art of flotation, rather than from that of the technician who requires a review of the subject. It is a most helpful book, logically arranged, clearly written, and well illustrated.

B. W. Holman.

☞ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London, E.C.2.

NEWS LETTERS

JOHANNESBURG

April 7.

Diamonds near Port Elizabeth. — Diamonds have been discovered in the limestone formation near Coega, about 18 miles from Port Elizabeth. The stones are small, but are of good quality. A geological peculiarity of note is the presence of worn stones and gravel in the limestone, which contains fossils. The source of the coastal diamond deposits in South-West Africa and Namaqualand has been attributed to pipes of kimberlite of which the locality has so far been indicated in a broad and vague sort of way as being somewhere in the hinterland, and very probably in the Orange Free State or in Griqualand West. It is possible that other workable occurrences are still to be found south of the Orange River and that diamonds found in the district of Port Elizabeth have been derived in some way from yet undiscovered sources. It has been suggested that kimberlite is not the only source of these diamonds. Some diamonds found in the Vaal River are said to have been originally embedded in amygdaloidal andesite, probably of the Ventersdorp Series.

Manganese Corporation.—Mr. H. L. Burnie, who has retired from the position of managing director of the Manganese Corporation, will devote himself during the next few months to continuing preparations for the negotiations at Ottawa between the Union and Canadian Governments in regard to the ferro-manganese scheme described by the chairman at the last annual meeting of shareholders. Mr. Burnie has been in continuous treaty with the Union Government and the Canadian authorities in regard to the matter, and either he or Mr. Aldridge, the chairman of the Manganese Corporation, will attend the Ottawa Conference in an advisory capacity in regard to the negotiations.

Canadian Capital for the Union.—A company has been registered in Pretoria with a capital of £300,000, mainly with the object of prospecting and mining in Namaqualand. Among the promoters of the company are Canadians who represent the Dome Mines, Ltd., of South Porcupine, Ontario, a company which acquired a block of shares in the East Geduld Mines some months ago. Messrs. de Pencier and Dowsett have carried out a considerable amount of inquiry and investigation during recent months on account of Canadian interests, with the object, it is said, of acquiring promising mineral occurrences, and the new company is the result of this enterprise. The company will acquire prospecting options on properties covering a very large area in Namaqualand. Reports are mentioned here that a gold-bearing reef carrying encouraging values has been discovered on one of the farms in which the company is acquiring an interest.

Geological Survey.—In his address at the annual meeting of the Geological Society of South Africa, Professor G. A. Watermeyer, the retiring president, declared that the Governments of the Union in the past had shown a want of appreciation of the value of the work done by the Geological Survey. The Survey was understaffed, and the work done by the staff as at present constituted was not published sufficiently expeditiously for the information of the public. The staff of the Survey had done wonderful work considering the paucity of numbers, but thousands of square miles, even in the vicinity of the Rand remained to be mapped. Delay in effecting this work retarded the flow of capital for exploration and development, and deferred the date at which the State would reap the benefit. Mr. Arthur French, president of the Chamber of Mines, endorsed Professor Watermeyer's remarks on the lack of appreciation shown by the Government of the Geological Survey, and said that not £9,000 but £90,000 a year should be spent on the work.

Dr. A. L. Hall's Successor.—Dr. W. Kupferburger, has been appointed Assistant Director of the Geological Survey in succession to Dr. A. L. Hall. He graduated at Stellenbosch University (then the Victoria College), and took his M.Sc. degree, later obtaining the degree of D.Sc. at the Witwatersrand University. For six months he was in London, where he was appointed Mineral Technologist to the Mines Department. In 1929 he was appointed Mineral Technologist in the Trade and Industries Division of the Union Department of Mines and Industries.

Mining in Swaziland.—The Swaziland authorities have decided to throw open to prospectors the Crown mineral area No. 7, hitherto held by a private company, but now lapsed to the Government. The area is a rectangle about 15 miles long by 10 miles wide, bounded on the north by the Komati River. There have been many small gold mines in the area, but of late none has met with any success. A gold rush is to take place from Forbes Reef.

Advances in Underground Practice.—In some of the mines of the Central Mining-Rand Mines administration several advances in underground practice were made during the past year. For example, in the City Deep the pumping position was strengthened, the ventilation system improved, marked progress was made in connexion with the sharpening and efficiency of drill bits, and advantageous modifications were effected in resuing, with which system a low stoping width of 38 in. has been economically maintained under adverse conditions at great depth.

The Pongola Beds.—The Department of Mines and Industries has published an explanation of the Geological Survey's Sheet No. 68 (Piet Retief) by Dr. W. A. Humphrey and Dr. L. J. Krige. The area was surveyed by Dr. Humphrey in 1912, 1913, and 1914, before the beds in the Transvaal and Natal lying above the Dwyka tillite and below the Bushveld sandstone had been subdivided in a satisfactory way, which was accomplished before 1918 by Dr. Du Toit, who followed the Ecca and Beaufort beds from the Cape

Province through Natal and carried his work into the western portion of this area. Dr. Krige mapped an area around Piet Retief and a strip extending along the Swaziland border; he also studied the Pongola beds in selected traverses in order to obtain a complete succession from their base. The measurements showed that the beds have a very great thickness, and together with the more complete information about them gained in the country to the north, require their removal from the Swaziland system to form a system of their own.

BRISBANE

March 22.

Mount Isa Capital.—At a meeting of shareholders in Mount Isa Mines, Ltd., held in Sydney, lately, resolutions were carried empowering the directors to pay debenture interest at fixed rates of 6% and 8%. The chairman (Mr. W. McCrae) explained that, if the company took advantage of the 22½% reduction permitted under the Interest Reduction Act of New South Wales, lately passed, investors in England would mark down the value of the company's securities and look askance at any proposal for raising additional capital which it might need. Such extra capital, Mr. McCrae mentioned, is necessary for the extension that is being made of the smelting plant. Through the good offices of the American Smelting and Refining Company this additional capital had been arranged for, on condition that no reduction in the rate of interest was contemplated.

Home-Made Coke.—In the early stages of work at the Mount Isa Company's mines it was stated that, if practicable, all branches of ore treatment, including refining, would be carried out in Queensland, and it was generally expected that both coal and coke would be obtained from the Bowen State mine at Collinsville, a short distance south of Townsville. After an investigation of the possibilities of establishing an electrolytic refinery, with water power, in North Queensland, it was found that the refining could be more economically done in England, and a refinery was erected on the Thames, whither the Mount Isa lead-silver bullion is being shipped. The coal needed for Mount Isa has been drawn from the Bowen mine since production began in the middle of last year, and the supplies of this fuel now amount to over 2,000 tons a month. With regard to coke, tests made with the Collinsville coal have proved that it is quite suitable for coke making, but coke ovens have not yet been installed at the State mine, and up to the present the coke needed at Mount Isa has been obtained elsewhere, almost entirely from New South Wales. It is understood that cause of the delay in erecting these ovens was that the Government, before incurring the heavy expenditure involved (about £50,000), wished to conclude an agreement with the Mount Isa Company as to supplies which would be taken that would warrant the outlay. It is now learned that a suitable arrangement has been reached. Coke ovens are to be installed, and from 20,000 to 30,000 tons will be taken annually for the Mount Isa mines, as well as 5,000 tons a year for the Chillagoe State smelters, North Queensland. At present the only place where coke is manufactured in Queensland is at North Ipswich, where the output, which is consumed locally, has been very small.

Progress at Mount Isa.—The local warden reports that during February the first of the new sintering machines was installed and the smelter buildings were being extended for receiving the two other machines. Orders have been placed for the erection of the No. 3 blast furnace, which has been designed to meet the particular conditions at Mount Isa. Underground, on the Black Rock section, the seven glory-holes have been operated regularly. Preparations in the Black Rock section are complete for stoping the main lode at No. 3 level. Exploration is being extended south from No. 41 shaft to a point over G40 cross-cut on No. 4 level. At present G42 south drive is progressing in ore, the width of which is being determined by cross-cuts. In No. 4 level the sub-level on the main lode has reached the limits of the ore and the construction of chutes has been in progress. This section will soon be ready for stoping. On the foot-wall lode at G40 section the cross-cut has cut the lode and the pyritic ore overlying it. On the Rio Grande section drawing of the main lode south stope at No. 1 has been continued and stoping started on the middle lode stope. At the same time opening out has been begun in the hanging-wall stope. At the Nos. 2 and 4 levels development work has also been in progress. In the latter the No. 1 hanging-wall north stope was completed at the

end of the month. Development on the pyritic sub-level has been continued to the north, and G25 has been finished. The diamond drilling at Christalena No. 1 bore-hole has been finished, and the plant removed to a site 200 ft. further south, where drilling is now in progress.

Oil in Queensland.—Although just now there is practically no boring for oil in Queensland, the Commonwealth Geological Adviser (Dr. W. G. Woolnough) is very emphatic in his opinion that petroleum will yet be found in this State in payable quantities. He holds the view, however, that the immediate vicinity of Roma, where much money has been spent in the search for oil, is not the best area in which to continue the search. He considers that what oil has been found there has migrated from elsewhere, and favours for prospecting the region lying to the north-east of Roma, and expresses regret that one existing bore (the Roma Mooga), which is the most distant one north-easterly from Roma, has not been carried to bedrock, and where boring had to be discontinued for lack of funds. Dr. Woolnough also remarks that the indications are such as to convince him that ultimate success in prospecting for oil in Central Queensland is practically certain. The company owning the Mooga bore (the Australian Roma Oil, Ltd.) has just announced that steps are being taken to have this bore, which is down 3,530 ft., completed, and the territory to the east-north-east of that bore tested.

Cloncurry Copper Mining.—Notwithstanding that copper continues to be extremely low in price, there are indications of a revival of mining for that metal in the vast Cloncurry mineral belt of North Queensland. Of the three mines—Mount Oxide, Dobbyn, and Orphan, owned and let on tribute by the Mount Elliott Company—that closed down last October because the miners employed refused to accept a reduced wage—one is now being unwatered preparatory to restarting production, while negotiations also are in train for a resumption in the other two. These mines were the chief suppliers of copper ore to the Chillagoe State smelters from the Cloncurry district. Furthermore, at the privately owned Trekelano mine, a fairly large producer, where work had been suspended since last September owing to low market prices, operations have been resumed.

Australian Gold Yield.—In the production of gold in Australia there was an increase from 466,000 oz. in 1930 to 592,000 oz. in 1931. The principal contributions were 510,500 oz. from Western Australia, 42,500 oz from Victoria, 19,700 oz. from New South Wales, and 10,300 oz. from Queensland. It appears to be almost certain that a further increase will be recorded in 1932, and it would not be surprising if the yield for this year reached 700,000 oz.

Newnes Petrol.—For the first time in nine years petrol produced at Newnes, in New South Wales, was for sale at Lithgow, the nearest railway station. The Federal Shale Oil Development Committee, which has at present control at Newnes, reports that the demand for the petrol from Sydney and elsewhere exceeds the supply. Motorists who have used the spirit are reported to have declared that it was found to be exceptionally good. Proposals are now being made for the transfer of the Newnes' industry to private enterprise.

IPOH

April 14.

Depletion of Ore Reserves.—The very low value realizable for tin ore and the small return, if any, possible on capital invested in undertakings with estimated lives of under or about ten years bring into prominence the question whether it is better to continue to produce at a restricted rate barely covering costs or to shut down, arrange for the property to be for a time on a care and maintenance basis, and to group, but not to produce its quota, which, being grouped, can be produced by the most economical and suitable unit in the group. The decision in this case must depend on two things—(*a*) whether the arrangements for grouping provide sufficient income to cover maintenance and depreciation costs, and (b) whether ore reserves are actually being depleted by continuation of mining on the present restricted scale. If the circumstances are so fortunate that a large proportion, if not all, of the permitted quota can be won in process of development in profitable values—giving proceeds sufficient to cover a little more than working costs and depreciation—the result of carrying on would be to increase the available ore reserves, without net loss or capital outlay, and at the end of any year or even several years of such work the position of the undertaking would be very

materially strengthened to the extent of proved additional ore in sight. The very low costs of labour and supervision at the present time have to be taken into account against the low prices realized for ore won and sold. On the other hand, it is clearly unwise to exhaust limited ore reserves by continuing work under conditions that preclude profit or appreciation of value otherwise, and unless some special circumstances prevent such action, the most advantageous course is to group and close down, if suitable arrangements can be made to cover maintenance and depreciation costs.

Declared Stocks.—Arising out of certain instructions issued in Selanger, some concern was caused by what seemed a departure from the original announcement that on any mine a quantity of ore equal to the stock brought in and declared at the commencement of restriction (March 1, 1931) might be carried forward at the end of any quota period. On representations being made an assurance has been given that amendments to the rules under consideration would probably remove any cause for anxiety as to the interpretation of what is actually a very important provision.

Decentralization. — The proposals for what has been called a policy of decentralization were mentioned in a letter that appeared in the MAGAZINE for December, 1931. The effect of giving anything resembling local self-government to each of the States in the Federation would be to break up what has been a combination, generally well-administered for the common good of all its parts, into a number of more loosely-connected units in which local and even personal interests would acquire influence in ways not possible while the States are administered as one Federation. If one object is to lessen the differences in administrative methods between the Federated and the Unfederated States it appears that the method proposed would tend to lower efficiency in the better organized States of the Federation towards the lower standards in the less efficiently administered States outside the Federation. Another result of the proposed policy would be to remove the effective seat of government from its present central situation at Kuala Lumpur to the Island of Singapore—at the end of the Peninsula—and to a centre of population that has little in common, and small acquaintance, with the problems of government in the States of this peninsula. It may be thought that such considerations are of little practical consequence to the mining industry, but, on the contrary, such an important industry with widely distributed activities benefits greatly by having its administrative centre well placed for easy access and actually within one of the active mining fields, in daily contact with work in progress under a variety of conditions. Intimate and general knowledge of the facts is the best protection against the errors in policy that are apt to be initiated by well intentioned but inadequately informed persons in positions of temporary authority.

Malaria Prevention.—The Engineering Association of Malaya has an active branch in Perak, under whose auspices during recent years there have been many interesting and instructive gatherings of civil, mining, electrical, and mechanical engineers. A recent meeting in Ipoh had for its subject anti-malaria work and research especially in connexion with the construction of the East Coast Railway. Valuable contributions were made in the discussion that followed, and one feature of outstanding interest to miners was a record of observations in Kelantan showing that where drains or natural water channels cut formations rich in iron, such as the ferruginous schists so characteristic of that State and of other parts of Malaya, there were never any mosquito larvæ to be found.

VANCOUVER

April 9.

Lode-Gold in B.C.—A special bulletin has been published recently by the Department of Mines dealing with the lode-gold deposits of the province. The publication contains much useful information of a geological character, as well as details supplied by the several resident engineers of interesting mines and prospects. The purpose of this issue is explained in a prefatory note by the Provincial Mineralogist, who states that the potentialities for successful gold mining in the province are greater than has been generally recognized and it is believed that the compilation of all material information in one publication will stimulate the exploitation of latent gold resources. Three features of importance noted in the bulletin are the exhaustion of the Rossland mines in 1927, the approaching end of known reserves in

the Premier, and the rising of the Pioneer as a new star on the horizon, with promise of a splendid career.

Premier Gold.—Of particular interest at this time, in connexion with the summary of important happenings in the lode-gold mining industry previously reviewed, is the recent report of the vice-president of Premier Gold Mines, Ltd., in which it is stated that intensive effort has been devoted towards the establishment of further ore reserves, and during the past year an amount of 7,898 ft. of underground development work has been done, in addition to a large amount of diamond drilling. The result of this work was to open up some 127,000 tons of new ore. Ore reserves at the beginning of 1931 were estimated at around 367,000 tons, and are now given as 252,000 tons, or, but little more than one year's supply at the present scale of operations. On these figures considerable curtailment is indicated in 1933. A 33% reduction in the total earnings for 1931 was attributable largely to the falling off of silver production, approximately 1,000,000 oz. less than in 1930 being marketed, at reduced prices. The average grade of ore in reserve is given at about $8·70 per ton and operating costs have been reduced from $3·60 to $3·33 per ton. The company's engineers were active in examining a number of other properties, and exploratory work was carried out on some of these, but results were not sufficiently good, and the options were dropped. The report deals also with Prosperity and Porter Idaho silver mines, controlled by the company, where operations have been suspended under market price conditions which render the working of these remote properties uneconomic at the present time.

Bridge River.—With reports of a $90,000 output from the Pioneer for the month of March, and net earnings of $21,000 from the first month's operation of the Lorne, Bridge River continues to hold its position and promises to be the banner gold-producing area of the province. The new three-compartment shaft at the Pioneer is rapidly approaching its immediate objective of 1,625 ft. depth. Looking at this area as one characterized by conditions which stamp it as an individual goldfield, it would seem to be regrettable, in one sense, that there should be so much duplication of effort in its development. This point of view is particularly appropriate in regard to the undoubted advantages to be secured by utilization of the strategic advantage of the Lorne position for purposes of exploration. In this connexion it is to be remarked that development of the Pioneer mine has been confined almost exclusively to the one vein, and no more is known of outside possibilities than in the earliest days of its history. There are also the matters of water and power supply which might be more satisfactorily compassed under a single control. The greatest amount of credit is dut to the management of Pioneer Gold Mines, Ltd., for the way in which the mine has been brought along, from a mere prospect, to its present outstanding position with a minimum of expenditure. In the interests of the field as a whole, however, more might have been achieved by capitalizing development at an earlier stage and by eliminating conflicting interests in the control of natural facilities. Pioneer has a not too satisfactory hydro-electric power station on the south fork of Bridge River, while Lorne is considering another on the main fork.

Sheep Creek. — While the diversified character of the lode-gold deposits of the province is shown clearly in the several reports of the government engineers, it is a remarkable fact that, with the exception perhaps of the Nickel Plate mine at Hedley, the outstanding producers have been typical of conditions common to the areas in which they were located, in other words, production has been associated with goldfields of individual characteristics. Such a field is the Sheep Creek field, south of Nelson, in which, as described by J. F. Walker, of the Dominion Geological Survey, the gold deposits occur as fissure veins cutting quartzites, and schists, and varying in width from almost nothing to about 20 ft., the average being less than stoping width. The vein filling is quartz with crushed country rock and there has been much displacement. Pyrite and a little galena and sphalerite are sparsely distributed. Ore-shoots appear to be confined to the quartzites, the fissures being tight with little vein matter where they cut the schist. The mines of this area are the Yellowstone, the Queen, the Kootenay Belle, the Mother Lode, the Nugget, and the Reno. The last-named property has proved an exception to the general experience in regard to economic mineralization in the primary ore, below the zone of oxidation. Average values around $40·00 per ton, over stoping widths have been

encountered at a depth of over 600 ft. The development of this mine was prosecuted actively during the past year, driving, cross-cutting, and rising totalling 2,487 ft., with a further 2,455 ft. of diamond drilling. The grade of all ore mined during 1931, including a proportion of waste rock from development headings, was $18·87 in gold, the total recovery amounting to $201,570·10, and the monthly output was between $25,000 and $30,000 up to the time that the mill was destroyed by fire.

Ymir.—The Ymir camp, a few miles north of the Sheep Creek area, is also characterized by special features and was prominent about 30 years ago in relation to the operation of the old Ymir mine. In this field quartz-filled fissures, carrying auriferous pyrite associated with galena and blende, cut diagonally across the Pend d'Oreille formation which is intruded by tongues of the Nelson granite. Within this area, in addition to the Ymir, are the Goodenough, on which some interesting discoveries have been made recently, the Yankee Girl, where gold values are found to be definitely associated with galena and ore-shoots are confined to the granite tongues, the Ymir Wilcox, Dundee, and Blackrock properties. This camp is likely to receive a good deal of attention during the campaign of intensive search for new gold mines that will be a feature of the coming season.

TORONTO

April 18.

Porcupine.—The output of bullion in this area during March showed a substantial increase over that of the preceding month, amounting to $1,822,986, from the treatment of 259,218 tons of ore, as compared with $1,676,673 from 258,987 during February. The annual report of the Dome Mines, Ltd., for 1931, showed a profit for the year of $1,690,825, before deductions for depreciation and depletion. Dividends paid for the year amounted to $953,334, leaving a net surplus of $37,490, bringing the surplus account up to $2,202,808. The ore reserves were estimated at 1,920,000 tons. Production during March amounted to $319,052, as compared with $319,057 in February. Hollinger Consolidated, which is now treating about 5,000 tons of ore a day, is preparing to increase production by advancing the rate to 5,500 tons daily. Recent development is stated to have disclosed some improvement in ore-bodies, but official information is lacking. The company has recently secured a group of claims in the Pascalis district of north-western Quebec, on which diamond drilling will be started immediately. The damage to the generator of the plant at the McIntyre Porcupine has been repaired, and the mill is now operating at its rated capacity of 2,000 tons per day, and production is understood to have reached its former high level. Development of the Platt-Vet section is progressing satisfactorily. The Vipond Consolidated during the first three months of the year produced bullion to the value of $120,017 from the treatment of 25,604 tons of ore, with a recovery of $4·69 per ton. There was a marked decrease in the grade of ore going to the mill, as compared with the previous quarter, when the recovery from 24,935 tons of ore was $5·43 per ton, and with the quarter ending March, 1931, when the recovery from 25,672 tons of ore was $7·13 per ton. The Porcupine-United is preparing to reopen its property adjoining the Hollinger.

Kirkland Lake.—Production of the Kirkland Lake gold mines during March was valued at $1,897,517 from 152,445 tons of ore, as compared with $1,817,887 in February, when 141,026 tons was milled. The mill of the Wright-Hargreaves is handling slightly more than 800 tons of ore per day, with an average recovery of about $12 per ton. Special attention is being given to the opening up of the lower workings. The bottom level at 3,000 ft. is stated to be proving up very well, some values produced being well above the mine average. The average for the level is understood to be between $12 and $15 in gold per ton. Diamond drilling is being actively carried on to prove up the downward extension of the ore zone. At the Teck-Hughes deeper mining is meeting with encouraging results. It is the intention of the management to continue its deep development programme and plans call for the opening up of five new levels below the 34th before the end of this year. The management of the Sylvanite are pushing operations at depth, as they expect better values from 2,500 to 3,000 ft. than are obtained on the levels above. Cross-cutting is now proceeding on the new 3,000-ft. level. Diamond drill results indicate a high-grade ore zone at 3,000 ft., about 200 ft. in from the main shaft, and it is towards this strike that work is being pushed. Lateral work is also in progress on the 2,500-ft. horizon. The

Bidgood has opened up an ore-body 5 ft. in width on the 500-ft. level, which yields high assays. On the north drive, where rising is being done, values average $21.20. Recent financing will enable the company to continue operations without interruption. The development programme of the Macassa is making steady progress. The drive from the Kirkland Lake gold mine at 2,500 ft. has opened up some good mineral sections and some high gold values are reported, but no official information is forthcoming. A new company has been organized to take over the property of the Telluride Gold Mines, which went into liquidation, and operations will be resumed. At the Kirkland Lake gold mine a diamond drill-hole put down to a depth of 215 ft. below the bottom level at 4,750 ft. is said to have passed through a good stretch of mineralization, from which assays of $10 per ton were obtained. It is not the intention, however, to develop the ground below the 4,750-ft. level at this time. Work will be centred on opening up the lower horizons, from which a large part of the ore is drawn for mill feed. Mill heads are holding around $12 per ton.

Other Ontario Gold Areas.—In the Matachewan field the Mining Corporation of Canada has begun the erection of a 150-ton mill on its Ashley property, with a view of beginning production in the autumn. A supply of electric power has now been obtained, enabling development work to be actively carried on. The Matachewan Premier Mining Syndicate has been organized and has secured 32 mining claims. It will carry out an intensive campaign of development. The Parkhill mine in the Michipicoten field is steadily maintaining production. Shaft sinking has been suspended at the fourth level, where the vein, on being opened up, shows higher values than at the surface. At the Minto, in the same area, the mill is being supplied in ore from the first level, the rest of the workings being under water. Production, it is stated, now averages $1,000 a day. The Howey, in Patricia district, according to an official estimate, produced gold during the first quarter of the year to the value of a new high record. A deep development programme is being carried out. A winze has been started from the 1,000-ft. level, its objective being a depth of 1,750 ft. Metals Development, Ltd., has resumed work on its property in the Clearwater Lake section of the Patricia district, and the shaft will be sunk to 500 ft.

Sudbury.—With no increase indicated in the demand for nickel products, and with the curtailment of copper output to 20% of capacity, the International Nickel Company has found it necessary to make a further temporary reduction in operations. The Falconbridge Nickel has recently made substantial sales of nickel to American consumers, which, together with previous contracts, will keep the mill busy for some time to come.

North-Western Quebec.—The Noranda continues to increase its gold output in order to offset the loss entailed by the curtailment of copper production. It is understood that the present rate of production of gold is approximately $7,000,000. The Waite-Montgomery copper mine has been closed down indefinitely, being unable to continue production profitably at the present low price of the metal. The Granada, having obtained electric power, is speeding up development, and has encountered good gold values in the lower workings. Production in March reached the value of about $39,000. The Siscoe gold mine, during the quarter ended March, produced $281,746, from the treatment of 15,560 tons, the recovery being $18·10 per ton.

Manitoba.—The annual report of the Sherritt-Gordon Mines, Limited, shows gross income from metal production of $1,316,253 against operating costs of $1,042,744, leaving an operating profit for the year of $273,509. After all deductions there remained a surplus of $4,843. For the operating period, the mine produced 14,718,387 lb. of copper and $134,304 of gold and silver from 211,081 tons of ore. The average cost per lb. of electrolytic power produced during the year was 6·275 cents, and only 5·946 cents per lb. in December. The annual report of the Hudson Bay Mining and Smelting Company for 1931 showed income from sales of metal of $5,101,312, and income from other sources of $258,508, making a total of $5,659,820. The net operating profit was $962,701, and deduction of $1,264,646 for depreciation left a deficit of $301,946. There was mined and delivered to the concentrator during the year 390,693 tons of ore assaying 0·120 oz. gold, 1·30 oz. silver, 2·19% copper and 4·4% zinc. From the open pit was mined 706,564 tons of ore. At the Central Manitoba gold mine a new ore-body of commercial grade has been disclosed in a drive where the ore was supposed to have petered out. Officials state

that there is more ore now in sight than ever before, and mill heads are running $14 to the ton. The mill at the San Antonio has been completed, and underground development has been resumed.

Great Bear Lake Area.—Great interest is being manifested in the discoveries of radium and silver in the Great Bear Lake mining field, where many companies are preparing to operate during the coming season, some having already sent in working crews and supplies. Airplanes are being extensively employed for transport. The companies which have already sent in crews of men include the Contact Mining Company, Ltd., Great Bear Development Company, Great Bear Lake Mines, Ltd., and Eldorado Gold Mines. The Eldorado Gold Mines, on whose property pitchblende deposits have been proved to occur in commercial quantities, will take in a mining plant this summer to open up the main zones underground and will make shipments of radium-bearing ores this summer to be treated at the refinery which will be established in Ontario. The location of the plant has not yet been determined, one important consideration in the selection of a site being the availability of the chemicals required in the refining process.

Ontario Radium Mine.—Canada Radium Mines, Ltd., holding 750 acres near Wilberforce, Ont., proposes to start work soon on a generally enlarged programme of development. A large amount of surface work has been done, and the shaft put down to a depth of 30 ft.

Mineral Production.—A report of the Dominion Bureau of Statistics gives the value of the total mineral production of Canada for the year 1931 at $227,456,365, a decline of nearly 19% as compared with the output of the previous year. The decline, however, was due to the decrease in prices rather than a falling-off in the volume of production. The large increase in gold output, from $43,453,601 in 1930 to $55,715,120 in 1931, was the outstanding feature. Refined copper exports were greater than in 1930, and silver, lead, and zinc were lower, due to falling-off in demand and low prices. Crude petroleum production showed a slight increase. Coal output was lower in all provinces except Saskatchewan, and asbestos sales dropped 42%. During the year the value of the metals produced showed a decline of 17%.

PERSONAL

W. Baddeley Adams is returning from Abyssinia.
Reginald F. Allen has left for Colombia.
John Brass has been elected president of the Institution of Mining Engineers, in succession to the late Professor R. W. Dron.
Walter Broadbridge has left for the Gold Coast.
J. M. Callow is returning from the United States.
E. E. Campbell is leaving Toronto for New York.
P. J. Crowle is here from India.
George S. Dyer has left California for Alaska.
J. K. L. Graham is home from Siam.
T. C. F. Hall has left for Korea.
G. F. Hatch has returned to Yugoslavia.
J. A. L. Henderson has left for Canada.
C. B. Kingston is home from Rhodesia.
C. F. Lloyd-Jones is now in Palestine.
Robert A. Mackay is returning from Panama.
P. R. McCarthy is returning from Nigeria.
H. R. Mitchell is returning from Nigeria.
John H. Morris is returning from Spanish Morocco.
J. W. Park has left for the Gold Coast.
J. S. Penberthy is now in West Africa.
Charles Pengilly is returning from India.
A Eric Pleming has left for the Gold Coast.
J. D. Pollett is returning from Sierra Leone.
Frank B. Powell has left for the Gold Coast.
R. W. Scott has left for the Gold Coast.
W. J. Sevier is returning from West Africa.
R. O. Simon has left for the Gold Coast.
William Thomas is returning from India.
J. C. Vivian is returning from Panama.
Charles H. White is here from France.
T. Williams is returning from India.

Robert Wilson Dron, professor of mining in Glasgow University since 1923, died on April 23 at the age of 63. Professor Dron, who was a Member of the Institution of Civil Engineers, was this year's president of the Institution of Mining Engineers. After holding appointments in several collieries in Scotland, he began a consulting practice in Glasgow in 1893 and was called upon to report on properties in America, Canada, Germany, France, Russia, Spain, and Spitzbergen.

TRADE PARAGRAPHS

Diamond Drill Carbon Co., Ltd., advise a change of address to River Plate House, Finsbury Circus, E.C. 2.

Lead Industries Association, of 420, Lexington Avenue, New York, U.S.A., issue a brochure full of interesting illustrations and describing the manufacture and principal uses of lead pipe.

British Standards Institution, of 28, Victoria Street, London, S.W. 1, issue brief details of a new British Standard for braided cables with copper conductors for overhead transmission lines, which, while seldom used in this country, are much used in the colonies.

Thomas Murby and Co., of 1, Fleet Lane, Ludgate Circus, London, E.C. 4, publish a catalogue of books on geology and related subjects. These include those on regional geology, palæontology, crystallography, mineralogy, petrology, etc., and an index of authors is included.

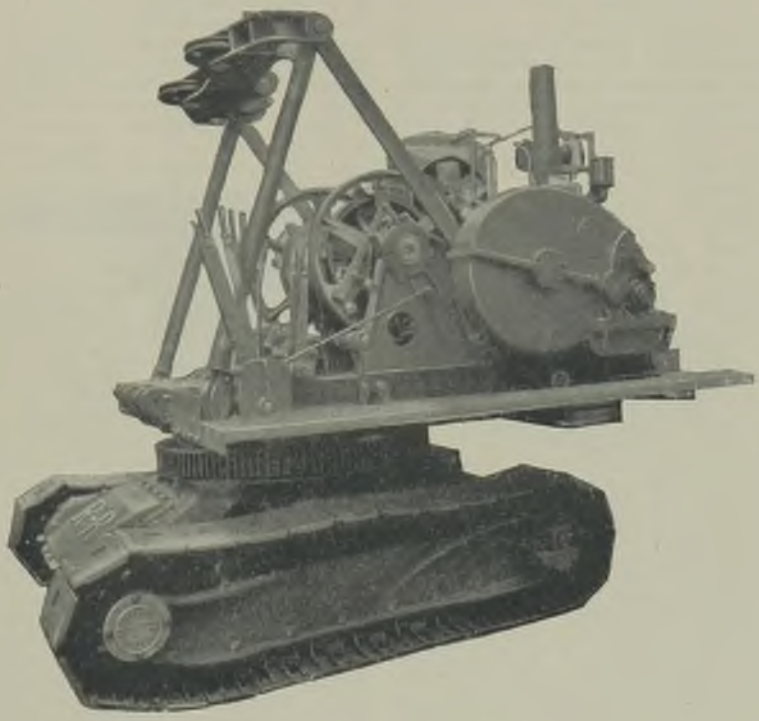
Samuel Osborn and Co., Ltd., of Clyde Steel Works, Sheffield, issue a leaflet drawing attention

to their self-tempering nickel steel and, what is of more interest to mining men, their forged steel pins for dredgers in nickel-chromium-molybdenum steel, as supplied largely to the Federated Malay States.

Hans Renold, Ltd., of Didsbury, Manchester, and the **Coventry Chain Co., Ltd.,** of Coventry, which for some time past have been working in close association with one another, have now definitely combined to form the **Renold and Coventry Chain Company, Ltd.,** which will continue to conduct business from the same addresses as the former companies.

and Engineering Year Book and the Rhodesian Mining and Engineering Year Book. These publications cover respectively 356 and 132 pages of useful information about South African and Rhodesian mines and mining companies and are fully illustrated and contain also maps and plans.

Ransomes and Rapier, Ltd., of Waterside Iron Works, Ipswich, have published a catalogue fully descriptive of their new Type 430 ¾-cu. yd. universal excavators, which are as usual convertible for use as shovels, draglines, grabs, trenchers, skimmer-scoops, or cranes. Like the ½-yard machine, this is driven from the Diesel or petrol



Ransomes and Rapier ¾ cu. yd. Excavator.

Petters, Ltd., of Westland Works, Yeovil, have published a booklet describing their oil-engine-driven small pumping plants for various purposes. These include horizontal double-acting pumps, deep-well pumps, centrifugal pumps, and diaphragm pumps. Petter pumping plants are also manufactured for heavy duties with engines up to 400 b.h.p.

British Aluminium Co., Ltd., of Adelaide House, King William Street, London, E.C. 4, issue the rules governing the aluminium competition, 1932, which is similar to previous competitions of this character and aims at encouraging the development of the industry, prizes being offered for the best suggestion dealing with the construction of new apparatus or improved applications of the metal or its alloys.

Argus South African Newspapers, Ltd., of 72–78, Fleet Street, London, E.C. 4., publish the 1932 editions of the South African Mining

engine power unit direct through gears, except that a Morse inverted tooth chain is included in the transmission of the new machine. The main driving shaft is carried on ball bearings. The reversing plate clutches are similar to those on the ½-yard machine, although a feature which distinguishes the 430 is that it is possible to steer the machine in any position of the cab. The machine has a cast-steel frame with crawler beams cast integrally and multiple rollers, as usual. As will be seen from the illustration the arrangement of the operating mechanism on the upper frame is such that it is entirely situated behind the centre post, or king post as it is sometimes called, thus giving greater stability. When the machine is equipped as a shovel it is fitted with a rope crowding motion and the inside type of bucket handle or dipper stick is adopted as on larger models. A distinguishing feature here is the mechanical tripper method for rapid dumping. This is achieved

by means of a short rope which is wound on a drum, clutch operated from the main shaft.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, have published a catalogue of sand and gravel plant washing equipment. This contains essential details of all crushers, screens, and washing plant required in a modern gravel pit. Details are also included of the Newhouse crusher, which is one of the gyratory type and is made under licence from Allis-Chalmers, and also the Stag centrifugal pump, to which attention was drawn in these columns in our February issue.

Mancha Storage Battery Locomotive Co., of 1909, South Kings Highway, St. Louis, U.S.A., has sold its business, goodwill, and a portion of its assets to the **Goodman Manufacturing Co.,** of Chicago. For the time being business will be conducted at the present address, but eventually it will be moved to Chicago. It will, however, continue to operate independently under the same name as before, the construction and designs being followed in the future as in the past for all types of mine and tunnelling haulage.

Hadfields, Ltd., of Sheffield, issue a copy of the chairman's speech at the recent annual general meeting of the company. As in previous years Sir Robert Hadfield makes a comprehensive review of his firm's operations and also of world affairs in general during the period. Under the heading of the firm's achievements in the year he referred to the part they had played in the Sydney Harbour Bridge—namely, the contract for the supply of manganese steel rails with which the railway is equipped, 14½ miles of rails being involved.

Greenwood and Batley, Ltd., of Albion Works, Leeds, have issued a catalogue describing their electric trucks, tractors, and locomotives. The last mentioned are more particularly interesting and are electric battery engines. Particulars are given of two standard sizes, respectively for duties of 15 tons and 20 tons. In each case the totally enclosed traction type driving motor is capable of developing 200% overloads for short periods. Particulars of their mining locomotives will be dealt with in a brochure, which is being prepared, at a later date.

Nor-Rust Liquid Lead Co., Ltd., of Iddesleigh House, Caxton Street, London, S.W. 1, state that the success attending the introduction of their liquified lead (Nust) has encouraged progress in manufacture, which has resulted in the production of a very fine metallic pigment that increases the rate of formation of a metallic coating impervious to corrosion and has the further advantage that the pigment is in complete suspension in the required proportion of the conveyer medium. A ready-mixed product in special containers with air-tight lids is now on the market.

Mining and Industrial Equipment, Ltd., 11, Southampton Row, London, W.C.1, report having received the following orders: For England: One 100 sq. ft. Rovac filter for caustic electrolyte, one 100 sq. ft. Rovac filter for caustic lime sludge, one 300 sq. ft. Rovac filter for coal slurry, one Spitzkasten for paper pulp thickening, one 18 in. Andrews deslimer for a pilot plant, six 4 ft. by 8 ft., one surface, type 60, Hum-mer screens for coal, and one 3 ft. Raymond separating plant for silica dust. For France: One No. 00 Raymond pulverizer for iron oxide. For Sweden: One No. 0000 Raymond pulverizer for coal. For Italy: One 3-roller "Baby" Raymond mill for talc.

Mavor and Coulson Joy Loader.

J. Pohlig, A.G., of Cologne, Germany, represented by **C. M. Hill and Co.,** of Coventry House, South Place, London, E.C.2., have just published three catalogues very fully illustrated and describing respectively their mechanical handling plant, printed in English, their monocable aerial ropeways, printed in four languages, and bicable aerial ropeways, printed in German. The booklet relating to the mechanical handling plant deals with gantry systems, various types of grabs suitable for handling coal and ore, and conveyors. The monocable ropeway catalogue sets forth the advantage of this particular type, notably its simple construction, low weight of the structural parts, and the consequent cheap initial cost. If high capacity is required and distances are very long there is a limit to the use of monocable ropeways and bicables would be used with advantage.

Mavor and Coulson, Ltd., of 47, Broad Street, Glasgow, S.E., announce co-operation between themselves and the **Joy Manufacturing Co.,** of America, for the manufacture and sale of the Joy loader. This machine, which is widely known in the United States and is suitable for a variety of ore-handling and transporting operations, consists essentially of three parts—the front conveyor, which includes a gathering mechanism, the rear conveyor, which is a continuation of the above and can be swung from side to side or raised or lowered, and the self-propelling caterpillar chassis. The loader is fed forward into the ore pile and the two gathering arms, already referred to, working

alternately, then sweep it on to the conveyor, which is of the scraper chain type. One centre drive chain runs over both front and rear conveyors, which are joined together by a flexible connexion. The special steel conveyor trough is 21 in. wide and the conveyor chain is driven through a multiple disc clutch, which protects the gathering arms from severe overload. The caterpillar mount, for which may be substituted an ordinary wheel mount if required, is equipped for ten speeds, eight forward and two reverse. The drive is either electric or compressed air, the motor running at full speed in one direction all the time, and the controls are close together near the centre of the loader under the hand of one man. Some idea of its capacity may be gathered from the fact that it is guaranteed to load 1½ ton of loose coal in one minute. The firm also issue some notes with regard to Ritchie joints for shaker conveyor troughing, by means of which considerable reduction in the cost of shaker conveyors can be made.

Holman Bros., Ltd., of Camborne, Cornwall, have recently prepared a brochure covering some 25 odd pages presenting a review of 1931 as it affects their operations. This commences with some notes about the works themselves and goes on to various exhibitions at which the firm has been represented. The development of certain rock-drills and drill-sharpeners is reviewed and some attention is also given to H.S.B. air-compressors, as also to Diesel-driven compressors. James tables and screens and the scraper loading department receive separate attention and there is a section also devoted to European tunnelling records giving some information about those effected with Holman drills in Westmorland. The Witwatersrand rock-drill census is also alluded to, since it shows the firm's leading position in this market. An interesting section draws attention to the use of rock-drills in dredging—as a means of clearing the limestone pinnacles away in advance of the dredge.

METAL MARKETS

Copper.—The copper market kept fairly steady on balance during April. Demand was universally quiet and Copper Exporters Inc., who towards the end of the month were quoting electrolytic at 6 cents c.i.f., found that outside sellers were shading this price. Producers believe that their latest curtailment measures will reduce output to below current consumption, thereby permitting stocks to be reduced, but it will be difficult to take a really optimistic view of the market until the world economic situation is rehabilitated.

Average price of Cash Standard Copper : April, 1932, £29 19s. 10d. ; March, 1932, £33 1s. 9d. ; April, 1931, £42 14s. 8d. ; March, 1931, £44 17s. 2d.

Tin.—The market underwent violent fluctuations during the past month and, quite early, panicky liquidation and forced selling pushed prices down until at one time Cash sold at £100. Subsequently prices recovered strongly, aided by support and by expectations of further drastic measures to be taken by producers. It has indeed now been decided to reduce the annual rate of world output by a further 20,000 tons with effect from June 1. In view of the extremely disappointing trend of consumption, sceptics are not lacking, however, who doubt whether even this will be adequate to ensure an early substantial reduction in world visible supplies in sight, which, incidentally, increased by about 400 tons during April.

Average price of Cash Standard Tin : April, 1932, £109 0s. 10d. ; March, 1932, £129 18s. 2d. ; April, 1931, £112 16s. 9d. ; March, 1931, £121 18s. 4d.

Lead.—Prices have fluctuated during the past few weeks, but, following weakness at the beginning of April, the tendency has been rather better on the whole. World stocks remain excessive and consuming demand, although it has shown an occasionally better tone, is still subnormal. Output in the United States is to be cut down further during the summer. Like other commodities, lead will probably have to await the advent of better world economic conditions before it can become a definitely healthier market.

Average mean price of soft foreign lead : April, 1932, £11 7s. 3d. ; March, 1932, £12 9s. 9d. ; April, 1931, £12 9s. 9d. ; March, 1931, £13 4s. 9d.

Spelter.—The London market has been firmer, sentiment having been doubtless encouraged by the announcements regarding the gradual diminution in the stocks held by the International Zinc Cartel. Demand from consumers here has been quite good at times, and London prices have also been assisted by the weakness in sterling witnessed during April. On the other hand, neither Continental nor American users are taking much interest and it is somewhat significant that the American quotation fell from 2·80 cents to 2·57½ cents per lb. despite the advance seen in London. A proposal is afoot that producers should initiate a still more drastic cut in output.

Average mean price of spelter : April, 1932, £11 16s. 3d. ; March, 1932, £12 16s. 4d. ; April, 1931, £11 11s. 10d. ; March, 1931, £12 8s. 7d.

Iron and Steel.—The chief event of April was, of course, the raising of the import duties on foreign material to 33⅓%. This ought to assist the British steelworks eventually, but at present trading conditions are so subdued that signs of the expected revival are slow to manifest themselves. Pig-iron is exempt from the increased duty, but in any case such duty would not exclude the British furnaces' most serious competitor, which is India. Cleveland pig-iron has remained at 58s. 6d. per ton minimum, with specially low prices quoted for Scotland. The British steelworks continue to be rather short of orders. On the Continent the disastrous price-war amongst the mills there has continued although some export markets have shown a little more interest.

Iron Ore.—Although the increased duties announced on imported steel should help makers here, most of them are well booked as regards iron ore and have done little fresh buying. Prices stand at about 15s. 6d. per ton c.i.f. for best Bilbao rubio.

Antimony.—At the close of April, English regulus was quoted at £35 to £42 10s. Demand was dull, not was there much interest taken in Chinese regulus, for which £18 15s. c.i.f. was quoted for shipment and £25 ex warehouse for spot.

Arsenic.—Cornish white is nominal at around £24 10s. to £25 per ton f.o.r. mines, Mexican high-grade being held for about £22 5s. to £22 10s. c.i.f.

Bismuth.—A quiet business continues at the official price of 4s. 6d. per lb. for 5 cwt. lots and over.

LONDON DAILY METAL PRICES.

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard		Electro-lytic.	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	For-ward.	
Apr.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
12	29 6 3	29 11 3	34 5 0	32 10 0	102 7 6	104 12 6	11 0 0	11 0 0	13 0 0	16 3/8	16 1/2	109 2
13	29 8 9	29 13 9	34 5 0	—	103 10 0	105 12 6	11 2 6	11 0 0	13 0 0	16 5/8	16 11/16	109 5
14	29 9 4 1/2	29 15 7 1/2	34 5 0	—	103 17 6	106 1 3	11 8 9	11 6 3	13 5 0	16 1/2	16 9/16	109 7
15	30 8 9	30 14 4 1/2	35 0 0	33 10 0	105 1 3	107 1 3	11 17 6	11 8 9	13 5 0	16 11/16	16 3/4	109 9
18	30 11 10 1/2	30 18 9	35 15 0	—	106 2 6	108 2 6	12 6 3	11 11 3	13 10 0	16 11/16	16 3/4	109 9
19	29 16 3	30 3 1 1/2	35 0 0	33 10 0	106 8 9	108 13 9	12 5 0	11 6 3	13 10 0	16 9/16	16 5/8	109 3
20	29 12 6	30 1 3	34 10 0	—	108 8 9	110 8 9	12 7 6	11 6 3	13 10 0	16 1/2	16 11/16	110 0
21	30 6 3	30 13 9	35 5 0	—	115 1 3	117 6 3	12 8 9	11 10 0	13 10 0	16 11/16	16 3/4	109 11
22	30 1 3	30 8 9	35 5 0	33 10 0	112 2 6	114 2 6	12 17 6	11 17 6	13 15 0	17	17 1/16	110 6
25	30 12 6	30 18 9	35 5 0	—	117 7 6	119 12 6	12 11 3	11 16 3	13 15 0	17	17 1/16	110 10
26	30 10 0	30 13 9	35 10 0	33 10 0	116 7 6	118 7 6	12 11 3	11 15 0	13 15 0	17	17 1/16	113 3
27	30 6 3	30 8 9	35 0 0	—	114 12 6	116 13 9	12 10 0	11 12 6	13 10 0	17 1/16	17 1/8	113 5
28	30 1 10 1/2	30 4 4 1/2	35 0 0	—	113 17 6	115 18 9	12 2 6	11 5 0	13 5 0	16 7/8	17	112 8
29	30 1 10 1/2	30 0 7 1/2	35 0 0	33 0 0	112 10 0	114 17 6	12 1 3	11 5 0	13 5 0	16 15/16	17 1/16	113 4
May												
2	29 16 3	29 13 9	34 15 0	—	114 8 9	116 11 3	12 5 0	11 8 9	13 5 0	16 11/16	16 13/16	112 9
3	30 10 0	30 3 9	34 15 0	33 0 0	120 13 9	122 17 6	12 15 0	11 15 0	13 15 0	16 9/16	16 11/16	113 1
4	30 5 0	30 0 7 1/2	34 10 0	—	126 2 6	128 7 6	13 0 0	11 13 9	13 15 0	16 1/2	16 5/8	112 6
5	30 6 3	30 1 3	34 10 0	—	129 7 6	131 12 6	13 0 0	11 10 0	13 10 0	16 11/16	16 13/16	112 9
6	29 13 1 1/2	29 15 0	34 10 0	33 0 0	129 12 6	131 17 6	12 18 9	11 7 6	13 10 0	16 9/16	16 11/16	112 8
9	29 13 9	29 16 10 1/2	34 10 0	—	124 15 0	127 0 0	12 16 3	11 1 3	13 0 0	16 1/2	16 11/16	112 8
10	29 8 9	29 11 3	34 5 0	33 0 0	120 2 6	122 1 3	12 10 0	10 16 3	12 15 0	17	17 1/16	112 9

Cadmium.—There has not been much business moving recently, but prices keep fairly steady at about 2s. 2d. per lb.

Cobalt.—After meeting with considerable outside competition, the official price was reduced to 8s. per lb. Demand generally, however, is not large.

Cobalt Oxides. — Easier conditions have prevailed in these markets, black oxide now being obtainable at about 4s. 3d. per lb. and grey at 5s. to 5s. 2d.

Chromium.—About 3s. per lb. is named for carbon-free metal.

Tantalum.—Quieter conditions have ruled in this market lately, and prices are if anything rather easier at about £25 per lb.

Platinum.—Demand is trifling, but, owing to the easiness in sterling, prices have risen to £10 6s. to £10 11s. per oz. for refined metal.

Palladium.—There is hardly anything moving and prices are easier at about £4 5s. to £4 15s. per oz.

Iridium.—The market is idle, but prices have not moved appreciably, sponge and powder being quoted at about £16 10s. to £18 10s. per oz.

Osmium.—Quotations are rather easier owing to the lack of demand at about £14 to £15 per oz.

Tellurium.—Business is at a standstill and quotations are quite nominal at about 10s. per lb. (gold.).

Selenium.—A quietly steady demand is reported for high grade black powder at 7s. 8d. to 7s. 9d. per lb. (gold).

Manganese Ore. — Generally speaking the market has been devoid of interesting features, new business being to all intents and purposes at a standstill. Best Indian stands at about 9d. to 9½d. per unit c.i.f. and good 48% Indian and washed Caucasian at about 8½d. to 9d. c.i.f.

Aluminium.—In common with most other metals demand during the past month has been rather slow, but so far no change in prices has been seen, £95 less 2% delivered being quoted for ingots and bars for the home trade, and £80 (gold) per metric ton, for export.

Sulphate of Copper.—Once again the tone of this market has been easier, British material now being quoted at about £17 15s. to £18 5s. per ton, less 5%.

Nickel.—Demand has been very moderate, but with the easiness in sterling quotations have been advanced to £225 to £230 per ton, according to quantity.

Chrome Ore.—Leading interests are keeping prices very steady, but business is at a low ebb. Good 48% Rhodesian ore stands at about 80s. to 85s. per ton c.i.f. and 55 to 57% New Caledonian at about 100s. to 110s. c.i.f.

Quicksilver.—The policy of the principal producers of keeping prices at an uneconomic level has led to the influx of outside supplies and with very little business passing prices have declined to about £16 10s. per bottle, net, for spot metal.

Tungsten Ore.—Buying interest seems to have become completely suspended, and China has been offering forward shipment at about 12s. per unit c.i.f. without attracting any demand.

Molybdenum Ore.—The market is steady but rather quiet at about 37s. 6d. to 39s. per unit c.i.f. for 80 to 85% concentrates.

Graphite.—In the absence of any appreciable demand quotations are nominally unchanged at about £16 to £18 per ton c.i.f. for 85 to 90% raw Madagascar flake, and £17 to £19 c.i.f. for 90% Ceylon lumps.

Silver.—After standing at 17 7/16d. for spot bars on April 1 prices had an easier tendency early in April, selling by India and other stale bulls not being adequately offset by the limited demand in evidence from China. On April 14 spot bars touched 16½d., but, subsequently, with some Continental enquiry and stronger Chinese buying, an improvement was seen, spot bars advancing to 17 3/8d. on April 27. Towards the end of the month, however, America was more inclined to sell and on April 30 spot bars closed at 16¾d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
April, 1931	840,259	42,078	882,337
May	867,949	42,330	910,279
June	855,073	42,677	897,750
July	872,198	44,645	916,843
August	870,822	45,603	916,425
September	872,053	43,971	916,024
October	900,353	44,760	945,113
November	855,102	45,408	900,510
December	877,178	46,175	923,353
January, 1932	890,688	46,096	936,784
February	869,711	44,301	914,012
March	914,017	46,018	960,035
April	901,894	47,902	949,796

TRANSVAAL GOLD OUTPUTS.

	March.		April.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	104,000	£160,922	101,000	£154,334
City Deep	83,000	21,486	83,000	21,282
Cons. Main Reef	67,500	22,804	70,300	23,068
Crown Mines	275,000	85,031	274,000	84,251
Daggafontein	36,000	£59,014	38,000	£60,269
D'rb'n Roodepoort Deep	49,500	16,133	48,500	15,656
East Geduld	56,000	17,265	57,300	17,791
East Rand P.M.	158,000	41,854	157,000	41,786
Geduld	85,300	26,923	84,000	26,895
Geldenhuis Deep	75,000	17,481	64,000	15,076
Glynn's Lydenburg	6,690	2,572	6,500	2,569
Government G.M. Areas	208,000	£46,678	207,000	£405,903
Kleinfontein	50,200	10,060	50,400	9,852
Langlaagte Estate	80,000	£112,415	79,000	£110,656
Luipaard's Vlei	33,500	8,377	34,000	8,504
Meyer and Charlton	18,200	£17,804	17,200	£17,482
Modderfontein New	167,000	66,336	167,000	65,579
Modderfontein B	76,000	21,495	75,000	21,092
Modderfontein Deep	44,800	21,715	44,500	21,574
Modderfontein East	73,500	21,549	73,500	21,580
New State Areas	87,000	£180,742	87,000	£179,810
Nourse	70,000	21,014	70,000	20,774
Randfontein	240,000	£283,485	240,000	£283,357
Robinson Deep	95,500	28,169	93,000	27,106
Rose Deep	62,500	12,986	62,000	12,756
Simmer and Jack	78,900	21,826	78,400	21,528
Springs	68,800	£160,554	74,000	£159,696
Sub Nigel	37,000	31,867	35,800	31,616
Transvaal G.M. Estates	18,300	5,175	18,500	4,963
Van Ryn	49,000	£43,163	49,000	£43,473
Van Ryn Deep	67,000	£92,421	69,000	£91,056
West Rand Consolidated	95,000	£107,723	93,000	£104,186
West Springs	77,000	£81,584	74,500	£80,335
Witw'tersr'nd (Knights)	66,000	£55,684	64,000	£53,690
Witwatersrand Deep	42,200	14,417	43,500	13,368

Values in S.A. currency.

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.	£
January, 1931	2,721,316	28 3	19 8	8 7	1,171,456
February	2,481,600	28 6	20 1	8 5	1,045,980
March	2,718,400	28 2	19 9	8 5	1,151,017
April	2,592,800	28 7	20 1	8 6	1,105,711
May	2,751,400	27 10	19 6	8 4	1,149,105
June	2,698,100	28 0	19 7	8 5	1,140,399
July	2,771,400	27 10	19 6	8 4	1,155,466
August	2,799,800	27 10	19 5	8 5	1,159,382
September	2,765,400	27 10	19 5	8 5	1,162,355
October	2,870,800	27 8	19 3	8 5	1,210,743
November	2,726,720	27 10	19 5	8 5	1,144,208
December	2,793,900	27 10	19 5	8 5	1,173,732
January, 1932	2,880,500	27 5	19 4	8 1	1,163,434
February	2,775,400	27 8	19 6	8 2	1,133,212
March	—	—	19 9	—	1,200,278

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
April 30, 1931	206,770	13,242	4,030	224,042
May 31	207,109	13,305	3,689	224,103
June 30	207,209	13,286	3,345	223,840
July 31	208,155	13,512	1,817	223,484
August 31	209,409	13,563	1,705	224,677
September 30	209,424	13,276	1,626	224,326
October 31	208,987	13,061	1,517	223,565
November 30	209,270	12,882	1,429	223,581
December 31	211,552	12,260	1,402	225,214
January 31, 1932	215,752	12,394	1,598	229,744
February 29	216,171	12,177	1,363	229,711
March 31	214,024	12,009	—	226,033
April 30	214,344	11,943	—	226,277

PRODUCTION OF GOLD IN RHODESIA.

	1929	1930	1931	1932
	oz.	oz.	oz.	oz.
January	46,231	46,121	45,677	42,706
February	44,551	43,385	42,818	45,032
March	47,388	45,511	42,278	47,239
April	48,210	45,806	43,776	—
May	48,189	47,645	43,731	—
June	48,406	45,208	44,118	—
July	46,369	45,810	44,765	—
August	46,473	46,152	43,292	—
September	45,025	46,151	42,846	—
October	46,923	45,006	44,260	—
November	46,219	44,351	44,516	—
December	46,829	46,485	50,034	—

RHODESIAN GOLD OUTPUTS.

	March.		April.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,800	9,955	24,800	9,778
Globe and Phœnix	6,152	6,538	6,094	6,344
Lonely Reef	8,000	2,346	8,100	2,488
Luiri Gold	1,324	775	—	—
Rezende	6,500	2,597	6,500	2,590
Sherwood Star	4,800	£7,930	4,800	£7,452
Wanderer Consolidated	15,500	3,587	15,200	3,004

WEST AFRICAN GOLD OUTPUTS.

	March.		April.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	5,060	£14,453	—	—
Ashanti Goldfields	13,300	14,610	13,590	14,631
Taquah and Abosso	10,799	£14,674	9,635	3,644

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland
	Oz.	Oz.	Oz.
April, 1931	38,891	3,250	732
May	38,255	4,196	784
June	47,507	3,194	893
July	38,785	3,641	1,220
August	52,501	3,020	610
September	38,173	—	638
October	52,741	7,838†	1,031
November	53,869	4,758	1,428
December	49,215	—	1,224
January, 1932	44,037	—	916
February	44,672	—	—
March	47,108	—	—
April	—	—	—

† Sept. and Oct.

AUSTRALASIAN GOLD OUTPUTS.

	March.		April.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,597	5,504	5,671	5,416
Blackwater (N.Z.)	3,573	8,352	3,442	8,185
Boulder Persev'ce (W.A.)	7,315	15,215	7,320	15,646
Grt. Boulder Pro. (W.A.)	10,026	25,721	—	—
Lake View & Star (W.A.)	21,633	24,822	—	—
Sons of Gwalia (W.A.)	13,476	14,775	12,318	15,575
South Kalgurli (W.A.)	9,339	15,996	9,707	16,156
Waihi (N.Z.)	16,965	{ 5,610* / 40,118†	—	{ — / —
Wiluna	27,010	36,118	—	—

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	March.		April.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	2,950	2,105	3,200	4,245*
Champion Reef	9,340	5,414	8,800	5,161
Mysore	16,600	7,160	16,020	7,523
Nundydroog	12,521	7,309	12,541	7,277
Ooregum	11,160	4,370	11,180	4,356

* 2,034 oz. from preliminary clean-up.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	March.		April.	
	Tons	Value £	Tons	Value £
Bulolo Gold	—	—	—	57,000*d*
Chosen Corp. (Korea)	10,070	20,346	—	—
Frontino Gold (C'lbia)	3,160	16,628	3,470	16,777
Fresnillo	77,322	10,818*d*†	—	—
New Goldfields of Venezuela	7,765	2,304*	7,257	1,997*
Oriental Cons. (Korea)	—	83,619*d*	—	91,600*d*
St. John del Rey (Brazil)	—	37,300	—	57,500
Santa Gertrudis (Mexico)	25,463	38,058*d*	—	—
Viborita	—	600	—	—
West Mexican Mines	1,330	20,000*d*	—	—

d Dollars. * Oz. gold. † Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

July, 1931	4,757	January, 1932	3,014
August	5,375	February	2,132
September	2,449	March	3,064
October	3,282	April	3,333
November	2,488	May	—
December	3,222	June	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	February.	March.	April.
Ayer Hitam	—	119	24
Batu Caves	—	25	16
Changkat	75	47	48
Gopeng	7	60	38
Hongkong Tin	—	78⅜	48
Idris Hydraulic	—	29⅜	18½
Ipoh	24¾	32½	119⅜
Kampar Malaya	—	—	—
Kampong Lanjut	35	8	35
Kamunting	96	120½	150
Kent (F.M.S.)	—	14½	—
Killinghall	—	23	21½
Kinta	—	30	11½
Kinta Kellas	—	21½	23¼
Kramat Tin	85	105	120
Kuala Kampar	38	32	43
Kundang	—	—	—
Lahat	7⅜	9½	27
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	90¼	107¼	95¼
Malim Nawar	21	28	25
Pahang	125	125	125
Penawat	—	—	70
Pengkalen	—	74⅓	15
Petaling	90	190	169½
Rahman	40⅕	40⅕	40⅕
Rambutan	—	16	—
Rantau	17½	48	12½
Rawang	52	40	38
Rawang Concessions	35	40	40
Renong	28	28½	15
Selayang	—	16½	10⅛
Southern Kampar	—	126	88
Southern Malayan	3¼	119	107¼
Southern Perak	11½	41⅜	50¼
Southern Tronoh	16	27	42
Sungei Besi	33	33	32½
Sungei Kinta	16	25	34⅜
Sungei Way	—	71½	68½
Taiping	14	19	14½
Tanjong	19	45	—
Tekka	—	36	27
Tekka Taiping	2	45	42½
Temoh	—	—	—
Tronoh	80	43	52
Ulu Klang	12¼	—	—

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	February.	March.	April.
Anglo-Nigerian	10½	48½	15½
Associated Tin Mines	129	235	120
Baba River	—	4½	4½
Batura Monguna	—	3	3
Bisichi	27	38	—
Daffo	2¼	—	—
Ex-Lands	34	45	41
Filani	—	—	1½
Jantar	18	13	11
Jos	11½	13	—
Juga Valley	8½	8	8
Kaduna Syndicate	12¼	16¾	17
Kaduna Prospectors	2	9	8
Kassa	—	11	5½
London Tin	143	135	145
Lower Bisichi	4	⅜	—
Naraguta Extended	—	—	—
Nigerian Consolidated	12½	7	7
Offiu River	3	2⅜	5
Ribon Valley	4⅜	17	13
Tin Fields	4½	—	—
United Tin Areas	—	24	18
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	February.	March.	April.
Anglo-Burma (Burma)	17½	18¾	—
Aramayo Mines (Bolivia)	134	141	132
Bangrin (Siam)	—	38½	42
Beralt	30*	31*	—
Consolidated Tin Mines (Burma)	95	103	95
East Pool (Cornwall)	46½	48	—
Fabulosa (Bolivia)	39†	47†	45†
Kagera (Uganda)	20	24	—
Kamra	63	—	—
Malaysiam Tin	8⅜	8⅜	8½
Mawchi	217*	225*	236*
Patino	813	813	—
Pattani	30⅜	—	—
San Finx (Spain)	16¾*	—	—
Siamese Tin (Siam)	25½	100	147
South Crofty	51½	54	59
Tavoy Tin (Burma)	27	46	50
Tongkah Harbour (Siam)	40	54	43
Toyo (Japan)	62	77½	81¾
Zaaiplaats	15½	14⅛	—

* Tin and Wolfram. † Tons fine tin.

COPPER, LEAD, AND ZINC OUTPUTS.

		March.	April.
Britannia Lead	Tons refined lead	1,466	—
	Oz. refined silver	168,114	—
Broken Hill South	Tons lead conc.	4,332	5,114
	Tons zinc conc.	4,569	5,454
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	500,503	520,795
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	350	370
Messina	Tons copper	845	818
Mount Isa	Tons lead bullion	3,616	—
Mount Lyell	Tons concentrates	3,754	3,573*
North Broken Hill	Tons lead conc.	5,510	—
	Tons zinc conc.	5,040	—
Rhodesia Broken Hill	Tons V_2O_5	40	30
	Tons V_2O_5 conc.	102	100
Roan Antelope	Tons concentrates	—	—
	Tons blister copper	2,054	2,113
San Francisco Mexico	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Trepca	Tons lead conc.	3,739	3,391
	Tons zinc conc.	4,135	4,659
Villemagne	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Zinc Corporation	Tons lead conc.	5,027	—
	Tons zinc conc.	3,531	—

* To April 20.

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

		February.	March.
Iron Ore	Tons	146,329	202,671
Manganese Ore	Tons	6,219	6,382
Iron and Steel	Tons	252,257	130,174
Copper and Iron Pyrites	Tons	34,029	19,068
Copper Ore, Matte, and Prec.	Tons	3,624	2,257
Copper Metal	Tons	16,878	10,401
Tin Concentrate	Tons	3,709	5,688
Tin Metal	Tons	979	675
Lead Pig and Sheet	Tons	31,737	19,987
Zinc (Spelter)	Tons	17,103	13,437
Zinc Sheets, etc.	Tons	3,010	1,375
Aluminium	Tons	2,355	531
Mercury	Lb.	158,018	204,253
Zinc Oxide	Tons	389	52
Zinc Ore	Tons	2,580	7,608
White Lead	Cwt.	19,899	5,686
Barytes, ground	Cwt.	63,179	10,228
Asbestos	Tons	2,163	1,067
Boron Minerals	Tons	745	751
Borax	Cwt.	33,190	16,998
Basic Slag	Tons	510	1,192
Superphosphates	Tons	20,302	9,274
Phosphate of Lime	Tons	33,692	31,992
Mica	Tons	104	217
Tungsten Ores	Tons	252	206
Sulphur	Tons	15,231	4,433
Nitrate of Soda	Cwt.	44,180	69,300
Potash Salts	Cwt.	297,097	203,917
Petroleum : Crude	Gallons	35,093,961	15,456,328
Lamp Oil	Gallons	20,818,181	24,109,167
Motor Spirit	Gallons	83,384,601	63,877,973
Lubricating Oil	Gallons	11,670,940	7,225,200
Gas Oil	Gallons	4,737,236	13,396,134
Fuel Oil	Gallons	42,083,451	33,378,478
Asphalt and Bitumen	Tons	10,377	13,373
Paraffin Wax	Cwt.	174,876	135,785

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	February.	March.	April.
Anglo-Ecuadorian	14,555	16,057	16,766
Apex Trinidad	43,870	43,310	45,170
Attock	1,782	1,493	1,489
British Burmah	3,949	4,169	—
British Controlled	37,204	44,231	46,362
Kern Mex	927	1,109	1,008
Kern River (Cal.)	2,195	2,529	2,396
Kern Romana	282	174	194
Kern Trinidad	3,084	3,685	2,530
Lobitos	21,701	23,406	24,004
Phœnix	44,572	58,501	68,787
St. Helen's Petroleum	4,911	4,987	4,793
Steaua Romana	80,394	88,677	—
Tampico	2,579	2,893	2,738
Tocuyo	1,384	1,270	981
Trinidad Leaseholds	25,700	27,050	25,600

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted

	Apr. 11, 1932.			May 10, 1932.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		6	0		6	0
Anglo-Egyptian B.	1	2	6	1	5	0
Anglo-Persian 1st Pref.	1	4	9	1	4	6
,, ,, Ord.	1	15	0	1	13	9
Apex Trinidad (5s.)		9	9		11	3
Attock		11	3		9	3
British Burmah (8s.)		3	9		3	9
British Controlled ($5)		1	0		1	3
Burmah Oil	2	1	9	2	3	9
Kern River Cal. (10s.)		1	6		1	9
Lobitos, Peru	1	3	9	1	3	0
Mexican Eagle, Ord. (4 pesos)		6	3		6	0
,, ,, 8% Pref. (4 pesos)		6	0		6	0
Phœnix, Roumanian		3	3		4	0
Royal Dutch (100 fl.)	13	0	0	13	10	0
Shell Transport, Ord	1	16	3	1	14	3
,, ,, 5% Pref. (£10)	10	0	0	10	0	0
Steaua Romana		4	6		4	3
Trinidad Leaseholds	1	3	9	1	7	6
United British of Trinidad (6s. 8d.)		2	0		2	3
V.O.C. Holding	1	0	0	1	1	3

PRICES OF CHEMICALS. May 9.

These quotations (some of which are affected by the devaluation of the pound sterling) are not absolute : they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	9
,, 80%	,,	1	17	3
,, Glacial	per ton	59	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	0
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	7	0	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	25	10	0
Barium, Carbonate (native), 94%	,,	4	10	0
,, Chloride	,,	10	10	0
Barytes	,,	8	5	0
Benzol, standard motor	per gal.		1	4
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	,,	16	10	0
Boric Acid	,,	26	10	0
Calcium Chloride, solid, 70/75%	,,	5	15	0
Carbolic Acid, crude 60's	per gal.		1	7
,, ,, crystallized, 40°	per lb.			6¾
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.		1	1
Copper Sulphate	per ton	18	0	0
Creosote Oil (f.o.b. in Bulk)	per gal.			5
Cresylic Acid, 98–100%	,,		1	4
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per lb.	1	0	4
Iron, Nitrate 80° Tw.	per ton	6	0	0
,, Sulphate	,,	2	0	0
Lead, Acetate, white	,,	37	0	0
,, Nitrate (ton lots)	,,	28	10	0
,, Oxide, Litharge	,,	28	10	0
,, White	,,	37	10	0
Lime, Acetate, brown	,,	7	0	0
,, ,, grey, 80%	,,	11	10	0
Magnesite, Calcined	,,	8	5	0
Magnesium Chloride	,,	5	10	0
,, Sulphate, comml.	,,	4	10	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	0
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	2	7	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	31	0	0
,, Chlorate	per lb.			4
,, Chloride 80%	per ton	12	10	0
,, Ethyl Xanthate	per 100 kilos	7	0	0
,, Hydrate (Caustic) 88/90%	per ton	40	0	0
,, Nitrate	,,	31	0	0
,, Permanganate	per lb.			8½
,, Prussiate, Yellow	,,			8½
,, ,, Red	,,		2	0
,, Sulphate, 90%	per ton	14	10	0
Sodium Acetate	,,	21	0	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			4
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	28	10	0
,, Cyanide 100% NaCN basis	per lb			8
,, Ethyl Xanthate	per 100 kilos	6	12	6
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	9	0	0
,, Phosphate, comml.	,,	13	10	0
,, Prussiate	per lb.			5
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	3	1	0
,, Sulphide Conc., 60/65%	,,	10	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	10	10	0
,, Roll	,,	10	0	0
Sulphuric Acid, 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw.	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	7	0
Tartaric Acid	per lb.		1	0½
Turpentine	per ton	55	0	0
Tin Crystals	per lb.		1	0
Titanous Chloride	,,			10½
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	8	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	April 11, 1932. £ s. d.	May 10, 1932. £ s. d.
SOUTH AFRICA:		
Brakpan	3 6 3	3 15 0
City Deep	5 3	5 0
Consolidated Main Reef	1 0 6	1 1 0
Crown Mines (10s.)	4 17 0	5 10 0
Daggafontein	2 12 6	2 8 9
Durban Roodepoort Deep (10s.)	17 9	17 9
East Geduld	2 14 0	2 18 0
East Rand Proprietary (10s.)	12 6	12 9
Geduld	3 17 0	4 3 9
Geldhenhuis Deep	10 0	10 0
Glynn's Lydenburg	5 0	6 3
Government Gold Mining Areas (5s.)	1 12 0	1 15 0
Grootvlei	1 2 6	1 1 3
Langlaagte Estate	19 0	1 0 0
Meyer & Charlton	1 5 0	1 7 6
Modderfontein New (10s.)	2 3 9	2 7 6
Modderfontein B (5s.)	9 6	11 3
Modderfontein Deep (5s.)	17 0	16 6
Modderfontein East	1 11 6	1 15 0
New State Areas	2 8 9	2 10 6
Nourse	14 9	15 6
Randfontein	1 4 9	1 7 3
Robinson Deep A (1s.)	15 6	15 0
,, ,, B (7s. 6d.)	9 0	9 3
Rose Deep	6 0	5 9
Simmer & Jack (2s. 6d.)	3 4	3 6
Springs	3 5 6	3 12 0
Sub Nigel (10s.)	3 15 0	4 1 3
Van Ryn	10 6	11 0
Van Ryn Deep	19 6	1 0 0
Village Deep (9s. 6d.)	2 6	2 6
West Rand Consolidated (10s.)	11 3	11 9
West Springs	11 9	12 3
Witwatersrand (Knight's)	7 0	7 0
Witwatersrand Deep	5 6	6 0
RHODESIA:		
Cam and Motor	1 8 9	1 11 3
Gaika	3 6	3 6
Globe and Phœnix (5s.)	14 3	14 0
Lonely Reef	16 3	15 0
Mayfair	4 6	4 6
Rezende	1 5 0	1 6 3
Shamva	1 0	1 0
Sherwood Starr (5s.)	13 9	14 6
GOLD COAST:		
Ashanti (4s.)	1 6 3	1 10 6
Taquah and Abosso (5s.)	4 6	5 0
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	3 6	3 9
Great Boulder Propriet'y (2s.), W.A.	2 9	3 0
Lake View and Star (4s.), W.A.	9 7	10 0
Sons of Gwalia, W.A.	6 9	9 6
South Kalgurli (10s.), W.A.	15 6	17 0
Waihi (5s.), N.Z.	15 6	14 6
Wiluna Gold, W.A.	17 0	19 0
INDIA:		
Balaghat (10s.)	8 9	9 2
Champion Reef (10s.)	8 6	8 9
Mysore (10s.)	8 3	8 6
Nundydroog (10s.)	17 6	18 6
Ooregum (10s.)	3 0	3 0
AMERICA:		
Camp Bird (2s.), Colorado	3	2
Exploration (10s.)	1 6	1 0
Frontino and Bolivia, Colombia	16 9	17 0
Mexican Corporation, Mexico (10s.)	3 6	2 6
Mexico Mines of El Oro, Mexico	2 0	2 0
Panama Corporation	5 0	3 0
St. John del Rey, Brazil	18 6	18 6
Santa Gertrudis, Mexico	4 9	4 3
Selukwe (2s. 6d.), British Columbia	1 9	1 4
MISCELLANEOUS:		
Chosen, Korea	3 0	3 0
Lena Goldfields, Russia	6	3

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	2 6	2 3
Esperanza Copper	13 9	13 9
Indian (2s.)	1 0	1 0
Loangwa (5s.), Rhodesia	1 6	1 3
Luiri (5s.), Rhodesia	2 6	2 3
Messina (5s.), Transvaal	5 0	4 0
Mount Lyell, Tasmania	15 6	15 6
Namaqua (£2), Cape Province	3 0	3 0
Rhodesia-Katanga	10 0	10 0
Rio Tinto (£5), Spain	12 10 0	12 15 0
Roan Antelope (5s.), Rhodesia	5 9	5 6
Tanganyika Con.	15 6	15 0
Tharsis (£2), Spain	2 10 0	2 7 6

LEAD-ZINC:	April 11, 1932. £ s. d.	May 10, 1932. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	5 6
Broken Hill Proprietary, N.S.W.	11 9	11 6
Broken Hill, North, N.S.W.	2 6 3	2 7 6
Broken Hill South, N.S.W.	1 11 6	1 11 3
Burma Corporation (10 rupees)	7 6	7 9
Electrolytic Zinc Pref., Tasmania	16 3	16 3
Mount Isa, Queensland	8 0	7 9
Rhodesia Broken Hill (5s.)	9	9
San Francisco (10s.), Mexico	6 9	5 6
Sulphide Corporation (15s.), N.S.W.	7 3	7 0
ditto, Pref.	9 0	9 0
Zinc Corporation (10s.), N.S.W.	19 6	1 3 0
ditto, Pref.	2 12 6	2 15 0

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

DIAMONDS:		
Consol. African Selection Trust (5s.)	5 6	5 0
Consolidated of S.W.A. (10s.)	1 6	1 3
De Beers Deferred (£2 10s.)	2 11 3	2 16 3
Jagersfontein	12 6	13 9
Premier Preferred (5s.)	1 5 0	1 0 0

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

SAMPLING WITH A BANKA DRILL

The keen interest aroused by Mr. W. R. Rumbold's paper on the valuation of alluvial deposits, which appeared in the *Bulletin* of the Institution of Mining and Metallurgy for April, 1928, will be recalled by a paper appearing in the same publication last month and which was discussed at the April meeting. This last article is by Mr. P. R. Lake, and he describes the systematic sampling of alluvial deposits with a Banka drill. The author describes his paper as a plea for simplification and standardization of sampling practice, together with a greater accuracy within practical limits.

He says that the subject may conveniently be grouped under three main headings :—

(*a*) The lay-out of the property for sampling and the preparation of the boring-plan.

(*b*) Taking the sample by Banka drill.

(*c*) The computation of mineral values.

As regards the general lay-out of the property for sampling, the fundamental principles expressed may be equally applied to any form of sampling, whether by means of pits, large power drill or Banka drill. In the same way, although the mineral particularly dealt with is cassiterite, the methods employed are equally applicable to gold or platinum, with the exception of the methods used to wash the sample and the unit used to weigh the concentrate.

The term "alluvial deposit" is used in its broadest sense, and an endeavour is made to show that whether it is a patchy narrow deposit, bearing definite relation to the course of a river, or a large and relatively homogeneous deposit of greater depth, the ultimate procedure can be applied to both with equal efficiency.

(*a*) In setting out the boring scheme too little attention is usually given to even distribution of the holes ; if the holes are uneven or haphazardly placed some will carry more "weight" than others and the result may mean a serious over or under estimation of the average value of the property. This is particularly marked if the bed-rock is uneven, which will cause a variation in the depth of the bore-holes, thus giving undue weight to the deeper holes. If each hole is to bear an equal "weight" then they must be distributed equally and uniformly over the property, irrespective of the richness or poorness of the different areas. These areas may subsequently be demarcated by various economic boundaries. The system of laying out the area in squares fulfils these conditions, and it is this system that is advocated. As to actual procedure in the field, a line is run north and south, starting from some conspicuous object, preferably a boundary stone as shown on the plans, in order that the system of bore-holes may be readily picked out at a later date if necessary. An east and west line is then run, say, 8 chains from the boundary stone. These two lines form the basis of the system on which the squares are built up, the bore-holes being placed at the corners of squares. This preliminary work in the field is best done by a prismatic compass, which can be fixed to a light tripod, and a 66-ft. chain, the two initial intersecting lines being defined by ranging rods. The bore plan must show the boundaries of the property or area to be valued, together with any prominent natural features, as well as all boundary stones and trig points. The two lines mentioned above must be clearly shown, cutting the entire property from north to south and east to west ; a network of squares is then built up whose sides are 2 chains long. Starting from the south-east corner the holes are numbered consecutively up and down the north and south lines. The bore plan is now complete, and although many of the holes shown may never be bored it is as well to make provision for check-boring in order that, later on, the numbering may run consecutively. A complete copy of the plan is forwarded to the head office, on which the value and depths of the appropriate holes can be marked as the prospecting progresses. The most convenient scale is 2 chains to the inch, or should the area be very large, 4 chains to the inch.

Distance between holes.—The number of holes per acre necessary to "prove" a property has always been the subject of controversy. In the initial stages of prospecting, they should be close enough together to detect a narrow and rich river deposit, should such exist, and yet so far apart as to make the preliminary investigation as rapid and economical as possible. With these two points in mind, a satisfactory interval for the first series of bores put down is 8 chains, that is to say every fourth hole as shown on the plan. This gives 1 hole per 6·4 acres and represents the bare minimum consistent with efficiency. If there is a deposit of possible economic value in the area one or more of these scout bores can hardly fail to disclose it, or at any rate give more or less definite indications. The economic boundary has now been roughly defined ; that is to say, a line may be sketched on the plan outside which no further boring should be done, or possibly several areas may thus be roughly defined. Holes are then put down at 4-chain intervals in the selected area or areas—that is to say, midway between the scout bores. There is now one hole per 1·6 acres. The economic boundary is fixed within two chains, and in cases where the values have proved fairly consistent throughout, the property may be said to be "proved." This second series of holes may be termed "normal boring." In the event of the values showing a distinct variation, or if a definite narrow lead is shown, then further boring must be undertaken.

The probability is, however, that "normal

bores " spaced at 4 chains will not give results sufficiently reliable to justify the whole property being called " proved," unless the values are very uniform, as mentioned above. Such being the case, it may be necessary to " check-bore " certain areas by a further series of holes put down at 2-chain intervals, giving one hole per 0·4 acres. A quantity of data are now available ; the payable area is known to within a chain, the rich and poor patches within the main area can also be confined within the same limit, and finally the nature of the deposit has been made clear. Unless the deposit has been shown to be narrow and patchy—that is to say, unless it bears definite relation to a river bed, no further boring need be carried out and it can be stated that so many cubic yards contain such a weight of mineral per cubic yard, or in other words that the property is " proved."

In extreme cases additional data may be required owing to the variation of the results within wide limits. In this case, such areas as are open to doubt should be " close-bored " at 1-chain intervals, giving 10 holes to the acre. This process only applies where the values are most irregular and confined to scattered patches or to a narrow lead. In addition, a limited amount of close-boring might be undertaken in advance of a dredge at work, in the event of recovery being unsatisfactory.

By following the system of uniformly decreasing squares, whereby every hole is given an equal weight and every hole bears the same responsibility, it is claimed that the sampling of alluvial deposits is simplified, with, at the same time, a gain in economy and accuracy. The various stages of the boring scheme may be summarized as follows :—

1. *Scout-boring.*—Holes at the corners of 8-chain squares. Economic boundary roughly defined and sufficient data available to justify abandoning the property, or to warrant further investigation. One hole per 6·4 acres.

2. *Normal boring.*—Holes at the corners of 4-chain squares. Economic boundary defined to within 2 chains and sufficient data available to call the property proved, should results indicate that the deposit is uniform. One hole per 1·6 acres.

3. *Check-boring.*—Holes at the corners of 2-chain squares. Boundary of deposit now accurately defined, such as to justify the property being called proved, provided the values are not abnormally uneven. One hole per 0·4 acres.

4. *Close-boring.*—Holes at the corners of 1-chain squares. Boundary of even a small abnormally patchy deposit should now be defined. Ten holes per acre. Further sub-division serves no definite or economic purpose, except perhaps where the deposit is very small and rich and could be worked on a small scale.

The practice of placing the bores at the intersection of the diagonals of the squares formed by the scout bores produces a spacing of 5·6 chains : that is to say, the number of holes is doubled and not quadrupled as in the method advocated. Though not sufficiently " drastic " for the first two stages, this system of diagonals could, for motives of economy or where the area is very large, be applied from the close boring stage, when quadrupling the holes would be an expensive and lengthy process.

It will be seen that the successive stages depend mainly on the comparative uniformity, or otherwise, of the results. In addition, the property should only be described as " proved " ; the term " probable " ore leads to misconception when applied to an alluvial property. A property may be said to be proved when it is bored at 4-chain intervals, and the values from individual holes show uniformity, lack of uniformity necessitating closer intervals, If certain areas are richer or poorer than others, then a statement should be made to that effect ; so many cubic yards having such an average value per cubic yard, made up of so many cubic yards at one value, and so many at another value, and so on. The reason for this is that it may be many years before the average recovery values agree with the average prospecting values, a state of affairs that nearly always leads to misapprehension and anxiety over outputs.

(*b*) It is generally agreed that the Banka drill falls short of perfection ; it is, however, the only instrument of its type available, and though in essence a makeshift it has a very wide and useful application. Its great advantage lies in its simplicity and ease of transport, especially in difficult country, its low operating cost, and its ability to bore to comparatively great depths. The results obtained from it are in no way comparable in accuracy to those obtained by means of pits and, in the rare cases where the latter method is practicable, it should always be preferred to boring, except for motives of rigid economy. There is always a doubt as to the accuracy of a sample taken by Banka drill both as regards volume and mineral content. The ideal instrument would be one that would enable the complete and representative core to be removed from the hole, but as unfortunately this happy state of affairs has not yet been attained, the best must be made of a somewhat indifferent instrument. When using the Banka drill for alluvial valuation it is therefore necessary to bear in mind its essential shortcomings, as otherwise unnecessarily minute corrections may be indulged in which only serve to complicate its use.

Its great disadvantage lies in the fact that the sample rarely, if ever, attains to the theoretical volume of the casing, calculated from either the internal or external diameter of the cutting shoe. In this connexion, the calculation of values from formulae, which are usually based on the volume of the casing, is to be deprecated. Although some of these formulae contain factors to allow for certain contingencies, such as wear of the cutting shoe, an allowance to balance the loss in actual working recovery, etc., they are invariably founded on a fallacy—in that it is assumed that the volume of material extracted by the sand-pump from a certain length of casing is represented by the volume of that casing or, if a factor has been introduced to allow for variation from the theoretical, then that variation is assumed to be constant. For these reasons, no reliance should be placed on results derived by means of formulae ; the theoretical volume of the sample is rarely if ever obtained, nor does the volume of this sample remain in any way constant. Some means must therefore be found to adjust the volume of material recovered from the casing to the actual volume it probably occupied *in situ*. This may be done in a variety of ways :—

1.—Measuring the sample in a box, whose capacity when full is designed to correspond to the volume occupied by the sample *in situ*.

2.—As in 1, but measuring the sample by displacement of water.

3.—Weighing the sample wet, taking as a standard the theoretical weight of the sample *in situ*.

4.—As in 3, but weighing the sample dry.

These methods all tend to achieve the same main object, but No. 1 in the opinion of the writer is the simplest and leaves less margin for mistakes. By weighing the sample allowance can be made for varying densities of material, but whatever modification is used, all serve the same main purpose, the choice mainly depending on the whim of the individual. In this paper, No. 1 method only is dealt with, the method having proved successful in practice in the alluvial tin deposits of Malaya.

Size and Dimensions of Equipment.—The author then deals with the size of the Banka drill equipment in general and the diameter of the casing in particular. As regards the casing, 5 ft. is the length of section in general use ; this is convenient for one man to carry and 5 ft. is an obvious unit of depth over which to take successive samples. The rods should thus be 10 ft. long, with the exception of two of 5 ft. The most suitable diameter for the casing is a question of prime importance. The greater the diameter of the casing, presumably the greater the accuracy of the sample ; but as the Banka drill is an instrument whose main advantage is that it can be carried and worked by hand, the diameter in practice is limited by the weight of each section and by the weight of the assembled rods and sand-pump, which increases as the hole deepens. In shallow deposits, i.e. depths not greater than 30 ft., a diameter of 6 in. or more might be used without detracting from the essential advantages of the drill. Beyond this depth, if the diameter is over a certain minimum, the instrument ceases to fulfil its purpose and tends to become cumbersome. The most suitable diameter for moderate and deep boring is 3 in. except, as already mentioned, when the deposit is shallow and the weight of the string of rods not a serious question. It is maintained that this diameter gives a sample of reasonable bulk and at the same time it allows the sand-pump and rods to be worked efficiently by hand down to depths of 100 ft. and more. It may be contended that a diameter of only 3 in. is insufficient when considered in the light of the ratio between the area of the sample and the area of ground surface it is destined to represent. Unless the constituent particles of the deposit are abnormally large, a casing of 3-in. diam. will, for practical purposes, isolate as relatively true a section as a 6 in. casing, the question of the ratio sample area to the superficial area it represents being adjusted preferably by the number of holes per acre, rather than by the diameter of the casing. With holes at 2-chain intervals the sample represents about 1 part in 350,000 using casing of 3 in. diam. With 6 in. casing the ratio would be 1 in 90,000.

Measuring Box.—Assuming the standard casing is in 5 ft. lengths of 3 in. diam., the theoretical cubic contents per length are 0·245 cu. ft. The box in which the sample from every successive length of casing is measured is 1 ft. by 1 ft. by 4½ in., internal dimensions. This gives a volume of 0·375 cu. ft. Thus, 0·13 cu. ft. is allowed for expansion, represented partly by the failure of the sand-pump to extract the core corresponding to the casing, and partly by voids when the sample is in the measuring box. This increase in volume allowed for is 50%, the figure being based on practical results extending over a number of years.

It is essential that the sample in the box should be of a consistency of thick porridge ; any clay being carefully hand-puddled and the water slowly decanted after the contents have been allowed to settle. The depth of sample can then be measured by means of a wooden rod of which 4½ in. is divided into tenths, this division facilitating the subsequent adjustment of the weight of concentrate.

The author does not deal with the many theories put forward regarding the effects on the concentrate produced by the motion of the sand-pump within the casing, and by the pressure exerted by the cutting shoe. He admits that these effects undoubtedly lessen the accuracy of the sample, but says that they are unfortunately an inherent fault in the apparatus and that they can be minimized if attention is paid to certain points during the operation of boring the hole.

Boring the Hole.—The principle that the sand-pump should not be allowed to extend beyond the cutting shoe of the casing should be adhered to as far as possible ; for this reason, the sand-pumps should measure 5 ft. from the head of the shank to the cutting shoe, in order that it may easily be judged when the pump has reached the end of the casing. This is not so important when the clay auger is in use, as the walls of the hole will then be partially self-supporting, but in loose or running ground it is essential. If the ground tends to be at all stubborn, however, it may be found necessary to send the pump ahead of the casing in order to force the latter down ; in such cases it will generally be found that the casing can be made to sink as the pump is withdrawn. Whether this is done or not, it must be ensured that the total sample collected is from 5 ft. of casing and 5 ft. only—that is to say, when the collar of the casing is flush with the surface of the ground at the upper end, in no circumstances must the pump project at the lower end. As the value of the samples taken is calculated on a depth by weight basis (5 ft. being the standard depth) any deviation from the above may lead to serious errors.

In easy ground the casing can usually be forced down well ahead of the sand-pump, and if the ground is at all loose, the first few lengths of casing may sink very rapidly with little or no assistance from the sand-pump. In certain types of loose ground, especially if marshy, the sand is liable to rise in the casing when the pump is withdrawn ; in this event the risen sand must be removed until the sand-pump reaches the depth it had attained when the sand commenced to rise. The surplus content, additional to the actual sample, may either be discarded, or measured in the box, the weight of clean concentrate being subsequently reduced proportionately, according to the amount in excess of one full box. Should the sand persist in rising a considerable height in the casing, then the hole should be abandoned, as the sample finally obtained will become increasingly unreliable. It will very often happen that the bulk of the sample from a 5-ft. length of casing is insufficient to fill the box half full ; in such event the sample should be continued over 10 ft., or even over 15 ft., until the box is more than half full.

Careful supervision must be given to washing out the sand-pump after discharging the sample, especially when the work is on contract. The cleaning of the sample in the field must be watched

and no attempt should be made to get a pure concentrate at this stage. With practice it is usually possible to tell, by the dull sound produced, when the sand-pump is on bedrock, though if the latter is at all decomposed, fragments will be seen on the cutting shoe. If small pebbles or stones are encountered they are usually thrust aside by the casing; larger ones may be disintegrated by the chisel. Boulders, however, may impede further progress, in which case it will be necessary to abandon the hole and start it again a few feet away.

Supervision.—Supervision is one of the essentials of boring, and for accurate results an engineer should not be responsible for more than two gangs, each gang being watched from start to finish on alternate days. Without full supervision there are many ways in which serious errors may arise; the most common being:—

1. The hole left unbottomed; because the ground is difficult.
2. The sand-pump allowed to project far beyond the cutting shoe. This facilitates sinking the casing.
3. Samples may not accurately represent 5 ft. of casing.
4. Careless measuring and washing of samples.
5. Insufficient attention paid to clay, sunken timber, etc.

In an extensive undertaking, necessitating the employment of several drills, the expense incurred by extra engineers is slight compared with the risks attendant on inadequate supervision. Apart from this fact an engineer may have as many as forty samples daily to weigh and enter in the bore book, usually in duplicate, when the day's work in the field is completed. Unless this part of the undertaking is to be left to a clerk, which opens up an almost unlimited field for error, he will find it impossible to cope with more than two gangs; one engineer for each gang is the ideal to be attained.

Boring Book.—A detailed and careful account must be kept of all results from all bore-holes. For this purpose it is best to use specially ruled and printed sheets measuring about 15 in. by 9 in. bound between strong covers to resist hard wear in the field and in order that they may be preserved for future reference. In addition, loose sheets will be required for forwarding to head office. Each sheet should show at the top the name of the property; the number of the hole; the names of the supervising engineer and native foreman, together with the dates on which the hole was started and completed. The longer side is ruled off horizontally into spaces for every 5 ft. in depth, representing each complete sample taken. The vertical headings should show the description of the strata, the box fraction, the actual weight and the corrected weight of the clean concentrate, the product of the weight of the clean concentrate and the depth over which it was taken, the sand percentage and a large margin on the right for remarks. At the base of the sheet should be shown the total corrected weight of the concentrate, the total product of weight and depth and finally the value of the hole.

Procedure in the Field.—A specimen of the sample from every 5 ft. of casing should be carefully examined and a complete description entered in the appropriate column. Particular attention must be paid to the presence or otherwise of clay, and to its consistency, e.g. whether tough, soft, or friable, etc., as on this evidence may depend the successful working of the property. It must be seen that the sample in the box attains the required porridge-like consistency and its depth must be measured and entered. If the sample covers more than 5 ft. then the integral depths must be bracketed together. The sample should then be thoroughly puddled and the percentage of sand measured in the sand-box, after which it may be washed. No attempt should be made to get a clean concentrate at this stage, the coarse sand only being washed out. The concentrate is then dried and enclosed in small cotton bags, into which are put slips of paper giving the number of the hole and the depths between which the sample was taken. Any distinctive feature of the ground met with, such as running sand, sunken timber and impurities in the concentrate should be entered in the appropriate remarks column.

Sand-box.—This is used to determine the proportion of sand in the sample as distinct from clay and slimes; an important factor when it comes to deciding on the method of working to be employed, or special machinery to deal with a high percentage of clay. The box has the same volume as the measuring box, 0·375 cu. ft., but is of a different shape, the internal dimensions being 6 in. by 6 in. by 18 in. deep. The sand percentage is directly measured by means of a stick, of which 18 in. is divided into tenths. The percentage is subject to the same adjustment that is applied to the weight of the concentrate, as determined by the measuring box.

Sand-pump.—There are several types of sand-pumps in use and considerable variation is shown in the design of the valve. The writer has found that the best type of valve is the common clack-valve, situated as near the cutting shoe as possible; this works on a very narrow seating and allows unimpeded entry to the sand and smaller stones. It has many advantages over the ball-valve, which of necessity works in a narrow throat some little distance inside the pump. Free entry of the sample is thus restricted and there is always danger of a stone becoming wedged in the narrow throat. Some sand-pumps are only 18 in. long and disproportionately cumbersome, so that the cubic capacity is restricted and extra labour imposed in frequent raising and lowering in the hole. For this reason the pump should be as long as possible and as light as is consistent with strength; 3 ft. 6 in. for the pump and 1 ft. 6 in. for the shank is a practical length.

Auger.—The pitch of the spirals is often too great and the auger does not retain the clay. The pitch should be sufficiently small for the clay to adhere firmly, in order that it may be peeled off when the auger reaches the surface.

The author does not deal with the table, the means of lowering and raising the rods, or the method of drawing the casing, as both design and methods vary with circumstances and must suit the particular form of labour employed; the latter is usually more efficient if native peculiarities are respected and native methods allowed reasonable scope.

(*c*) The rough concentrate must now be very carefully washed; this is best done by a skilled native dresser who is accustomed to such work and who should be able to dress the samples up to 72% metal without difficulty or loss. If there is any doubt as to his skill the value-

less portion may be kept for further washing or for a test by assay. The samples from individual holes should not be assayed as, apart from the question of expense, the results are liable to be misleading, as they will express the total content and not the recoverable content; a bulk sample should be assayed later in order to ascertain what degree of purity is to be expected when actual working commences; 72% metal is a reasonable basis for the calculation of values and represents in Malaya a good average purity to send to the smelter. It is not likely that in actual working a cleaner concentrate will be produced than that obtained by careful washing of the bore samples, and such being the case the sample concentrate should closely correspond to the working concentrate; values based on assays will generally lead to the expectation of better results than will actually be the case.

For weighing the concentrate an apothecary's balance may be employed. In Malaya 100 grains are taken to represent 1 katti per cu. yd. (1·3 lb.), when a 3-in. diam. casing is used. Actually 100 grains represents 1·54 lb. per cu. yd., but by calling this 1·33 lb., or 1 katti, an allowance of 15% is made for probable loss in recovery when working. A small balance on the steelyard principle, known as Valentine's scale, enables the value in katties per cu. yd. to be read off directly on the arm; this also only applies to a 3 in. casing. Both these methods of weighing the concentrate are very suitable, as no calculations are necessary and mistakes therefore are improbable. Such a scale as that mentioned could be graduated to read lb. per cu. yd. and could also of course be adapted for casing greater than 3-in. in diam. It may be mentioned here that the dimensions of the measuring box do not affect the means used to weigh the concentrate, but only determine the extent of subsequent corrections to the weight.

The value of the concentrate from every 5 ft. of casing is entered in the bore book and the corresponding corrected weight. That is to say, if at a particular depth the value of the concentrate is 20 lb. per cu. yd. and the box fraction $\frac{3}{4}$, then the corrected weight will be 33 lb. per cu. yd.; if the box fraction is $\frac{3}{4}$ it will be 26 lb. per cu. yd. and so on. The foot-pounds are entered; this is the product of the corrected value and the corresponding depth in feet that the sample represents. If most of the values lie directly on bed-rock, calculation on the foot-pound principle is essential if accuracy is to be obtained. Finally, the total foot-pounds are divided by the depth of the hole, the result being the value of the hole in pounds per cu. yd.

It now remains to compute the average mineral value of the property from the values of the individual holes. If the values of the various holes are fairly uniform, an average is taken for the whole payable area. This course must also be taken if the values are irregular, but are so disposed that it is impossible to segregate a sub-area or areas containing values either higher or lower than the average. In the event, however, of there being a sub-area or areas whose values are consistently higher or lower than those of the main area, then a separate yardage and mineral content should be given.

Just as it is necessary to calculate the values of the holes on the foot-pound basis, so is it even more important when it comes to calculating the average mineral content of the property, especially when the depths of the holes and the values vary.

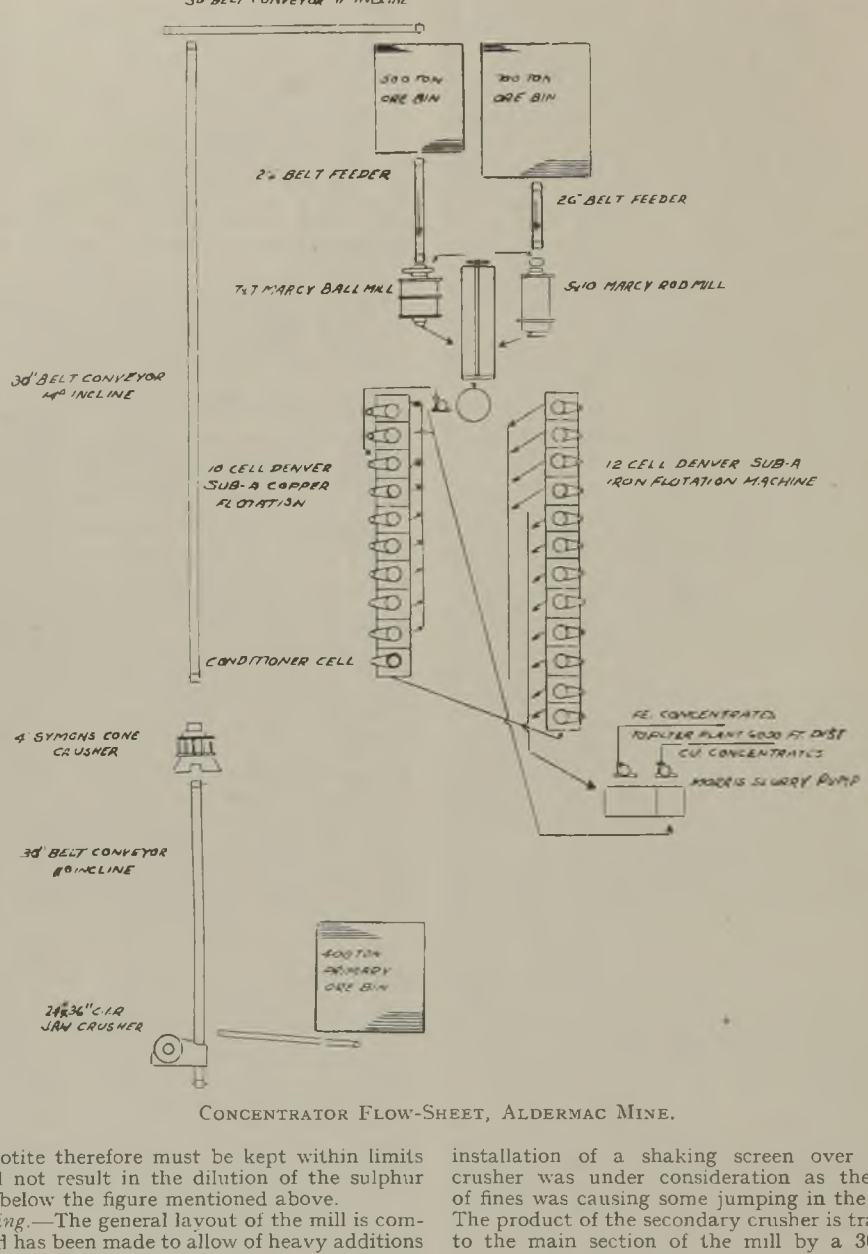
The author claims that the system of uniformly decreasing squares makes for accurate averaging of results. Every hole carries the same weight, complicated and uncertain systems of triangle and rhombus are avoided, and a relatively true average is obtained. Finally, if the prospecting results are presented so that it can be seen at a glance how many cubic yards there are at one value and how many at another, together with their monetary worth at various prices of the metal, then there should be less misconception as to the potential worth of alluvial properties in general.

THE ALDERMAC MILL

In the MAGAZINE for January, 1931, a description of the ore-bodies at the Aldermac mine, 10 miles west of Noranda, on the Nipissing Central Railway, Quebec, together with an account of the Freeman pyrite burner, by W. P. Anderson and A. A. MacKay, were given in the Mining Digest. This description has now been amplified by R. C. Rowe, who, in the *Canadian Mining Journal* for April, gives details of the new mill at this property. The author says that there are two factors which give more than ordinary interest to a description of the mine, the one being the fact that concentrates are pumped for more than a mile, while the other is that the Aldermac mine is primarily a sulphur property under existing conditions.

Little is needed to amplify the description of the ore-bodies already given, but the following summary, by the present author, may be given. He says that the ore-bodies so far discovered are of the replacement type, sulphides having replaced rhyolite and breccia flows. In the major deposits this replacement is practically complete, as over 90% of the original rock has been replaced by sulphides. Development work underground has demonstrated the existence of large quantities of ore, there being enough above the 750 ft. level to keep a 500 ton mill operating for ten years. In the major ore-bodies about 70% of the total sulphides is pyrite. The copper content is around 2%; the sulphur content is approximately 40%, and precious metal values run from 60 to 70 cents per ton. Large scale metallurgical tests have shown that 90% of the copper can be recovered in a 20 to 25% concentrate, and that 60 to 70% of the ore can be recovered in a 50% sulphur concentrate. Iron pyrite concentrates containing as high as 52% sulphur have been obtained in some of these tests, and it is worth noting that the concentrates obtained in the large scale tests have been perfectly suited to the requirements of flash roasting, as practically all impurities have been eliminated, and the residue, after roasting, makes a very high grade iron ore.

As the ore occurs in massive form, with very little rock, the mill takes on the form of a separator rather than a concentrator. Naturally it is desirable to obtain as perfect a separation between the iron and the copper as may be possible. In the case of the iron product it is essential that the sulphur content does not fall below 50%. The lifting



Concentrator Flow-Sheet, Aldermac Mine.

of pyrrhotite therefore must be kept within limits that will not result in the dilution of the sulphur content below the figure mentioned above.

Crushing.—The general layout of the mill is compact, and has been made to allow of heavy additions to capacity. The crushing plant is located right at the head frame and hoisted ore is dumped into a run-of-mine ore bin. This is equipped with a ball and chain gate. This device consists of a number of lengths of heavy chain with a heavy ball attached to the end of each of them. The feeder is a 30 in. belt conveyor, which feeds a 24 in. by 36 in. Canadian Ingersoll-Rand jaw crusher, equipped with a Texrope drive. The primary crusher discharges to a 30 in. belt conveyor (80 ft. centres) which conveys the product to a 4 ft. Symons cone crusher, reducing to a maximum of ½ in. When the writer visited the plant the installation of a shaking screen over the cone crusher was under consideration as the packing of fines was causing some jumping in the machine. The product of the secondary crusher is transported to the main section of the mill by a 30 in. conveyor belt, with 212 ft. centres, and an incline of 14°. All conveyor discharges are fitted with large square casings which permit the conveyed material being discharged to form its natural angle of repose, thus taking up the impact of discharge, and preventing wear of spouts.

Grinding.—The mill feed bin is built up of 2 in. by 6 in. plank, and has a total capacity of 600 tons, and a live ore capacity of 500 tons. It is equipped with belt feeders which deliver the ore to the grinding unit, which consists of a 7 ft. by 7 ft. Marcy ball-mill. A Marcy rod-mill is also installed to take care of any increases in capacity. The ball charge

is ten tons of 3 in. and 4 in. balls. The ball-mill operates in closed circuit with a 72 in. by 30 ft. Akins classifier, the overflow of which is maintained at 55% solids. The classifier overflow is pumped to a 6 ft. diameter by 16 ft. deep conditioning tank using compressed air for agitation. The conditioner overflows a pulp running around 40% solids to the copper flotation machines. Coarse sand is discharged from the bottom of the conditioner and combined with the ball-mill discharge to the classifier. The conditioner overflow, or flotation feed, is about 70% minus 200 mesh. Careful checks are kept on dilution, and tests for both classifier and conditioner overflows are taken every fifteen minutes.

Grinding is done in a dilute pulp—a large circulating load being carried in the classifier—to prevent the formation of undesirable sulphide slimes, and to produce a pulp in better condition for flotation. It has been noted that grinding in a thick pulp produces a small amount of pyrrhotite slimes, which greatly interferes with copper flotation, apparently acting as a depressant of the copper mineral.

Reagents.—Dry hydrated lime is fed to the ball-mill at a rate sufficient to maintain an alkalinity of ·05 to ·10 lb. per ton of solution.

MILLING DUMP ORE

	Per ton of ore
At ball-mill.—	
Lime	6 to 8 lb.
Cyanide	·03 lb.
Thio-Carbanalide	·10 lb.
At classifier sump overflow.—	
Pine oil	·10 lb.
Xanthate	·05 lb.
At primary copper rougher.—	
Copper sulphate	·10 lb.
Pine oil	·05 lb.
At iron agitation cell.—	
Copper sulphate	·50 lb.
Xanthate	·25 lb.
Water gas tar	·20 lb.

MINE ORE.

At ball-mill.—	
Soda ash	2 lb.
Cyanide	·04 lb.
Thio-Carbanalide	·09 lb.
At classifier overflow.—	
Pine oil	·05 lb.
To copper roughers.—	
Pine oil	·04 lb.
Xanthate	·08 to ·15 lb.
To iron agitator cell.—	
Copper sulphate	24 lb.
Xanthate	·17 lb.
Distributed to cells 4-6-8-10 on iron machine.—	
Xanthate	·17 lb.
To cell 8 iron circuit.—	
Water Gas tar	·15 lb.

The mill feed averages about 40% iron and 2% copper and the specific gravity of the ground ore is 4·00. It is comparatively easy to depress the iron and to make a copper flotation, but considerable care has to be exercised not to depress the iron too much in the copper circuit or difficulty is experienced in reactivating the pyrite in order that a satisfactory recovery can be made. Control of dilution must therefore be constant and the amount of cyanide that will give both copper grade and maximum pyrite recovery must be very accurately determined. An increase of ·01 lb. per ton of ore will appreciably lower pyrite recovery.

It has been found that more benefit is derived from the xanthate when it is fed in a number of places throughout the pyrite circuit, rather than at one place. Its action is rapid and does not carry over through the circuit when the entire amount is added at one place. Water gas tar is used to condition the froth in the last four cells of the iron machine as the froth tends to be watery and brittle at this point due to the lowering of the specific gravity of the pulp.

Flotation.—Denver 24 in. Sub A machines are used throughout. A battery of 10 cells is used in the copper circuit, made up as follows : 3 primary, 4 roughers and 2 cleaners. The tenth cell is used as an iron conditioner. About 90% of the copper is recovered in the form of a concentrate running around 25% copper. Copper circuit tailings flow to the flotation cell mentioned above, which is used as the iron conditioner, and here the reagents for pyrite concentration are introduced. The iron circuit consists of 12 cells all making a finished product.

Thickening and Filtering.—The matters of thickening and filtering are of particular interest in the case of the Aldermac mine, inasmuch as they are carried out in a separate plant located over a mile from the concentrating mill. Naturally, the main plant is located at the mine and the mine is situated about a mile from the main line of the Nipissing Central Railway. The company was, therefore, faced with the alternative propositions of either building a spur line into the mine, or of transporting their shipping products to the railway. The cost of building such a spur would have been heavy, as the general topography does not lend itself very readily to railway construction. Furthermore, there would always be a substantial switching charge to pay for service on a spur.

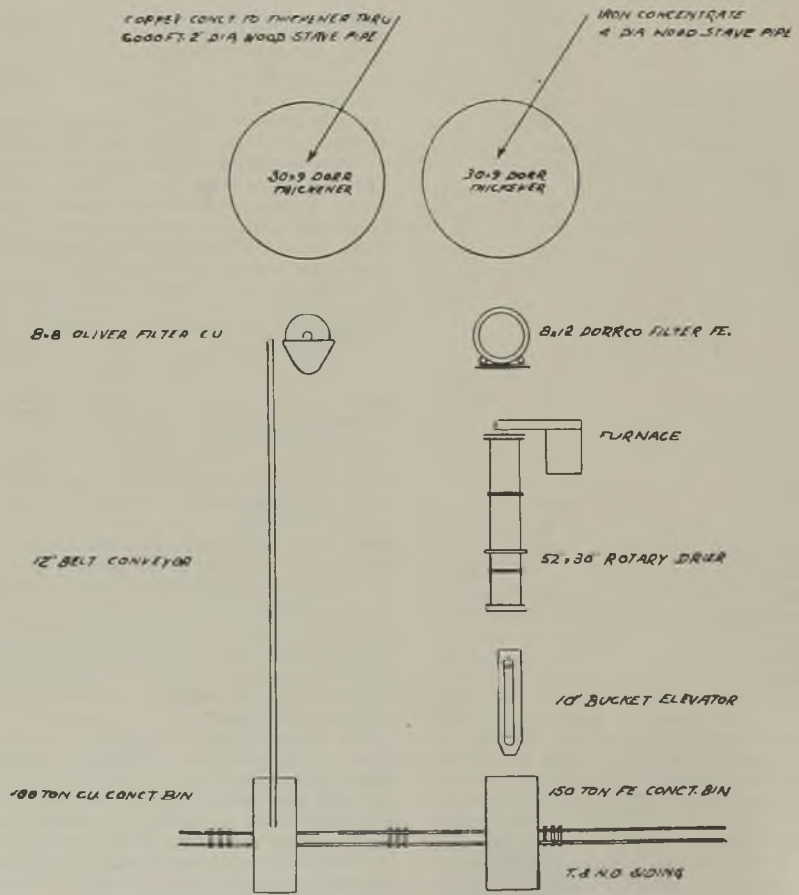
The question of transporting shipping products to the railway presented two angles. In one case the filtering plant could have been built at the mine, and the resulting products transported by truck or tractor to the main railway line. Here again heavy handling charges would have been a perpetual charge, even though the large capital expenditure involved in constructing a spur line was avoided. The remaining alternative was to build the thickening and filtering plant at the railway, and pump mill concentrates over the intervening distance. This plan was adopted after some investigation, though there was not much precedent to give guidance as the pumping of heavy concentrates over such a long distance is not by any means common.

The pipe lines from the mill to the filtering plant are 6,000 ft. long, and are of wood stave pipe. Great care has, of course, been taken to prevent any sags or low spots in which the heavy concentrates might settle.

The pumping plant consists of one 1½ in. Morris slurry pump for the copper and one 2 in. Morris slurry pump for the iron. The pumps draw from large sumps, which are of sufficient size to hold a considerable amount of concentrates should pump repairs be necessary. Complete spare pump units are carried so that if a major repair is necessary the unit involved can be removed bodily, and the spare unit quickly substituted.

The Aldermac Mine.

The distance from the pumping station to the top of the hill, over which the concentrates are pumped, is 1,400 ft. and there is a 45 ft. lift in this distance. From the top of the hill the lines run down grade for 3,600 ft. with a fall of 2·95%. To the top of the hill, the copper pipe is 1½ in., and from then on, down to the filter plant, 2 in. pipe is used. The iron concentrate pipe line is 3 in. to the



Filter Plant Flow-Sheet, Aldermac Mine.

top of the hill, and is 4 in. from there to the filter plant. Arrangements have been made to run high pressure steam through the lines, should a tendency to freeze become noticeable. No figures covering the actual costs of this pumping are yet available as the plant has not been long enough in operation to meet all conditions ; but there is not the slightest doubt that they will eventually prove to be very low, and the smoothness with which the pumping plant operates justifies the enterprise that embarked upon a rather unique project.

Naturally, the filter plant is in two units, one for each product. Each pipe line discharges into a 30 ft. by 9 ft. thickener. In the case of the iron thickener, care is taken to overflow any slimed concentrate as its presence is undesirable in the burners for which it is ultimately destined. The thickened pyrite pulp is fed to an 8 ft. by 12 ft. Dorrco filter. As the product must be dried for flash roasting, the filter cake from the Dorrco filter passes to a rotary drier, from which it is transported to the loading bins which straddle the railway track.

The thickened pulp from the copper thickener is passed to an 8 ft. by 8 ft. Oliver filter. Copper concentrates are not dried, but are conveyed immediately to the loading bins. Copper concentrates are being shipped to the Noranda smelter, which is only a distance of about 12 miles, and in very cold weather the freight cars can be heated if necessary. The filter plant is built on a side hill, and full advantage is taken of gravity for the flow of materials. An Ingersoll-Rand vacuum pump serves both filters.

CANADIAN PLACER GEOLOGY

In the *Canadian Mining and Metallurgical Bulletin* for February, W. E. Cockfield, of the Geological Survey of Canada, deals with the geology of placer deposits. He says that his paper is not intended as an original contribution to the subject, but rather as a review of the main theories which are held with regard to placer deposits, with particular reference to the placers of British Columbia.

Origin.—The idea which is prevailingly held is that placer or alluvial gold is detrital in origin, that is to say, the gold originally existed in veins, lodes, or disseminations in the country rock of the regions in which the placer deposits are now found, and that, through the various erosive forces of nature, it was liberated from those veins or lodes and concentrated in the form in which we now find it. The lines of evidence are many, and if the Cariboo district is taken as a typical example, Johnston and Uglow have shown that the placer and vein gold are identical in character. Crystals occur both in the placers and in the lodes, but the crystals in the placers are nearly always slightly worn, indicating transportation. Secondly, the same heavy minerals, such as pyrite, galena, scheelite, and barytes that occur in the lode deposits, occur also with the gold in the placers. Thirdly, the gold in placers occurs in quantity where the bedrock forms good riffles to retain it and the grade of bedrock of many of the auriferous channels is such as to indicate rapid streams, in which the conditions do not favour deposition from solution. Probably the chief stumbling block to many in accepting the view of a detrital origin for placer gold is the supposed size of placer gold, particularly the larger nuggets, as contrasted with the gold found in veins. This objection is groundless. Lindgren points out that large masses of gold do occur in veins. For example, a mass of native gold from the Monumental mine, Sierra county, California, weighed 1,146 troy oz., and at End Hill, New South Wales, a specimen from a quartz vein contained about 3,000 oz. Almost all the so-called placer nuggets of unusual size have been obtained from superficial deposits just at or below the croppings of quartz veins. This applies to the Ballarat nuggets weighing from 80 to 160 lb.

The richest placer deposits contain no spectacular large pieces of gold. The mining of placer gold valued at upwards of $35,000,000 in the Cariboo yielded only two nuggets reported to be over 30 oz. In the same district, from a relatively few thousand dollars' worth of lode gold produced, specimens up to a maximum of 5 oz. have been found. If lode mining had progressed to the extent of extracting a similar yield to that of the placers, it is not unreasonable to suppose that masses as large as the largest nuggets obtained in the placers would have been found. Moreover, the view is held by these authors that rich Tertiary bonanzas were destroyed in the formation of these placers, which, on the whole, were richer than the remaining portions of many of the veins. Similarly in the Klondike, the largest nugget found is reported to have weighed 85 oz.

Formation. — The following are the chief requisites for the formation of placer deposits :—

(1) The occurrence of gold in veins or lodes in the country rock.

(2) A period of erosion during which the gold is set free from the country rock.

(3) Concentration of the gold by some agency but chiefly that of running water.

To those three I will add a fourth, which, while not absolutely essential, is at least highly desirable, namely, freedom from glaciation.

(1) *Veins or Lodes in Country Rock.*—If now, each of these factors are examined in detail, certain facts stand out in connexion with the known placer fields of British Columbia. The occurrence of rich placer deposits does not always signify the presence of a rich " mother lode ". The Klondike, the Atlin placer area, and the Cariboo, have not yet produced lode gold to more than a minor extent. It is not beyond the bounds of possibility that they will yet produce gold from lodes in considerable quantities, but, in certain instances at least, it is believed that the gold may have come from the oxidized upper parts of sulphide deposits, leaving largely the poorer unoxidized parts. In some instances, the veins may have been almost entirely removed by erosion. The inference, however, is not warranted that because in the past attempts at quartz mining have resulted in failure, the values are always too low for successful mining. The close connexion of the veins with the placer gold in these and similar districts points to possibilities which are worthy of consideration in view of the progress which has been made in mining and milling of low-grade deposits in general.

The platinum-gold placers of the Tulameen likewise furnish evidence that the concentration of mineral in the mother lode may not be rich

enough to work. The source of the platinum has been proved beyond doubt by Kemp, but no concentrations sufficiently rich to mine have been found.

(2) *Erosion.*—Most rich placers are concentrations from enormous volumes of rock. They consequently occur in regions which have been subjected to prolonged erosion and which usually have been worn down several thousand feet to a condition of plains of relatively low relief, which later have been uplifted and dissected by the streams. If we take the Klondike as an example, the large amount of residual quartz in the gravels indicates that many cubic miles of material have been removed by erosion. In fact, the calculation has been made that the original content of the veins did not necessarily exceed five cents a ton to produce the placers which have yielded, to date, gold valued at upwards of 125 million dollars.

Insofar as the Canadian Cordilleran region is concerned, the most productive of the placer fields, namely—the Klondike and the Cariboo—are regions of crystalline schists, and in both instances these carry quartz veins with sulphides and free gold. It is not to be supposed, however, that all areas of schistose rocks are therefore potential placer fields ; the inference naturally is that those areas where the rocks are most easily attacked by the forces of erosion are the most likely to furnish extensive placer deposits, if the rocks themselves contained gold lodes to start with.

The gold in the mother lodes need not necessarily exist in the native state. Johnston and Uglow have shown, with respect to the Cariboo, that the gold existed to a large extent in the form of sulphide deposits. As weathering proceeded, the gold was leached from the upper part of the deposits and concentrated in the lower parts of the veins in the form of rich secondary bonanzas of free gold. As erosion proceeded, these rich concentrations were set free, but by their removal fresh supplies of sulphides were being brought within the reach of oxidation. This argues a long cycle of erosion, with sluggish transportation by the stream, which is precisely the geological history of large tracts of British Columbia during the Tertiary period. In the Cariboo, for example, there is a deeply dissected high level plateau, the uplands being composed of remnants of a plain-like surface of erosion. Streams which flowed at or somewhat below this plateau level must have been sluggish, for they occupied broad shallow valleys.

If the geological record of British Columbia is examined in outline, insofar as it is known, we find that Tertiary marine sediments are missing from most of the province, with the exception of small areas on the western side of the Coast range. The Tertiary was therefore a time of erosion, but it was also a time of deposition of continental sediments, of vulcanism, and of mountain building. The Coast range and Rocky mountains were formed during this time, but the central interior region appears either not to have been seriously involved in the mountain building or else, before the close of the Eocene, to have had its topography so modified that it was a region of relatively slight relief. The mountainous tracts to the east and west, with their youthful topography, their sharply cut canyons, and intense valley glaciation, do not offer the same chances for extensive placer deposits that the more mature plateau region does. As a matter of fact, the concentrations of placer gold in the Coast Range region that have proved most productive are the flood or bar gold deposits of the larger rivers, such as the Fraser, Stikine, etc. Large placers are also few in number in the Rocky Mountain region. The reason for this is probably to be found partly in more intense glaciation, as it is believed that in these mountainous tracts the glaciers were eroding, rather than depositing. It may, however, be also partly due to the fact that, in such mountainous regions, erosion is much more rapid than weathering (using the latter term in a strict sense of chemical alteration). Consequently, only those deposits in which gold existed in the native state would serve as a supply for gold placers. Sulphide deposits would be removed as such to a large extent without the development of secondary native gold. Amongst the gold deposits of British Columbia, we know that those in which the gold exists in sulphide bodies far outnumber those of the native-gold-quartz type, and of the latter many change at depth to sulphide deposits. Consequently, in areas of mountainous topography, the initial supply of gold available to form placers is less than in the areas where prolonged weathering operated to produce secondary enrichment of the gold-bearing veins.

(3) *Concentration.*—Placer gold is usually concentrated by running water. There are other methods of concentration, but for the purpose of this paper they are not important. The gold set free from the enclosing rock reaches the streams either by gravitation or by a process of slow soil creep, and along with it is the rock that formerly held it. Here a process of concentration, similar to that of ordinary water concentration of the miner, takes place. The gold quickly settles down from the stream and tends to work its way through the gravel until it reaches an impermeable stratum. We see an exactly similar process in the sluice boxes of the miner : coarse gold, in spite of the rush of water through the boxes, settles to the bottom and is caught in the riffles of the first box or two. In the stream, the gravel tends to move downstream, becoming comminuted as it goes, so that, with a prolonged period of erosion and transportation, much of the rock that originally enclosed the gold is removed from the region altogether, leaving the gold concentrated in the form of pay-streaks.

The distribution of gold in placers is irregular. Coarse gold, usually accompanied by some fine or moderately coarse gold, may be scattered through the lower 10 or 15 ft. of gravels, but usually it is concentrated on or near bedrock, for the reason that coarse or even moderately fine gold tends to work down through the gravels of a stream-bed until it reaches an impermeable stratum. Gold is never uniformly distributed through great thicknesses of gravel, but pay-streaks may occur at different elevations in such gravel deposits on a false bedrock of clay or other impervious bed. The position of a pay-streak in valleys varies greatly with the type of stream. The pay-streak may occupy the whole width of the stream-bottom in narrow V-shaped valleys, whereas, in broad flat-bottomed valleys, the pay-streak is likely to be much narrower than in the valley flat ; and it may follow a course quite different from that of the present streams. Most pay-streaks in broad valleys were originally formed in narrow valleys with fairly high gradients. As the valley widened

and the gradient became less, the pay-streak became buried under gravel. A stream of low gradient tends to meander and the bends to shift downstream, so that the alluvium in the valley may be re-worked several times and pay-streaks may be shifted in the course of such re-working. Pay-streaks are not necessarily continuous, because the gold tends to concentrate at points favourable to deposition, such as where bedrock forms good riffles, on the inside of bends, and at the head of bars.

Uplift or some other agency may cause the stream to deepen its valley and the pay-streak may be destroyed in such process and be reconcentrated in the new valley-bottom, or it may remain in its original position as an old channel-placer on a bench. We may thus have the phenomenon of a valley-bottom in itself barren with placer-gold deposits on the benches, or we may have bench deposits with some gold concentrated in portions of the newer channel where it has cut the old channel.

Flood gold, or bar gold, is sufficiently fine or flaky to be transported in muddy water. As a general rule it is concentrated in pay-streaks from a few inches to a few feet thick between extreme high- and extreme low-water marks, in places such as the upstream ends of bars where alternate deposition and erosion takes place. The general tendency is for bars to shift downstream, but at a very slow rate, and thus new pay-streaks are continually forming and old ones being destroyed. The concentrations of gold along the Fraser, Stikine, and other rivers, are examples of such deposits, and many of them have been worked several times. The first concentrations removed are, of course, the richest. Here again, the gradual cutting down of the stream may leave the "bar deposits" in the benches. Such deposits have led to many failures in mining on a large scale, owing to the fact that the character of the pay-streak was not recognized. The pay-streaks are thin and discontinuous and the gold extremely fine and difficult to save. Dredging and other large scale operations are not usually successful on such deposits.

(4) *Glaciation.*—While not absolutely essential, lack of glaciation is a condition desirable for the formation of placer deposits. Unfortunately, it is a condition which does not hold with regard to the placers of British Columbia. The effects of glaciation with respect to placer deposits may be summarized as follows: Glaciers do not concentrate placer gold; on the contrary, they dissipate the gold which they pick up. Moraines, kames, eskers, and glacial outwash plains do not contain gold in paying quantities. Scattered pieces of gold and isolated patches of gold-bearing gravels may occur in boulder clay, but stratified glacial silt and clay contain no gold. Interglacial pay-streaks may be formed by erosion during times of retreat of the ice, and consequently, may occur in glaciated regions. However, the general effect of glaciations is to scour away pre-existing gold-bearing gravels and dissipate their contents through great masses of boulder clay.

However, in certain sections at least, the glaciers were depositing their material rather than actively eroding, and in many valleys of the Cariboo district, on account of the narrowness of the valley, the gold-bearing gravels became covered over with till and thus protected from erosion. Gold-bearing gravels may therefore occur in the bottoms of valleys and on rock benches covered over with great or small thicknesses of glacial drift. Such valleys are V-shaped. Rounded or U-shaped valleys are not likely to contain buried pay-streaks, because of the effects of glacial erosion. Glacial gravels in the bottoms of such valleys may contain some gold, but usually it is so scattered that it cannot be mined profitably. Many of the rich pay-streaks mined in the early days of the Cariboo and other districts were deposits buried beneath glacial drift. It is this fact which gives these districts their importance at the present time. The "old timers" did their prospecting well, and it is fairly certain that there are few obvious deposits, which were workable by the methods employed, which escaped their attention. To us are left, then, deposits which these early miners could not work, but which could possibly be worked by modern methods and machinery, and those deposits which are not so obvious. To find these latter will require careful study of the physiography, probably coupled with our more modern methods of prospecting, such as geophysical methods and the use of the drill. In other words, as far as some of the older districts are concerned, the prospector has done his work and the finding of other large deposits probably rests on the employment of more scientific methods which the ordinary prospector has not at his disposal.

In non-glaciated regions, overloading of the streams may cause deposition of much barren material above the placers. This is exemplified in Arctic and sub-Arctic regions such as the Klondike, where the ground is permanently frozen, and thick deposits of muck have accumulated over the gravels. Placers in glaciated regions differ from those of the non-glaciated regions in that they contain large boulders, which may render impossible the use of the dredge. Similarly, the bedrock in glaciated areas is likely to be hard and unweathered, and this may cause difficulties in the recovery of all the gold in dredging.

TEMPERATURE OF ORE FORMATION

To the *Bulletin* of the Institution of Mining and Metallurgy for April, H. C. Boydell contributes a paper on the temperature of formation of an epi-thermal ore-deposit, the example investigated being the Camp Bird mine at Silverton, Colorado. It will be recalled that in 1926, Dr. Boydell criticized certain of the assumptions put forward by J. E. Spurr in his account of "The Camp Bird Compound Vein Dyke" which had appeared in *Economic Geology* in the previous year and in the present paper Dr. Boydell endeavours to prove, mathematically, that Spurr's contention that—"It is, indeed, difficult to conceive . . . that in centres of active vulcanism, where ore-injection was in many cases preceded and followed by lava eruptions, the temperature did not exceed 150° down to a depth of several thousand feet"—is not justified.

The following brief description of the Camp Bird deposit is given in the present paper. The lode, striking about east to west and dipping 65° south, intersects in turn, a surface capping of rhyolite flows, then an alternation of andesite flows and

breccias, followed by some 2,600 ft. of andesite breccia (San Juan Tuff) which, in its turn, rests on a basement of Mesozoic and Palæozoic sediments. The portion of this succession that is germane to the paper is the thick, lowest andesite breccia and the andesite flow, 50 ft. thick, which caps it. The productive portion of the Camp Bird lode, 600 to 700 ft. in depth, was situated in this lowest breccia immediately under the lowest andesite flow, though a little ore occurred in that andesite itself. The fissure on which the lode was situated extended upward to the surface rhyolite flows and down into the breccia as far as it was followed, some 1,500 ft. below the top of the ore, and was intersected much deeper still by a low-level adit. Values were unpayable both lower than 700 ft. beneath, as well as above, the lowest andesite flow.

Omitting the mathematical portion of the author's paper, we may reproduce here the summary which he gives at the end. The following are his conclusions :—

1. Apart from geological structure and mineralization, temperature is an important factor in the formation of ore deposits of magmatic origin. Despite this, but little that is definite and specific is known about such temperature influence. The paper seeks to remedy this deficiency partly.

2. The cause of temperature rise, in the vicinity of the locus of an ore deposit, neglecting radioactivity, may be (*a*) igneous rock, or (*b*) heated solutions.

3. The igneous rock may be plutonic, hypabyssal or extrusive.

4. The temperature rise produced by extrusive rocks, since the latter are accessible for observation and heat conduction need only be considered in one direction, downward, is most readily studied.

5. The paper deals with rise of temperature caused by heat conduction from a lava flow, in the basement rock on which it is poured out.

6. The Camp Bird Mine, Silverton, Colorado, with its andesite lava flows and volcanic breccia basement, is the illustrative example studied.

7. J. E. Spurr having written " . . . it is indeed difficult to conceive how the idea arose that in centres of active vulcanism, where ore injection was in many cases preceded and followed by lava eruptions, the temperature did not exceed 150° down to a depth of several thousand feet . . ." this statement is critically examined.

8. For calculation of the temperature at different depths in the rock under the lava, a general mathematical basis is found in the work of Ingersoll and Zobel.

9. To fit the Camp Bird case to this mathematical treatment, for purposes of simplification, it has to be assumed that the temperature of the air-lava interface is maintained at or about zero Centigrade, and that the initial temperature of the basement rock is zero. Camp Bird conditions are discussed and found to conform to, or at any rate not seriously to depart from, these conditions.

10. With the help of Fourier's series a mathematical mechanism is found for calculating the temperature rise in the basement rock due to emplacement of hot lava on it, and suitable equations are derived.

11. With the help of these equations, the question " What temperature will be reached at such and such a depth, x, after such and such a time, t ? " is answered graphically by temperature curves for depths up to 200 metres (656 ft.) and for times of one quarter, one, four, nine, twenty-five, forty-nine, and one hundred years. By means of these it is shown, for example, that the temperature rise at a depth of 200 metres (656 ft.), after 100 years, would be only 1° C.

12. To the further question, " After what time, t, will a temperature, θ, be attained at depth, x ? " by means of a derived curve it is shown that, except for the maximum, such a temperature will be reached twice, first on heating up and again during the, later, cooling down.

13. A third question, " What will be the maximum temperature reached at any point, x, and what time will be required to reach it ? " leads, after differentiation of one of the equations, to the derivation of a transcendental equation that yields curves that show, for example, the maximum temperature at a depth of 200 metres (656 ft.) is only 2° C., and is attained after 208 years.

14. Still another question, " How long will it take such and such a point in the underlying rock to heat up to a given temperature and then cool down again ? " is discussed, its limitations shown and answered for a specific point, 20 metres (65 6 ft.) under the lava, which will take 1 year to heat up to 5° C. and (after rising to its maximum) 83 years to cool down again to 5° C.

15. Results are tabulated, and the conclusion arrived at that, except at the immediate contact, temperature rise in the underlying rock due to heat conduction from the superimposed lava cannot have had any worth-while influence on vein mineralization and that such rise is well within the temperature range assumed by Lindgren for epi-thermal, or shallow zone, ore deposits, such as that of Camp Bird.

16. Regarding temperature rise due to heated solutions circulating in, or entering geological structures of various kinds, it is assumed that the solutions rise, in the case of an ore deposit of magmatic origin, from some igneous source in depth and lead eventually to the setting up of a " steady state " zone of temperature in the " walls " of the opening in which they flow.

17. Applying such general conditions to the Camp Bird case, the simplifying assumptions so usual in geological problems to render solution possible have to be made. These are those of a fissure 5 feet wide extending downward for 5,000 feet, and a constant temperature at the source in depth, etc.

18. Two cases have to be distinguished :—

(*a*) Ore-forming solution flows upward at definite rate, so long that a " steady-state zone " is established in the wall rock for some distance on either side of the fissure.

(*b*) Ore-forming solution rises in the empty fissure, fills it and then ceases to flow.

19. In the first case, assuming an upward velocity of flow of one foot per minute, a steady-state zone 100 ft. wide on either side of the fissure, and a constant temperature of 1000° Fah. (538° C.) for the solution at its source in depth, on the basis of supposing the fissure to be the annular space between two concentric cylinders of very large diameter, the problem is made analogous to one concerning heat loss from insulated pipes ; computation shows the temperature of the solution at the top of the fissure would be 1·7° C., say 2° C. lower than at the bottom.

20. If the fissure width were only one foot, other conditions being unchanged, the temperature drop

of solution during ascent would be 7·8° C., say 8° C., whilst if the width were reduced to one *inch*, the temperature drop (assuming formulæ to hold good, which is doubtful) would be 88° C.

21. The openings leading to the formation of veins having widths, in places, almost certainly much less than one inch, with consequently reduced velocity of upward flow, it seems probable that the temperature drop of ascending solutions is considerably more than 88° C. and that the temperature of the wall rock is correspondingly lower too.

22. No method is known to the writer of finding the temperature drop in case *b*, but it is hoped that ensuing discussion may elicit one.

23. It is concluded generally from the preceding considerations therefore, that *heat conduction* from the andesite lava can have exercised no important influence on mineralization of the Camp Bird vein. Regarding temperature rise due to heated ore-forming solutions, the evidence adduced is inconclusive, though it is probable that actual geological conditions lead to a considerably greater temperature drop during ascent of solutions than those computed.

24. It is submitted as abundantly evident that Mr. J. E. Spurr's contention that in cases like the Camp Bird the temperature exceeded 150° down to a depth of several thousand feet is quite unjustified.

25. The writer specially emphasizes the warning that the figures computed for heat transfer from an effusive rock do *not* apply to intrusive conditions where heat conduction must be considered in three dimensions instead of one.

Southern Kavirondo, Kenya Colony.—At the request of the Government of Kenya Colony, the Director of the Geological Survey of Uganda, Mr. E. J. Wayland, made a geological reconnaissance of Southern Kavirondo early in 1930. His report [1] has now been published in full, while the petrology and assay results of the two hundred specimens collected are dealt with in appendixes by Dr. A. W. Groves, also of the Geological Survey of Uganda. The area dealt with covers much of the country south of the Kavirondo Gulf of Lake Victoria and north of the Kenya–Tanganyika border and was examined with a view to determining whether any part of it is worthy of a detailed survey on account of its economic possibilities.

The existence of auriferous lodes in Southern Kavirondo has been known for some years and even in pre-war days the Germans had shown considerable prospecting activity. In south-western Kavirondo between the Gori and Myunyo Rivers some of these lodes have been worked on a small scale since 1929. One of the principal points brought out in Mr. Wayland's report is that the gold-bearing quartz dykes are found to occur in early north-west–south-east shatter belts. This north-west–south-east line is an important one in the geology of East Central Africa, and is frequently one of crushing and shearing. The reefs are of quartz, containing pyrite, which decomposes to limonite at the surface. The quartz itself is the typical waxy-looking gold-bearing variety and contains a little siderite. The country rock is shown in the petrological appendix to be a granite-porphyry converted by intense shearing to slabby and slaty rocks, which, in the hand specimen, resemble altered sediments rather than igneous rocks. All gradations are found between almost normal granite-porphyry, through sheared types (locally called "suet-rock") to mylonites superficially resembling schists, the various stages being illustrated by a series of six photomicrographs. It not infrequently happens that on the westerly side the wall of the reef is porphyry while the easterly wall is of mylonized porphyry resembling a schist The dip of the coutry in general is steep to the S.S.W. Specimens for assay were collected in an endeavour to locate possible extensions of the gold-bearing quartz veins as well as to re-examine some of the material from the old German prospect trenches. Of seventeen fire assays for gold and silver, several yielded some silver and in two cases gold, the highest figured being six dwt. of gold.

Mr. Wayland collected a great deal of new geological information with regard to the area amongst which the following are the most important features :—

(1) The discovery of large extensions of the Miocene beds, especially on Rusinga Island at the mouth of the Kavirondo Gulf.

(2) Much of the gneissose and other rocks included by Felix Oswald (Q.J.G.S., 1914) in the "Basement floor" are found, both from their field and microscopical characters, to be Newer Granites.

(3) Certain notable geological features which have already been proved in Northern Kavirondo are also found in Southern Kavirondo, e.g. the existence of Karagwe-Ankolean beds with the remarkable boulder conglomerate at or near their base.

A great variety of igneous rocks were collected, all of which have been examined in detail under the microscope. The lavas belong to two or three volcanic episodes, an earlier one of Karagwe-Ankolean and Pre-Karagwe-Ankolean age, and a later one which existed during Miocene times at least. The earlier one is represented mainly by andesites, while the Tertiary lavas all have alkaline affinities. Other types such as rhyolites, trachy-andesites, basalts, limburgites, and many altered amygdaloidal lavas cannot be correlated without further work. The Tertiary lavas are for the most part ægirine-augite-nephelinites, although there are also some trachytes of which one type is characterized by anorthoclase. Some of the nephelinites contain much melanite and a nephelinite tuff on Kaswanga Hill, Rusinga Island, on weathering has made the ground a glistening mass of these black garnets which are readily collected by hand. Among the hypabyssal rocks the granite-porphyries have already been mentioned, but there are also granophyres, quartz-porphyries, diorite-porphyries, and dolerites. In a number of cases the dolerites are similar to a common type in Uganda and Tanganyika. The correlation of several of the granites with the Newer Granites (the G 2 granites of the Geological Survey of Uganda) has been confirmed by an examination of their heavy mineral assemblages.

Sandstones in the Kisii Highlands (the Kisii Sandstone) which were discovered by Mr. Wayland were believed by him on stratigraphical and lithological grounds to be the equivalents of the Bukoba Sandstone of the Bukoba Province of Tanganyika. A study of the petrography and

[1] Report on a Geological Reconnaissance of Southern Kavirondo. By E. J. Wayland, with appendixes by Dr. A. W. Groves. Price 2s. 50 cents. Nairobi: Government Printer.

heavy mineral suite by Dr. Groves has confirmed this correlation. The heavy mineral suites of both are characterized by a considerable proportion of "Newer Granite" detritus including a notable amount of cassiterite. It is recommended that the area should be mapped if and when a geological survey is formed in Kenya Colony. With regard to gold, further prospecting should be undertaken by locating continuations of the shatter zone, or determining others, and prospecting quartz-dykes, etc. within them, as well as sampling stream beds and alluvial deposits. It is also suggested that a study of the basin in which the Kisii Sandstone was deposited should reveal the source of the tinstone.

Concentrating Tungsten Ores at Atolia, California.—The methods and costs of concentrating scheelite, as practised in two mills of the Atolia Mining Co., Atolia, California, are described in Information Circular 6,532 of the United States Bureau of Mines, by W. O. Vanderburg. The Atolia Mining Co. operates two concentrators; one of 800 tons daily capacity for recovering scheelite contained in placer material and the other, of 150 tons daily capacity, for the treatment of scheelite ore.

The placer material, which averages a little over 1½ lb. of scheelite per ton, is mined by a revolving-type shovel and passed through a grizzly with 6 in. spaces. The undersize is reduced to 2 in. size by a swing-hammer disintegrator. The minus 2 in. material is concentrated in jigs which produce concentrates, hutch, and tailings. The hutch is cleaned on tables. The table concentrates, after being dried, are fed to a magnetic separator for the removal of magnetite. The concentration ratio averages 1,369 tons into 1; the combined concentrates contain approximately 62% of tungstic oxide and 0·01% of phosphorous; the recovery of scheelite amounts to about 70%. The cost of concentrating for 10 months of the year 1930 was $0·37 per ton of material treated.

The mill for the treatment of ore operated last in 1929 on dump material, which contained about 6 lb. of scheelite per ton. The treatment of this material was much the same as the treatment of placer material except that the ore after the removal of waste by sorting was reduced by crushing to ¼ in. size. The minus ¼ in. material was sized by screens; the oversize was treated by jigs and the undersize combined with jig hutch was concentrated on tables. The table concentrates were cleaned by a magnetic concentrator before and after roasting for the removal of magnetite and pyrite, respectively. In the treatment of ore the concentration ratio was about 400 tons into 1; the concentrates contained approximately 67% of tungstic oxides, 0·45% sulphur and 0·075% phosphorous; the recovery of scheelite amounted to about 80%. The cost of concentrating ore for the year 1929 was $1·22 per ton.

SHORT NOTICES

Ventilation.—The system of ventilation installed at the Frood mine of the International Nickel Company is described by R. D. Parker in the *Canadian Mining and Metallurgical Bulletin* for April.

Electrical Equipment.—F. A. Becker describes the electrical equipment at the Flin Flon mine in the *Canadian Mining Journal* for April.

Plant at Mount Isa.—The first part of a description of the electrical equipment and mining plant at Mount Isa appeared in the *Engineer* for April 15.

Winding Engines.—In *Engineering* for April 22 a full description is given of a winding engine with hydraulic brake which is to be installed at Daggafontein No. 2 shaft.

Mining at Gilman, Colorado.—R. E. Kirkhuff deals with electric power and underground milling at Gilman, Colorado, in *Engineering and Mining Journal* for April.

Fireclay Mining.—An article on the mining and processing of fireclay, by G. J. Young, appears in the *Engineering and Mining Journal* for April.

Noranda Smelters.—W. B. Boggs, J. N. Anderson, and R. J. Westwood contribute a description of the anode department of the Noranda smelter to the *Canadian Mining and Metallurgical Bulletin* for April.

Copper Electro-Hydrometallurgy.—In the *Monthly Bulletin* of the State College of Washington the second progress report of C. F. Floe and A. E. Drucker on the development of an electro-hydrometallurgical process for copper flotation concentrate is given.

Cyanide Solutions.—The effect of adding common salt to cyanide solutions is discussed by A. McA. Johnston in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for February.

Copper Determination.—Observations on the Clarke and Jones of determining traces of copper are given by L. C. Hurd and J. S. Chambers in *Industrial and Engineering Chemistry* (Analytical Edition) for April 15.

Vanadium in Steels.—H. H. Willard and P. Young describe a rapid method for the determination of vanadium in alloy steels in *Industrial and Engineering Chemistry* (Analytical Edition) for April 15.

Geophysical Prospecting.—An account of a lecture given by A. B. Broughton-Edge on geophysical methods of prospecting appears in the *Journal* of the Royal Society of Arts for April 22.

Explosive Testing.—*Bulletin* 346 of the United States Bureau of Mines, by C. E. Munroe and J. E. Tiffany, describes the physical testing of explosives carried out at the Explosives Experiment Station, Brucetown, Pennsylvania.

Asbestos.—The results of an X-ray study on the structure of asbestos by B. E. Warren are given in *Industrial and Engineering Chemistry* for April.

Kwangsi Province, China.—In the *Far Eastern Review* for March an account is given of the mineral resources of the Kwangsi province in South-West China.

South-West Africa.—In the *Journal* of the South African Institution of Engineers for March, D. Holtzhausen describes some hydrological features of South-West Africa.

Gold Supplies.—A review of the gold supplies of the world, by S. D. Strauss, appears in the *Engineering and Mining Journal* for April.

Pulacayo, Bolivia.—The silver-lead-zinc mines of Pulacayo are described by A. Rudroff in *Metall und Erz* for April 1.

French West Africa.—E. A. de la Rue describes the mines and ore deposits of French West Africa in *Mines, Carrières, Grandes Entreprises* for April.

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.*

33,054 of 1930 (368,316). Norddeutsche Affinerie, Hamburg. Pure white As_2O_3 is prepared from crude arsenical products, such as flue dusts, by extracting at elevated temperatures with water, or dilute acid, or alkali. The oxide is deposited in crystalline form on cooling the hot extracts.

33,983 of 1930 (367,384). A. G. McGregor, London. Method and furnace for the fire-refining of copper and other metals

36,491 of 1930 (367,481). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Process for the manufacture of molybdenum and tungsten carbonyls.

37,521 of 1930 (368,410). R. G. Christie, London. An instrument for the rapid determination of the direction of the horizontal component of the earth's magnetic field.

1,621 of 1931 (367,996). I. G. Farbenindustrie A.-G. Metallic carbonyls are converted into metals, especially in the case of those having high degrees of dispersion, by causing them to fall through a heated space in a comminuted solid state.

1887 of 1931 (367,524). G. A. Blanc, Rome. Leucite is treated with nitric acid for the recovery of potash.

7,603 of 1931 (367,588). A. R. Powell, E. C. Davies, and Johnson, Matthey and Co., Ltd., London. Metals of the platinum group are electrolytically plated onto precious metals, and most of the base metals, from solutions of the double sodium nitrite of the platinum metals desired, the solutions being preferably neutral or faintly acid.

9,591 of 1931 (367,819). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. The stability of suspensions, so important as initial materials in many methods of producing metal carbonyls, is increased by the addition of small amounts of water.

9,770 of 1931 (367,611). Berzelius Metallhütten G.m.b.H., Duisberg-Wanheim, Germany. Tin and zinc are recovered separately from materials containing them both, by a process in which the zinc is first volatilized, the tin being subsequently recovered from the residue.

29,742 of 1931 (369,536). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Magnesium is produced by electrolysis of a molten bath, which, in contradistinction to known processes, only contains a comparatively small amount of magnesium chloride.

30,095 of 1931 (369,162). C. Adamoli, Milan. Beryllium carbonate is obtained from minerals low in beryllium oxide content by treating the pulverized minerals with CO_2, in a large volume of water.

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.

Bauxite and Aluminous Laterite. By Dr. C. S. Fox. 2nd edition. Cloth, octavo, 312 pages, illustrated. Price 30s. London : Crosby Lockwood and Son.

Oil Economics. By Campbell Osborn. Cloth, octavo, 402 pages, illustrated. Price 24s. London : McGraw-Hill.

Le Centre Africain : Le Domaine Minier et La Cuvette Congolaise. By M. Robert. Paper covers, 261 pages, illustrated, with maps. Brussels : Maurice Lamertin.

The Unstable Earth : Some recent views in geomorphology. By J. A. Steers. Cloth, octavo, 341 pages, illustrated. Price 15s. London : Methuen.

Chromium Plating. By E. S. Richards. Cloth, octavo, 131 pages, illustrated. Price 7s. 6d. London : Charles Griffin.

American Electricians' Handbook. By Terrell Croft. 3rd edition. Cloth, octavo, 1051 pages, illustrated. Price 24s. London : McGraw-Hill.

Geophysics, 1931. *Transactions* of the Society of Petroleum Geophysicists. Vol. 1. Paper covers, 113 pages, illustrated. Price $2·50. London : Thomas Murby.

Geophysical Prospecting, 1932. *Transactions* of the American Institute of Mining and Metallurgical Engineers. Cloth, octavo, 510 pages, illustrated. Price $5. New York : American Institute.

Traité Pratique de Prospection Géophysique. By C. L. Alexanian. Cloth, octavo, 268 pages, illustrated. Price 62 francs. Paris : Librairie Polytechnique Ch. Béranger.

Gems and Gem Minerals. By Dr. E. H. Kraus and Dr. E. F. Holden. 2nd edition. Cloth, octavo, 260 pages, illustrated. Price 18s. London : McGraw-Hill.

Stratigraphy of the Plains of Southern Alberta. Donaldson Bogart Dowling Memorial Symposium. Cloth, octavo, 166 pages, illustrated. Price $3·00 U.S.A. London : Thomas Murby.

Canada. Investigations of Fuels and Fuel Testing, 1929. Paper covers, 130 pages, illustrated. Ottawa : Department of Mines.

British Columbia : Lode-Gold Deposits. Compiled by J. D. Galloway. Paper covers, 147 pages, illustrated. Bulletin No 1, 1932, British Columbia Department of Mines, Victoria, B.C.

Nova Scotia : Annual Report on Mines, 1931. Paper covers, 296 pages, illustrated. Halifax : Department of Public Works and Mines.

Ontario. Mineral Production in 1931 (Preliminary Report). Paper covers, 32 pages. Toronto : Department of Mines.

Tanganyika Territory : Report on the Geology of the Ruhuhu Coalfields, Njombe-Songea Districts. Geological Survey Department Bulletin No. 2. By G. M. Stockley and F. Oates. Paper covers, 63 pages, illustrated. Price 5s. Dodoma : Geological Survey.

Mineral Resources of the United States, 1930. Part II, pp. 315 332, Phosphate Rock, by B. L. Johnson ; pp. 387–395, Mica, by B. H. Stoddard. Washington : Superintendent of Documents.

Sheffield University. Report on Research Work carried out in the Departments of Mining and Fuel Technology, 1930–31. Paper covers, 18 pages. Sheffield : The University.

Quin's Metal Handbook and Statistics, 1932. Cloth, pocket size, 277 pages. Price 5s. London : Metal Information Bureau.

Nickel Steel. The Semi-Direct Production of Nickel Steel from Sudbury Ore. By T. W. Hardy and H. H. Bleakney. Canadian Department of Mines Memorandum Series No. 54. Typescript. Ottawa : Dept. of Mines.

Coal: A Classification of Coals for use in the By-Product Coking Industry. By E. J. BURROUGH and E. SWARTZMAN. Reviewed by R. E. GILMORE. Canadian Department of Mines Memorandum Series No. 55. Typescript. Ottawa: Dept. of Mines.

Canada: Mineral Production, 1931, Preliminary Report. Paper covers, 39 pages. Ottawa: Dominion Bureau of Statistics.

Mines Department: Report of H.M. Electrical Inspector of Mines, 1930. Paper covers, 28 pages, illustrated. Price 6d. London: H.M. Stationery Office.

COMPANY REPORTS

Waihi Gold.—This company was formed in 1887 and works gold mining properties in the Thames district, New Zealand. The report for the year 1931 shows that the ore crushed totalled 223,722 dry short tons, included in which is 26,496 tons of ore and 18 tons of residues from the Waihi Grand Junction Company's property and 328 tons of ore crushed for the government. The ore treated averaged 7 dwt. gold and 2 oz. 13 dwt. 9 gr. silver, the value being 34s. 8·8d. per ton. The total output was 75,347 oz. of gold and 434,476 oz. of silver, the whole being valued at £359,907. The credit balance at the end of the year was £100,471, to which must be added the sum of £2,556 brought in, giving an available total of £103,027, of which £99,181 was distributed as dividends, equal to 2s. per share, leaving a balance of £3,846 to be carried forward. The ore reserves at the end of the year were estimated to be 167,021 tons, averaging 32s. per ton, in "General Account" and 175,851 tons, averaging 34s. 6d. per ton, in "Suspense Account," a total reduction of 21,890 tons in amount and of 11d. in value when compared with the previous year. The reserve ore in the Junction Company's ground was 23,126 tons, averaging 34s. 9d. per ton. The reduction in value of the ore in general account, together with rising mining costs, are considered disturbing, but every advantage is being taken of the present premium on gold. Arrangements for the taking over of the tin property in Siam, in which the company has a large interest, are still under way, the slow progress, it is considered, may be an advantage in view of the present price of tin.

Oroville Dredging.—This company was formed in 1909 and has a controlling interest in Pato Mines (Colombia), Ltd. The report for the year to September 30 last shows that 3,766,813 cu. yd. of ground and tailings was excavated by the dredges of the Pato company for a yield of $525,832, as compared with 3,283,724 cu. yd. for $568,077 in the previous year. Dividends received from the Pato company amounted to £49,954, the credit balance for the year being £38,830, which, with the amount brought in, gave an available total of £87,092. A dividend of 9d. per share was paid for the year. The company has acquired a substantial interest in Bulolo Gold Dredging, Ltd., operating in New Guinea.

Naraguta Karama Areas.—This company was formed in 1926 and operates alluvial tin properties in Northern Nigeria. The report for 1931 shows the production to have amounted to 191¾ tons, against 309⅛ tons in the previous year, the average price realized being £71 18s. 10d., as compared with £74 9s. 4d. in 1930. The profit for the year was £2,124, which, added to the amount brought in, gave an available total of £7,974, which was carried forward.

Buena Tierra Mining.—Formed in 1912, this company owns a silver-lead property in the State of Chihuahua, Mexico, which has been leased to the Potosi Mining Company. The report for the year 1931 shows that 45,251 tons of ore, averaging 9·58% lead and 6·59 oz. silver per ton, were taken from the mine. The net profit for the year was £5,233, which reduces the debit balance brought in to £68,023. The lease to the Potosi company expired at the end of January, but it has been renewed. Diamond drilling is said to have encountered ore-bodies between the 17th and 18th levels of the mine, but so far their importance is not known.

Patino Mines.—This company was formed, in America, in 1924, and operates tin properties at Uncia-Llallagua in Bolivia. The report for 1931 shows that 14,382 tons of fine tin was produced as against 17,015 tons in 1930, the year's operations resulting in a loss of £114,642, as against a loss of £240,060 in the previous year. Development during the year added 16,550 tons of fine tin to the reserves, which, at the end of the year, amounted to 77,559 tons.

Mason and Barry.—Formed in 1892, this company works the San Domingos mine in the province of Alemtejo, Portugal. The report for the year 1931 shows the total quantity of ore broken and raised at the mine to have been 198,725 tons, against 202,848 tons in 1930, shipments over the same period being 178,203 tons, against 204,875 tons. The profit for the year was £4,899, increasing the credit balance carried forward to £17,355.

DIVIDENDS DECLARED

Central Mining.—6s., less tax.

Changkat Tin.—6d., less tax, payable May 25.

Chinese Engineering and Mining.—6d., payable May 4.

Globe and Phoenix.—1s. 6d., free of tax, payable May 10.

Kaduna Syndicate.—3d., less tax.

Pahang Consolidated.—Pref. ½%, less tax, payable May 2.

Petaling Tin.—4%, less tax, payable April 30.

Tehidy Minerals.—4½d., less tax, payable April 19.

Transvaal Gold Mining.—6d. (S.A. currency), less tax, payable May 11.

Union Corporation.—2s. 6d. (English currency), less tax, payable May 19.

Waihi Gold.—1s., free of tax, payable May 6.

West African Diamond.—1½d., less tax, payable April 21.

NEW COMPANY REGISTERED

British Tin Investment Corporation.—Capital: £1,250,000 in 10s. shares. Objects: To acquire the undertaking and assets, except metallic tin, of the British-American Tin Corporation. Directors: O. V. G. Hoare, J. H. C. E. Howeson, J. Ortiz-Linares, O. Lyttelton, A. J. G. Murray-Graham, A. Patino, S. H. Smith, C. V. Stephens. Office: Princes House, 95, Gresham Street, E.C.2.