The Mining Magazine

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EDITORIAL

A FINE tunnelling performance was recently completed at Halkyn, North Wales. In a period of 31 days 1,087 ft. was driven, the best weekly total being 250 ft. It is also interesting to note that the five-mile drive under the Lakeland hills, which forms part of the Haweswater scheme of the Manchester Corporation, has been completed.

SOME explanation of the increased demand for tin in the United States is furnished by the Bureau of Mines, a report from which refers to the consumption of the metal by the aircraft and refrigerator manufacturing industries. Attention is also drawn to the increased demand for brewing equipment, following the loosening of the Prohibition strings.

FITTING tribute was paid to Sir Ronald Ross at the commemorative service held at the church of St. Martin-in-the-Fields last month on the occasion of the thirty-sixth anniversary of his epoch-making discovery of the malaria parasite. Sir Ronald was a poet and musician as well as a great scientist and it was appropriate, therefore, that the Poet Laureate should deliver an appreciative address.

WRITING in the July issue of *Mining and Metallurgy* on bygone customs in metal mining still extant in this country Mr. F. E. Gregory reveals a state of affairs that will be a revelation to mining men on this side. We are told of organized towns underground in Cornwall and of other wonders of which heretofore we have been in ignorance. The tale, in fact, reminds us of others written by an individual whose name also started with G.

THAT electrification has increased in the collieries, metal mines, and quarries in this country is revealed by a report [1] just issued. In coal mines, compared with the year 1927, while there were in 1932 169 fewer mines at work using electricity there was a net increase of horse-power of motors installed of 171,139, the number of motors having increased by 5,663. In metal mines the total increase over 1931 was 1,498 h.p., compared with a decrease of 3,078 h.p. shown in the previous report. In quarries the year's increase was 11,856 h.p., with 89 more quarries at work.

[1] Report of H.M. Electrical Inspector of Mines. London: H.M. Stationery Office. Price 1s.

PRELIMINARY details of an air survey over approximately 88,000 square miles of country in Western Australia were announced last month. The work has been commissioned by Austral Development, Ltd., on behalf of the Western Mining Corporation, Ltd., and it is expected that a start will be made early next year. The survey is expected to be of considerable assistance to the corporation's geologists in locating likely ground for close prospection on foot.

THE British Association meeting took place at Leicester this year, from September 6 to September 13, under the presidency of Sir Gowland Hopkins. Of special interest were addresses by Sir Gilbert Walker, before the mathematical and physical sciences section, on seasonal weather and its prediction and by Professor J. H. Jones, before the economics section, on the gold standard. Professor J. F. Thorpe addressed an evening meeting and also gave demonstrations of the work of the Safety in Mines Research Board and Sir Josiah Stamp read a paper bearing the provocative title "Must Science ruin Economic Progress."

THE results of recent work on the analysis of coal ash [1] recorded by the Department of Scientific and Industrial Research recall a point raised during the discussion on the late Professor Gregory's paper on the Mansfeld copper deposits, read before the Institution in December, 1930. Progress in spectrum analysis has led to the detection of many elements in coal ash that have hitherto been unsuspected, no fewer than 31 metals being found in a flue dust obtained from the combustion of South Yorkshire coal. At the Institution meeting referred to the presence of a large number of elements in the Mansfeld ore was taken as evidence of syngenetic origin, a point disputed by Dr. W. R. Jones.

[1] London: H.M. Stationery Office. Price 6d.

THE annual report of the Nigerian Mines Department for 1932 shows that there were 47 mining companies and 51 private individuals operating on tin, the slight decrease in numbers as compared with the previous year being due almost entirely to the amalgamation of certain of these interests. The tin concentrates recovered amounted to 5,999 tons, a decrease of 3,801 tons on the output for the previous year. Exports of tin over the same period amounted to 5,967 tons, valued at £579,504. The total working costs, including royalties, freights, returning charges, and London office expenses, averaged £75 per ton of concentrate produced, while the average value per ton of tin, based on the London price of the metal, was approximately £95. The profit per ton, therefore, was £20, making an estimated total profit of £119,991 for the year, an increase of £110,190 on the corresponding figure for 1931. Turning now to the gold production the output for the year amounted to 2,700 oz., worth £15,900, as compared with 699 oz. recovered in the previous year. Gold-mining activities are at present centred mainly in the Kano, Niger, Sokoto, and Zaria provinces. (A description of the potentialities of the Minna district, Niger province, by Mr. W. C. Grummitt, will be found elsewhere in this issue.) Towards the end of 1931 considerable interest was aroused by discoveries on the Koriga River, in the Niger province, and Dr. Russ, of the Geological Survey Department, made an examination of the area, the results of his work being contained in the annual report of his department for that year. Operations on the silver-lead deposits of the colony are still under way, the output for 1932 amounting to 682 tons of lead concentrates, estimated to contain 85,368 oz. of silver. Northern Nigeria Lead Mines, Ltd., is stated to be installing machinery for the examination of the deposits at Zurak, Adamawa province, in depth, prospecting by diamond drill having been carried on continuously during the year under review. The price of mica has severely curtailed the exploitation of the deposits of this mineral at Ogbom, Kabba province, the output recorded being less than one ton. Before concluding this summary of the report one noteworthy amendment to the Minerals Ordinance should be recorded. Regulation No. 2 (1)d has been altered in order that the Governor may, for a sufficient cause, reduce the rent payable on a water right.

Iron and Steel

It is the opinion of many observers—and the hope of all—that at last world trade is slowly improving as the disastrous depression through which we have been passing tends to fill up. In the intensive struggle for world markets that is even now developing the British manufacturer must be ready to play his part and in this connexion it is important to examine the progress that has been made towards rehabilitating the iron and steel industry of this country. Speaking in South Africa in 1929, following Dr. Hans Pirow's presidential address to the Chemical, Metallurgical, and Mining Society, Sir Thomas Holland stressed the importance of a well-founded iron and steel industry to the economic well-being of any community, especially if other base-metal industries are to be carried on. He pointed out—and his remarks seem peculiarly applicable to the present state of affairs in this country—that only by the possession of a stable iron and steel industry can a country conduct manufacturing operations on a large scale.

During the War the iron and steel makers in this country were compelled to increase their productive capacity in order to meet the enormous demands made on them. Conditions remained prosperous during the boom which followed the signing of the Armistice, but in the subsequent collapse of prices it soon became evident that the war capacity that had been built up was far too great for post-war conditions, while experience gained during those active years had shown much even of the newly-installed plant to be already obsolete and quite unsuitable for use in the intense competition that resulted. Once these deficiencies of the industry had been clearly recognized much was heard of the "rationalization" of the industry—a delightfully vague term that was long held to cover those things that obviously should be done and many that were probably necessary but still unnoticed. Reorganization of the industry was patently needed, however, and in 1932 the Tariff Advisory Committee, in making its recommendation that a protective duty be placed on imports of iron and steel, wisely suggested that protection would not of itself be sufficient to place the industry in a position to play its proper part in the national economy, but must be accompanied by a "considerable measure of reorganization," while, when the extension of the tariff for two years was

granted last autumn, it was conditional on "satisfactory progress being made in the preparation of the scheme for reorganization and in putting the approved scheme into force." A preliminary scheme drafted early this year has been formally approved by the authorities, but the results to date are obviously meagre and it seems evident that protection has given many of the smaller units an excuse for delaying the putting into execution of that progressive policy which is necessary if the industry is to be ready to deal with the condition of trade expansion which it is hoped may be near at hand.

In an article that recently appeared in the *Times* the difficulties that stand in the way of reorganization were clearly set out. The author felt that these difficulties sprang mainly from two sources—first, the intense individualism, jealousy, and mutual suspicion of the various manufacturers and, secondly, the enormous load of financial charge incurred during the war period and the following boom. The main feature of the reorganization scheme proposed early this year was the setting up of a national body, incorporated by Royal Charter, to be called the Iron and Steel Corporation of Great Britain. This body was to provide services of an advisory and business character for its members and associates, to assist approved associations in measures calculated to promote efficient operation, to co-operate in promoting export trade, and to act on behalf of the industry in all negotiations. Such a body will obviously not have the power to compel constructive reorganization, so that much still remains to be done. Approved amalgamations of the correct kind—as, for example, the recent fusion of the Dorman Long undertaking with that of the Cargo Fleet-South Durham group—have no difficulty in finding the necessary finance for working capital and re-equipment, so that the value of concentrated effort towards the rehabilitation of this basic industry seems to be more widely appreciated outside the industry than within it. If progress is slow it is to be hoped that the success of such amalgamations as that mentioned will have their effect, for the sooner the industry realizes that regional amalgamations and the co-ordination of secondary industries are absolutely essential preliminaries to the building up of a stable industrial foundation the sooner will the country be fitted to cope successfully with its unemployment problem.

Africana

Late in 1931 a disastrous fire at the University of the Witwatersrand resulted in the loss of the books and documents housed in the Gubbins Library of Africana, in the Hoernle Anthropological Museum, and in the Leonard Memorial Law Library, a loss infinitely more serious than was the damage to the fabric itself, for much of the material destroyed was irreplaceable. In the MAGAZINE for June, 1932, attention was drawn to the efforts then being made to make good the University's loss and the formation of a committee in this country, under the chairmanship of Lord Athlone, to co-ordinate work here in aid of the appeal for books to replace those lost, was recorded. The activities of this organization now appear to be approaching their end, although it will remain in existence as long as there is any work to be done.

The operations of the committee have followed two separate and distinct paths—first, the collection of books for the library and, secondly, the collection of material bearing on the early history of South Africa, by which is meant Africa south of the Equator. With this latter section the name of Mr. J. G. Gubbins is most intimately associated and when he was in this country last summer he gave a great stimulus to the movement, which it is hoped will lead ultimately to the establishment of a museum in Johannesburg. During July an exhibition of selected material from his collection of Africana was held at South Africa House and between four and five thousand people visited it. This has now been sent to Johannesburg and it is hoped it will be shown there as it was in London. Some specially interesting material, however, is being kept here for a time in order that it may be copied for the British Museum, the Records Office, and historical research societies. Most of this had to be purchased, the funds having been provided by the University, Mr. Gubbins, and some friends. The collection of books, however, has cost practically nothing for purchase, although the expenditure to date for cataloguing, etc., has amounted to nearly £1,500, the greater part of which has had to be provided by the University out of its limited funds, for within the past two years the Government grant has been very considerably reduced. Still, there is something to show for this work, as already 25,000 books have been sent out and the total is expected to

reach 30,000. The British Association gave the committee a good start by circularizing its members and the learned, scientific, and technical societies, the Universities, the Colleges, and many industrial firms have also contributed very largely, but the bulk of the books have come from private individuals. The result of the appeal has, in fact, been so encouraging that it is hoped when the new fireproof library is opened next March it may be even better than the old one.

No attempt has been made by the committee on this side to appeal for funds, yet nearly £1,000 has been given. Without this financial assistance the organization might have been compelled to close down months ago, for Universities are not as a rule rich. Perhaps the most noteworthy effort, however, was that of Johannesburg itself. During a time of depression that city actually raised over £40,000 for the building of the library. The bequest of £10,000 left by the late Sir Otto Beit gave the fund a good start, but all sections of the community shared in the responsibility for the balance. The University has been well served in this matter by its many friends and the Chancellor, Prince Arthur of Connaught, and the London committee, of which Sir Lionel Phillips is chairman and Dr. Cullen is secretary, cannot but feel gratified at the fine response made to their appeal.

Secondary Metals in the United States

Figures concerning the production of primary metals—*i.e.*, those derived directly from their ores—are apt to give both producers and consumers a false idea of the total quantities of metal available for consumption, a point stressed by Mr. J. B. Richardson in his paper on "The Importance of Recovered or Secondary Tin" read before the Institution of Mining and Metallurgy in December, 1928. Such data make no allowance for the quantities of metal that are recovered from scrap, sweepings, and drosses, generally known as secondary metals. The United States Bureau of Mines has annually collected figures relating to seven metals—copper, lead, zinc, tin, aluminium, antimony, and nickel—in order to supplement the primary metal statistics and the latest returns from that source, dealing with 1932, show a further falling off in value and quantity as compared with the previous year. The total value of these non-ferrous metals in 1932 was $65,022,800, or $45,651,800 less than in 1931, the total quantity having decreased by 175,420 short tons. The decrease in total value was due partly to lower average prices for the metals other than nickel and aluminium, but mainly to the decreased output.

During 1932 the trend of prices in the United States was steadily downward and scrap metals, alloys, drosses, and residues bought by dealers could seldom be sold at a profit, so that foundry purchases were at a minimum, many establishments being idle and others only purchasing in order to fill spasmodic orders. The table given below summarizes the production in short tons of secondary metals in the United States for 1932 and the figures for 1931 are added for comparison :—

	1931	1932
Copper, including that in alloys other than brass	261,000	187,700
Brass scrap remelted	122,800	86,400
Lead as metal	128,800	128,000
Lead in alloys	105,900	70,300
Zinc as metal	34,800	20,000
Zinc in alloys other than brass	7,400	6,300
Tin as metal	5,500	4,650
Tin in alloys and chemical compounds	14,300	10,100
Aluminium as metal	15,200	12,200
Aluminium in alloys	15,100	11,800
Antimony as metal and in alloys	7,900	6,450
Nickel as metal	270	200
Nickel in non-ferrous alloys and salts	1,800	1,250

While primary supplies coming on to the market tend to diminish, it will be evident from the above figures that the quantities of metal produced from secondary sources are still important.

Examining the figures given in the report, it seems that secondary copper recovered and brass remelted decreased by nearly 110,000 tons and the calculated value was less than half that of the 1931 production. The quantity of zinc used for galvanizing was markedly less during the year, so that zinc drosses were scarce, redistilled zinc decreasing by about 6,900 tons, while smaller quantities of skimmings were available for the manufacture of zinc chloride, lithopone, etc. As regards tin, the report shows that detinning plants treated about 47,800 long tons less clean tinplate clippings in 1932 than in the previous year. The other important metals covered by the returns, as will be seen from the table, are lead, aluminium, antimony, and nickel and scrap of these was also dealt with on a reduced scale during the year, although all must still be regarded as important items.

REVIEW OF MINING

Introduction.—Conditions have remained unchanged during the past month, metal prices showing little alteration, but there is a growing disposition to accept the underlying firmness as genuine. A pleasing feature has been the continued improvement shown by the employment figures, especially as the basic industries are prominent in the increases noted.

Transvaal.—The output of gold on the Rand for August was 882,587 oz. and in outside districts 52,127 oz., making a total of 934,714 oz., as compared with 923,671 oz. in July. The number of natives employed in the gold mines at the end of August totalled 231,341, as compared with 230,306 at the end of July.

The report of the Consolidated Main Reef Mines and Estate for the three months ended June 30 last states that the terms of the company's tender for the undermining rights of part of the Farm Vogelstruisfontein No. 62 have been modified, the area having been reduced to approximately 155 claims.

The intentions of two of the Rand companies to increase their plant capacity was announced last month. The Luipaards Vlei has acquired from the Government approximately 150 claims on the Farm Witpoortje No. 44, which will give the company altogether an additional 264 claims, including two shafts of the former Tudor Gold Mining Company in proximity to the Midas section of the Luipaards Vlei mine. Plans for re-opening the Tudor shaft are in hand, while alterations to the reduction plant are expected to increase its capacity to 40,000 tons per month. At the Daggafontein plant extensions projected will increase the monthly capacity to 80,000 tons, the cost of the additions being estimated at approximately £40,000.

The report of West Witwatersrand Areas, Ltd., for the three months to June 30 last gives particulars of drilling in four holes in the eastern section and two in the western section, while two original holes on the property have been cleaned out for re-drilling. Geophysical, topographical, and aerial work was continued during the quarter, the aerial survey having now been completed. Meanwhile details have been issued of the reef intersected at 4,123 ft. in bore-hole No. 11 Venterspost, the thickness being 21 in., averaging 3·8 dwt. At 4,170 ft. this hole has encountered another reef 7 in. in thickness, assaying 10·6 dwt. Correlation of these reefs still remains uncertain.

Shareholders of Durban Roodepoort Deep have been informed of the acquisition from the Coronation Syndicate, Ltd., of 54 claims on Roodepoort No. 43, situated to the west of the company's mine. Further ground has also been obtained by the Rose Deep, the Government having accepted that company's tender for 129 claims situated to the south of the existing mine.

New Central Witwatersrand Areas, Ltd., was formed in South Africa last month by the African and European Investment Co., in conjunction with New Consolidated Gold Fields, Rhodesian Anglo American, and South African Townships. The new company has acquired options over about 30,000 morgen adjoining the areas held by West Witwatersrand Areas and the Middle Witwatersrand and Western Reefs companies. In addition the company has acquired a controlling interest in Machavie Gold Mining, whose mine is situated 15 miles west of Potchefstroom. This mine has been closed since 1918, but arrangements have now been made to bring it to the producing stage as soon as possible.

The payment of interim dividends has been resumed by the General Mining and Finance Corporation, Ltd., which announces a distribution of 1s. 6d. per share, equal to 7½%.

A rumoured scheme involving the amalgamation of the Witwatersrand Deep and the East Rand Proprietary Mines has been officially contradicted.

Nigel Gold Mining Company announced last month that its tender for the lease of 1,726 claims on the farms Varkensfontein and Bultfontein had been accepted by the Mining Leases Board.

Shareholders of the Rooiberg Minerals Development Company were informed last month of negotiations in progress for the acquisition of the mineral rights of Leeuwpoort Tin Mines' farm.

At an extraordinary meeting of Onverwacht Platinum to be held in Johannesburg next month it will be proposed that the company should go into voluntary liquidation.

Diamonds.—The new agreement between the Union Government, the leading producers, and the Diamond Corporation is

said to be approaching completion and is expected to provide that diamond sales should be centralized in the Diamond Corporation, which will act both for the producers and the Government.

Southern Rhodesia.—The output of gold from Southern Rhodesia during July was 54,561 oz., as compared with 54,442 oz. for the previous month and 47,331 oz. for July, 1932. Other outputs for July were : Silver, 9,469 oz. ; coal, 44,925 tons ; chrome ore, 4,236 tons ; asbestos, 3,653 tons ; tin, 4 tons ; iron pyrites, 549 tons.

A reorganization of the capital of the Mashaba Rhodesian Asbestos Company, which will enable it to re-enter into possession of its properties and to resume working, was announced last month. The existing 5s. shares are to be reduced in value to 3s. and then split into three 1s. shares, of which two are to be forfeited to the company. The reduced capital will then be increased to £150,000 by the creation of 1,200,000 new 1s. shares, of which 1,000,000 will be issued to debenture holders in satisfaction for their stock and interest.

The report of Wanderer Consolidated Gold Mines, Ltd., for the three months to June 30 last states that the Wanderer incline shaft had reached the horizon of the 11th level at the end of the quarter.

Northern Rhodesia.—The accounts of Roan Antelope Copper Mines, Ltd., for the three months ended June 30 last show an estimated surplus of £97,424, subject to depreciation and taxation. During the period 478,100 dry short tons of ore, containing 3·42% of copper, was extracted, blister production amounting to 3,708 long tons. Costs over the three months reviewed averaged £22 6s. 5d. per long ton of blister copper, before charging debenture interest and depreciation.

Gold Coast.—The statutory report of Konongo Gold Mines, Ltd., issued this month, shows that the total amount received by the company in cash in respect of shares issued was £103,758, the balance in hand, after allowing for all issue and other expenses, being £79,524. News from the property is to the effect that the completion of the power-house is well advanced and that preparations for unwatering the Akyenase shaft are complete.

At a meeting of debenture-holders of Ashanti-Obuasi Reefs held this month resolutions proposing the allotment of shares in full satisfaction of debenture holdings were approved.

It was announced last month that a controlling interest in the North Ashanti Mining Company had been acquired by an Anglo-French group.

Kenya.—The accounts of the Kenya Gold Mining Syndicate for the seven months to July 31 show a profit of £2,014, increasing the sum brought in to £2,417. During the period under review 1,000 oz. of gold and 125 oz. of silver were produced.

Australia.—At an extraordinary meeting of the Wiluna Gold Corporation held this month resolutions proposing an increase in the capital from £1,350,000 to £1,600,000 by the creation of 250,000 new £1 shares were approved. The new shares are to be offered to existing holders at 40s. per share in the proportion of one new for every five shares held and the proceeds are to be applied for the redemption of the outstanding indebtedness of the operating company, Wiluna Gold Mines, and for developing the northern part of the property. In the returns for July shareholders were informed that the lode struck on the Moonlight property, which was thought probably to be an extension of No. 2 West lode, is apparently a distinct occurrence.

Shareholders of Great Boulder Proprietary have been notified that a cross-cut in section 29 at a point 455 ft. east of the main shaft encountered a well-defined lode 6 ft. wide and that driving for 35 ft. shows ore running 12 dwt. per ton.

A strike of underground workers at the Lake View and Star early this month, which necessitated the closing down of the mill for a few days, was soon called off, a satisfactory agreement on all matters in dispute having been arrived at.

Shareholders of Associated Northern Blocks were informed early this month of the sale of the Iron Duke lease at Kalgoorlie to the Gold Fields Australian Development Co. for £10,500 cash and a 25% interest in any arrangement for the working of the lease.

Developments on the Reidys Mararoa property, in the Meekatharra district, Western Australia, have been reported during the past month. The work is being undertaken by the Western Mining Corporation in conjunction with Gold Mines of Australia and geophysical methods have been adopted for the location of favourable bore-hole sites. One such hole, No. 9, on the Cue option, was down to 494 ft. at the

beginning of the month and had been in lode material from 415 ft. The hole has now been completed and shows a true width of 29·9 ft. of payable ore, assaying 7·46 dwt. per ton.

New Zealand.—Shareholders of Komata Reefs Gold Mining Company, whose interests are now chiefly in Western Australia, are offered one new share for each share now held, the price being 4s. per share. The company recently declared an interim dividend equal to 3d. per share, free of tax.

Malaya.—The accounts of the Raub Australian Gold Mining Co., Ltd., for the year to February 28 last show a profit of £88,918, against £71,647 in the previous year. The tonnage milled was 38,190, an increase of 2,060 on the previous year's total, while the yield of gold from all sources was 26,258 oz., against 26,136 oz. The ore reserves at the end of the year were estimated to be 53,950 tons, of which 37,050 tons averaged more than 10 dwt.

India.—A severe rockburst occurred last month on the Champion Reef mine at the 67 to 72 levels, several men being killed.

An interim dividend of 3s. 6d. per share has been declared by Nundydroog Mines. The payment at the same period last year was 2s.

The report of the Indian Copper Corporation for the three months to June 30 last shows that 47,464 tons of ore was treated, copper production amounting to 1,200 long tons. During the same period the rolling mill produced 1,371 tons of yellow metal sheet and 134 tons of circles. It is stated that the installation of the new plant is proceeding satisfactorily.

Siam.—Shareholders of Southern Siamese Tin Dredging, formed earlier this year to acquire part of the Talerng undertaking, have been informed that the dredge started up early last month.

Korea.—A circular to shareholders of Chosen Corporation, Ltd., issued last month, contained particulars of developments on the Moon-ji-ryong and Yun-ja-kol mines and stated that it was thought likely that the former would develop into an important producer. A treatment plant is in course of erection at the property.

Canada.—Circulars to shareholders of the Yukon Consolidated Gold Corporation issued last month give the results of the new trial in the action against Mr. A. C. N. Treadgold and others, the company's case being upheld. Dredging on the properties was delayed this year by an unusually late spring, the gold recovery up to June 30 last being valued at $112,103, as compared with $140,834 during the same period last year. Mr. E. A. Austin, of San Francisco, has been appointed general manager for the present season.

Spain.—An interim report issued by Tigon Mining and Finance states that the output of sulphur is now at the rate of over 3,000 tons per annum, while operations in Chile continue to be satisfactory. Negotiations are said to be in hand for doubling the output of the Chilean properties.

A plan for the reorganization of San Finx Tin was approved by the debenture holders early this month. A new English company is to be formed, with a capital of £18,750 in 9d. shares, which will resell the whole of its newly-acquired assets to a Spanish company for a consideration which will include a mortgage of not less than £7,000 at 5%.

Portugal.—Shareholders of Beralt Tin and Wolfram were informed last month that the old Panasqueira wolfram mine is being reopened. The mill has been reconditioned and crushing was expected to start last month.

Anglo-Oriental Mining Corporation.—The accounts of the Anglo-Oriental Mining Corporation for the year ended February 28 last show a profit of £27,915, as compared with £23,553 the previous year. The balance available was £126,387, of which £5,000 has been transferred to reserve, leaving £121,387 to be carried forward. The report indicates an appreciable improvement in the current year's operations.

Johannesburg Consolidated.—The report of the Johannesburg Consolidated Investment Company for the year to June 30 last shows a profit of £824,270. To this sum must be added £473,643, representing the restoration of depreciations provided out of reserves and profits in past years, in addition to the balance of £155,654 brought in from the previous account, the total sum available being £1,453,567. Of this amount £700,000 has been transferred to reserve and £592,500 absorbed as a dividend payment, equal to 3s. per share, leaving £161,067 to be carried forward.

Tin.—The figures relating to tin issued at the end of August show a heavy reduction in the visible supplies, which have dropped to 32,854 tons, a decrease of 4,582 tons. In addition the carry-over in the Straits Settlements was 6,090 tons, a decrease of 876 tons, making a net shrinkage of 5,458 tons.

SULPHUR IN CHILE

By S. V. GRIFFITH, A.I.M.M.

A description of the Chilean Industry in 1931, which covers the methods of mining and refining the sulphur and gives costs for the various operations.

While literature dealing with the sulphur industry in the U.S.A. and Sicily is fairly abundant, very little is known of the Chilean industry and it is the purpose of this paper to describe in some detail the occurrence, mining, and preparation of Chilean sulphur. It is true that of the annual world production of some 2,770,000 tons Chile is responsible for 12,000 tons only, but there is every prospect in the near future of this production being considerably increased, especially now that British and other capital has become interested in the industry.

Although in Chile sulphur is used chiefly for the manufacture of black powder, sheep-dip, and as a dressing for vines, yet this should not be taken as being the sum total of its usefulness, as the world-wide uses of this product are innumerable. Its most important use is in the manufacture of sulphuric acid, after which comes its use in the making of pulp and paper; substantial quantities are also consumed in the refining of petroleum and in the rubber industry and it is also extensively used in the manufacture of matches, in medicines, as a fertilizer, and also as a dressing in viniculture for killing the moulds (oidium or uncinula) and, as stated before, in the preparation of sheep-dip and the manufacture of black powder. Dr. H. A. Auden in his book "Sulphur and Allied Products" writes as follows:—

> The important rôle played by sulphur products is not much in evidence in everyday life, but there are, in reality, few manufactured articles which have not required at some stage or other of their preparation a compound containing sulphur.

Sulphur, in combination with chlorine, is also largely used in the rubber industry and in the manufacture of medicinal substances and dye-stuffs.

LOCATION AND TOPOGRAPHY.—Numerous volcanic peaks, varying in altitude from 4,500 m. to 6,500 m. above sea-level, exist in the Cordillera, forming the boundary between Chile on the one side and Bolivia and the Argentine on the other, many of which still retain well-preserved craters, with fumaroles and hot mineral springs along their flanks, and it is on the slopes and in the craters of these volcanoes that the sulphur deposits occur. Fig. 1 shows the location of the best-known deposits, but of these only the following, reading from north to south, are of any real importance and will be referred to in this paper:—

(*a*) Tacora and Chupiquiña,
(*b*) Irruputunco, and
(*c*) Ollague and Aucanquilcha.

No value can at present be attached to the remainder, as they are too remote from transport facilities and centres of population.

Climatic conditions at these altitudes are very severe. Summer extends from September to March, but after November the rains begin and continue to March, after which the winter commences with heavy falls of snow. It is bitterly cold and high winds are prevalent all the year round, making working conditions anything but pleasant. Owing to these rigorous climatic conditions, the ordinary Chilean miner is unable to work in the mines and it is therefore

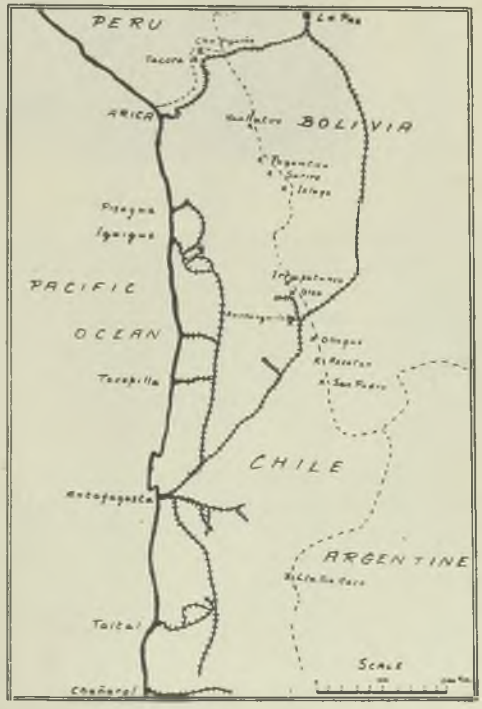


FIG. 1.—SKETCH MAP, SHOWING LOCATION OF DEPOSITS.

necessary to depend on Bolivian and Peruvian Indians, who come over into Chile in fairly large numbers ; they are inefficient, but are accustomed to working and living under these conditions and at these altitudes. (Fig. 2.)

GEOLOGY.—The peaks are composed of andesitic lavas, tuffs, and ashes and, according to Dr. Juan Brüggen,[1] " they are extinct volcanoes of tertiary age." While it is true that the lava flows appear to have undergone very little alteration, thus indicating a short period of quiescence, the " extinction " of the volcanoes is by no means true, as during the examination of the Tacora and Chupiquina deposits by the writer in December, 1929, Mount Huallatire could be seen quite plainly in violent eruption, emitting enormous volumes of smoke and débris. Severe earthquake shocks were also experienced due to this eruption, which did considerable damage to the buildings and plant of the Tacora and Chupiquiña region and even " shook up " Arica, on the coast, 170 Km. away.

The deposits themselves are of volcanic origin and have been formed by precipitation from the sulphurous vapours from ancient craters and fumaroles and occur in irregular patches on the sides of the mountains and in the craters themselves. Quoting from the " Mineral Deposits of South America," by Miller and Singewald,

> The sulphur, in crystalline form, occurs mainly as cavity fillings in the fragmental and vesicular volcanic materials near the surface. In some places, where large masses of practically pure sulphur, several feet in diameter, are found, it seems that some of the rock minerals have been removed by the dissolving action of the steam and other gases, and sulphur deposited in their stead. All of the rock minerals have been greatly altered, particularly the feldspars, so that the rock fragments can be crumbled in the fingers.

Active fumaroles, which emit a constant stream of sulphuretted hydrogen and other gases, are present in many places on Mounts Tacora, Irruputunco, and Ollague ; the latter contains the largest and most active fumarole in Chile. (Fig. 3.)

In some places the deposits are exposed to the air, but in others they are covered over with 0·50 to 4 m. of overburden, consisting of volcanic ash, rock-slides, etc. Under this overburden a light rock capping is usually encountered, from 0·10 to 0·50 m. thick, and carrying up to 45% S and is known as " costra." The rock with the contained sulphur is known as " caliche " and varies from 45% S to practically pure sulphur.

FIG. 2.—TYPES OF BOLIVIAN-INDIAN WORKMEN.

HISTORY OF THE INDUSTRY.—It is difficult to state exactly when the mining and sale of sulphur in Chile first reached the status of an industry, but it probably dates back to the early days of the nitrate workings about 110 years ago, as the sulphur required for the manufacture of the black powder needed to break up the nitrate ground has been supplied from the native sulphur deposits from the beginning of the nitrate industry and the growth of this industry led to the development of the sulphur. Those deposits lying directly east of the nitrate workings and closest at

[1] " Chilean Ore Deposits." By Dr. Juan Brüggen.

FIG. 3.—ACTIVE FUMAROLE ON MT. OLLAGUE.

hand have been the ones worked to supply the required sulphur, which was transported by pack mule to the oficinas. However, it was the building of the Arica-La Paz Railway and the Antofagasta-Bolivia Railway, both of which pass near important sulphur deposits, which really stimulated the sulphur industry and has made it possible within recent years to meet the country's needs.

Some idea of the growth of this industry may be obtained from Table 1, which shows production, imports, exports, and consumption.

MINING METHODS.—Mining usually consisted in the digging of shallow, irregular pits wherever the "caliche" appeared to be richest, no attempt being made to work the deposit systematically. Crowbars, picks, and shovels are the only tools used because of the soft nature of the "caliche," although sometimes a little blasting is required to loosen the rock, the powder used being made locally by the miners themselves. (Fig. 4.)

The mined "caliche" is usually broken up into pieces of about 4-in. ring, sorted and graded—anything under about 60% S being rejected—and stacked ready for transport to the refining plants. Some deposits are worked by a series of benches, which has the advantage of obtaining all available material, but as about one half of the "caliche" mined is discarded as being too low in sulphur content this advantage is largely offset.

As mining operations are usually suspended during the rainy months—*i.e.*, from November to March—enough "caliche" is mined during the remainder of the year to keep the refining plants supplied for the full 12 months. Details of mining and other costs are given at the end of the paper, together with data concerning producing companies.

As has been mentioned before, labour is obtained from Bolivia and Peru and is very casual. During the rainy season there is a shortage, as nearly all the Indians have land and return to their homes to work it, but for the rest of the year there is generally sufficient labour to keep the work going satisfactorily. The hours of work are limited to 48 per week by law and no workman can be employed for more than six days per week; should more than 48 hours per week be worked then overtime at the rate of time and a half has to be paid.

TABLE 1.

Year.	*Production.* Tons.	*Imports.* Tons.	*Exports.* Tons.	*Consumption.* Tons.
1888	20			20
1889	156			156
1890	317			317
1891	481			481
1892	647			647
1893	1,142			1,142
1894	832	2,291		3,123
1895	931	1,679		2,610
1896	940	1,775		2,715
1897	664	2,635		3,299
1898	1,256	3,317		4,573
1899	983	306		1,289
1900	1,687	1,353		3,040
1901	2,070	1,494		3,564
1902	2,735	245		2,980
1903–8	20,833	9,320	355	29,798
1909	4,508	193	9	4,692
1910	3,823	1,400		5,223
1911	4,451	4,013		8,464
1912	4,431	4,451		8,882
1913	6,647	1,961		8,608
1914	10,008	526	14	10,520
1915	9,769	712	57	10,424
1916	14,879	1,080	191	15,768
1917	18,942	48	3,555	15,435
1918	19,557	15	6,409	13,163
1919	18,910	52	6,569	12,393
1920	13,340	24	567	12,797
1921	9,670	48	318	9,400
1922	12,250	43	281	12,012
1923	11,380	43	349	11,074
1924	9,765	229	110	9,884
1925	9,072	2,133	253	10,952
1926	8,928	262	123	9,067
1927	12,500	106	473	12,133
1928	15,670	169	436	15,403
1929	16,300	83	322	16,061

TRANSPORT.—For transporting the mined "caliche" from the various deposits, which are situated from 10 to 30 Km. from the nearest railway, to the refining establishments, which are usually located alongside the railway, four different methods are employed—(1) animal, (2) light railway, (3) aerial ropeway, and (4) lorry.

Animal transport is by "llamas," the camel-sheep of the Andes, but this method at the best of times is very expensive and unsuitable; this is readily understood when it is stated that each "llama" is only capable of working 10 to 15 days per month and that although the maximum load carried by one of these animals is 100 lb. yet from two to three days are required to do the "round trip" from the mines to the plant and back again to the mines. Still, it is a curious fact that this means of transport is still adhered to by some companies.

Transport by light railway, 0·75 m. gauge, was the means adopted by one company and appeared to be fairly successful, although here again transport costs were on the high side, owing to lack of proper supervision.

Transport by aerial ropeway and lorry seems to be the most favoured method. The ropeways, which are either locally made or purchased from one of the well-known ropeway companies, usually deliver the "caliche" to road-head, whence it is transported to the refining plants by lorry. Fuller details of these methods, together with costs, etc., are given later, but the reader is also referred to a paper [1] by the writer, dealing in detail with this subject.

REFINING METHODS AND PREPARATION OF THE SULPHUR FOR MARKET. — A small quantity of hand-picked, high-grade, raw sulphur or "caliche" is sold in the country for black powder manufacture, but the greater portion of the "caliche" mined has to be prepared for market by—

(1) Refining for the production of lump and sublimed sulphur or

(2) Refining for the production of lump sulphur and then crushing or ventilating it for the production of fine-ground and ventilated sulphur.

FIG. 4.—SULPHUR MINING IN THE CRATER OF MT. TACORA, AT AN ELEVATION OF 5,700 METRES ABOVE SEA-LEVEL.

(1) *Refining.*—Refining of sulphur is done by retorting and two distinct methods are employed, depending on whether the refined sulphur is to be produced as lump or sublimed.

(*a*) *Production of Lump Sulphur.* — For lump sulphur or "granulado," as it is called in the country, the retorting battery consists of brick furnaces, cast-iron retorts, or melting chambers, each with two cast-iron hoppers, small condensing chambers, and solidifying tanks. (Fig. 5.) One hearth or furnace usually supplies the heat for two retorts, the flame

[1] "Transport on an Andean Mine" (THE MINING MAGAZINE, Vol. XLVIII, No. 1—January 1933).

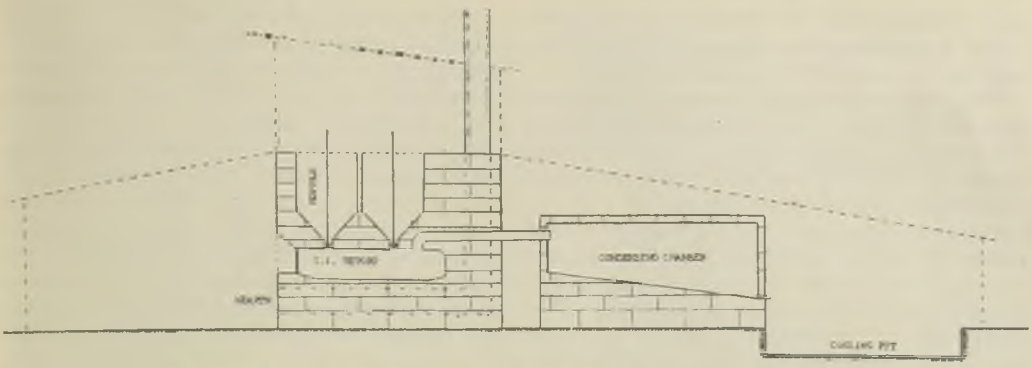


FIG. 5.—SECTION OF RETORTING UNIT FOR PRODUCING LUMP SULPHUR.

being split by means of a system of flues and utilized partly for heating the retorts and partly for preheating the new charge.

The cycle of operations takes approximately eight hours and is as follows: A complete charge of 560 Kg. of "caliche" is loaded into each of the hoppers, which are used alternately, the charge being therefore under heat for 16 hours in the hopper plus eight hours in the retort. At the end of the 16 hours preheating period it is burning at its surface and completely molten. In the meantime—in the retort—the molten charge has been vaporized and a large percentage of the sulphur boiled off and allowed to escape by means of the cast-iron "goose-neck" connecting-tube into the small condensing chambers and, although at the conclusion of the eight hours the residue of ash, impurities, etc., still contains a fair percentage of sulphur, it is not considered worth while heating it further, but is scraped out through the retort door and trammed to the waste dump, the already-molten charge from the next hopper being dropped in.

The vaporized sulphur in the small condensing chamber cools and liquefies and is allowed to run out in a molten state into the solidifying tanks, where, after cooling, it is dug out with pick and crowbar and stored.

The producing capacity of each retort is approximately 1 ton (1,000 Kg.) of refined lump sulphur per 24 hours. The lump sulphur or "granulado," which averages from 99·5% to 99·8% S, is of a bright lemon colour and is ready for the market.

(*b*) *Production of Sublimed Sulphur.*—For sublimed sulphur or "sublimado," as it is known locally, the retorting battery consists of brick furnaces, cast-iron retorts each with two hoppers, and large condensing chambers approximately 20 m. by 4 m. by 4 m. (Fig. 6.) The cycle of operations for this method is the same as that already described, except that the sulphur vapour, instead of being passed into small condensing chambers where it would cool and liquefy, is allowed to escape direct into the large condensing chambers, upon the walls of which it condenses as a pale yellow powder. The lightest and

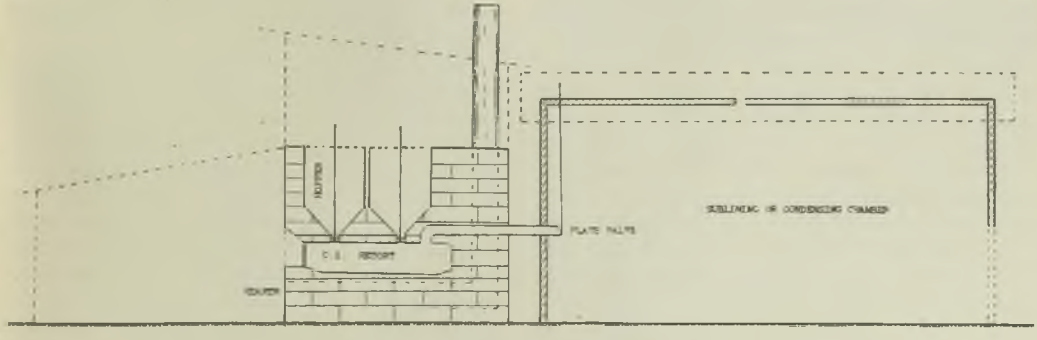


FIG. 6.—RETORTING UNIT FOR PRODUCING SUBLIMED SULPHUR.

best " sublimado " is obtained in that part of the chamber farthest away from the vapour inlet or " goose-neck " connecting tube.

The plate valve is closed every time a new charge is dropped into the retort to prevent the possibility of any ash or impurities being blown into the condensing chamber and contaminating the fine sulphur.

A small percentage of lump sulphur is also produced in the chambers, right under the vapour inlets, as the temperature here is too great to allow the sulphur to condense. The proportion of sublimed sulphur to lump sulphur is approximately 75% to 25%. This sublimed sulphur, averaging 99·7% S, is sacked and stored ready for market, although sometimes it is screened first in revolving trommels or impact screens of 100 mesh and sold as an insecticide for the vineyards.

The cost of installing a retorting unit, consisting of one furnace with two retorts, condensing chambers, etc., is as follows :—

4 C.I. hoppers with fittings . .	$5,978·00 Ch. or £149	9s. 0d.
2 C.I. Retorts .	$8,229·00 Ch. or £205	14s. 6d.
Brick work, chambers, etc. .	$8,000·00 Ch. or £200	0s. 0d.
Sundry material, labour, etc. .	$18,000·00 Ch. or £450	0s. 0d.
Total . .	$40,207·00 Ch. or £1,005	3s. 6d.

Time for erection is 45 days.

The fuel used for heating purposes is " yareta," a dried resinous moss belonging to the genus " Azorella," which is found growing on the slopes of the mountains in large quantities and which has a calorific value of 6,300 B.Th.U. per pound. The average fuel consumption varies from one to three tons of " yareta " per ton of refined sulphur (lump or sublimed) produced.

(2) *Refining, Crushing, and Ventilating.*—As the lump sulphur produced by refining far exceeds the Chilean consumption of this product, some companies treat the excess for the production of fine-ground or " molido " sulphur and ventilated or " ventilado " sulphur, which is done in a " Guseo " crushing and ventilating installation of Italian manufacture. (Fig. 7.) The lump sulphur or " granulado " is first put through an ordinary crusher, crushing to 1-in. ring and the crushed product is then elevated into the feed hopper " A," whence it is fed into the crushing mill " B," where it is ground to a very fine powder and blown into the chambers " C " and " D " by means of a fan or disc, situated above the grinding crown in mill " B " and which is driven at a speed of 2,400 r.p.m. A small portion of the fine sulphur is deposited in chamber " C," whence it is drawn off in sacks attached to opening " E " and classified as fine-ground or " molido " sulphur, but the major portion of the sulphur-laden air passes into chamber " D," where, owing to the shape of the chamber, it is forced to the outer periphery of the cone instead of travelling in a whirling horizontal line. This causes most of the material in suspension to drop to the bottom, whence it is drawn off in sacks attached to the openings " F "

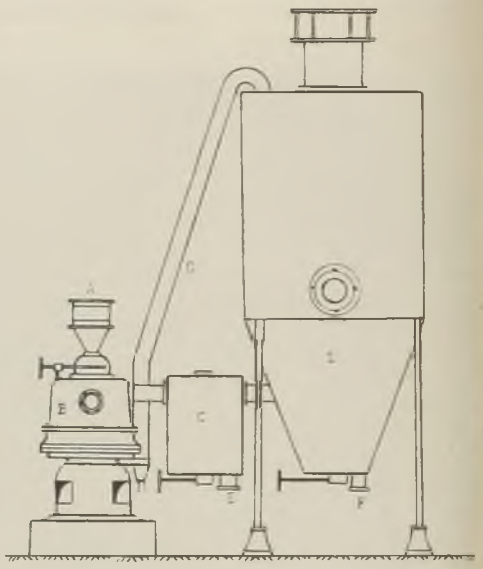


FIG. 7.—" GUSEO " SULPHUR VENTILATING INSTALLATION.

and classified as air-blown, ventilated, or " ventilado " sulphur.

The capacity of these installations—*i.e.*, the type used in Chile—is approximately one ton per hour and the proportion of fine ground sulphur to ventilated sulphur produced is one to two.

As it is very necessary in all sulphur-grinding mills to use a neutral gas to prevent explosions CO_2 gas, made by burning anthracite in a small furnace, is pumped into these installations and enters mill " B " by means of valve " H." Anthracite consumption is approximately 80 Kg. per week, costing 31½ cents Chilean or 1·89d. per Kg.

In order to explain how the powdered sulphur and the inert or neutral gas is forced to the top of the mill " B " and into the pipes of the cyclone it will be necessary

to refer to Fig. 8, which represents a section of the mill. The sulphur, previously broken up into small pieces by the crusher, is elevated into the feed hopper "A," which is provided with a screw-feed, which sends the sulphur through the internal tube "T" on to the rapidly rotating disc "K." This causes the sulphur to be thrown against the notched circular plate, or grinding crown, "L," where it is violently smitten by the hammers "M" set on the disc "K." The powder thus formed is now taken up by a strong current of inert gas and sucked in by the agitating vanes "N" beneath the circular disc. As the vanes constantly suck in fresh gas, it consequently rotates upwards in the same direction as the disc, forcing with it the powdered sulphur and, finding a free passage between the two cones, streams out by pipe "P."

As the gas rises in a rotating motion between the two cones it produces a centrifugal force within the powdered sulphur forced up with it, pushing back the larger pieces of sulphur towards that part of the cone which has the biggest diameter and consequently towards the bottom of the cones, where they are again crushed, and only allows the infinitely small particles to pass upwards—that is, those particles in which the centrifugal force is overcome by the force of the rising gas.

The powdered sulphur and the gas escape by pipe "P" and enter the cyclone, or chamber, by an aperture in the lower part.

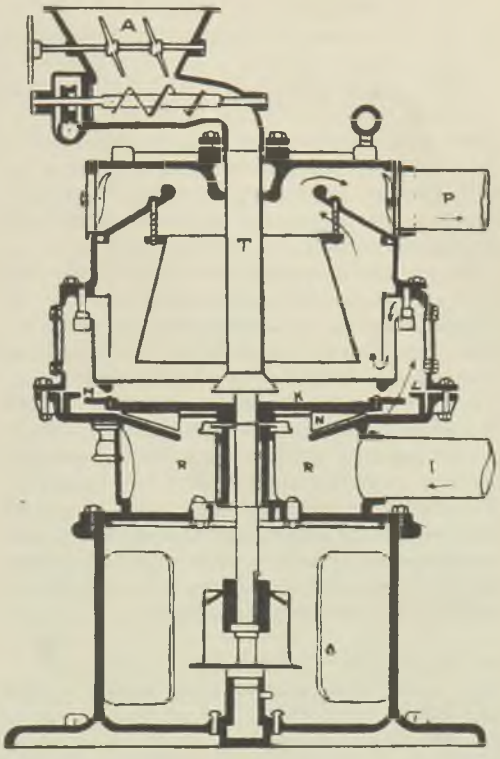


FIG. 8.—"GUSEO" MILL.

Here the gas, as it rises, is progressively rarefied, for at the top of the cyclone is the aperture of the return tube, which has a sucking function, being connected directly

TABLE 2.

	Lump or "Granulado."	*Ground or "Molido."*	*Sublimed or "Sublimado," "Ventilado."*
	Per ton of 1,000 *kg.*	*Per ton of* 1,000 *kg.*	*Per ton of* 1,000 *kg.*
Valparaiso	$400·00 = £10 0s. 0d.	$450·00 = £11 5s. 0d.	$570·00 = £14 5s. 0d.
San Antonio	do.	do.	$590·00 = £14 15s. 0d.
Talcahuano	do.	do.	do.
Magallanes	do.	$480·00 = £12 0s. 0d.	$550·00 = £13 15s. 0d.
Coquimbo	$410·00 = £10 5s. 0d.	$470·00 = £11 15s. 0d.	$590·00 = £14 15s. 0d.
Taltal	$430·00 = £10 15s. 0d.	$480·00 = £12 0s. 0d.	—
Chañaral	do.	do.	—
Tocopilla	do.	do.	—
Pisagua	do.	do.	—
Iquique, ex store	$450·00 = £11 5s. 0d.	$500·00 = £12 10s. 0d.	—

Local shipping freight rates are as follows:—

From Arica to Iquique	$8·00 Ch. or 4s. per ton.
Antofagasta	$12·00 Ch. or 6s. ,, ,,
Valparaiso	$16·00 Ch. or 8s. ,, ,,
San Antonio / Coquimbo	$16·00 Ch. or 8s. ,, ,,
Tomé	$18·00 Ch. or 9s. ,, ,,
Puerto Montt	$25·00 Ch. or 12s. 6d. per ton.
Magallanes	$50·00 Ch. or 25s. per ton.

with the depression chamber "R," underneath the vanes in which an atmospheric void is formed, by tube "I." The powdered sulphur is therefore decanted on the bottom of the cyclone, whereas the gas, purified from the decanted sulphur, returns to the closed circuit within the machine in order to gather fresh powder, for it has the double function of separating and conveying the powdered sulphur.

MARKETING AND PRICE.—In Chile the sulphur comes into the market in four different forms—*viz.*, as lump or "granulado," fine-ground or "molido," ventilated or "ventilado," and sublimed or "sublimado." The lump sulphur, which is used chiefly for black powder manufacture and also as a fumigant, is sometimes sold in bulk, but usually in gunny bags of 69 to 80 Kg. gross. The fine ground sulphur is sold in gunny bags of 80 Kg. gross and the sublimed and ventilated products in bags of 69 Kg. gross. Selling prices for the various grades of sulphur are shown in Table 2.

TABLE 3.

Country.	*Lump Sulphur. Tons.*	*Fine Sulphur. Tons.*	*Total Tons.*
U.S.A.	12,090	—	12,090
Italy	1,490	555	2,045
France	—	58	58
Chile	—	19	19
Germany	—	3	3
U.K.	—	37	37
Total	13,580	672	14,252

CONCLUSION.—From Table 1 it will be seen that as far as Chile is concerned the supply of sulphur is about equal to the demand. No efforts had been made by Chilean producers to capture the Argentine market, due chiefly to lack of capital for improvements, and so all sulphur used in the Argentine for the manufacture of sulphuric acid and as an insecticide in the Mendoza vineyards is brought down from the U.S.A. With the high freights obtaining from the U.S.A. to Buenos Aires and from Buenos Aires to the Mendoza vine-growing district, the prices of refined sulphur are very high and vary from £20 to £30 per ton, the annual consumption being about 2,000 tons. Some 9,000 tons also of lump or "granulado" sulphur are consumed annually in Buenos Aires in the manufacture of sulphuric acid, the price per ton being £10 10s. Table 3 gives the imports of sulphur into the Argentine for the year 1926.

TABLE 4.

(1) *Lump sulphur delivered to Mendoza by the Transandine Railway.*

	£	s.	d.
Cost per ton, f.o.b. Arica	8	0	2
Freight to Valparaiso		8	0
Loading and handling charges			9
Rail freight, Valparaiso to Los Andes		16	0
Transhipment at Los Andes		2	9
Rail freight, Los Andes to Mendoza	2	11	0
Unloading dues, duty, taxes, etc.		6	9
Crushing costs at Mendoza,[1] to produce "Ventilated"		10	0
General and miscellaneous	2	10	0
Total cost, per ton	£15	5	5

Selling price, as stated before, varies from £20 to £30 per ton.

(2) *Lump sulphur delivered to Buenos Aires for East Coast Markets.*

	£	s.	d.
Cost per ton, f.o.b. Arica	8	0	2
Steamer freight, Arica to Buenos Aires		17	6
Total cost per ton, f.o.b. Buenos Aires	£8	17	8

Selling price in Buenos Aires is £10 10s. 0d. per ton.

[1] Lump sulphur only should be exported to the Argentine for the production of other grades, as this only pays a duty of 4s. 2d. per ton as compared with the duty of £5 8s. 0d. per ton for fine sulphur.

With the high sulphur prices ruling in the Argentine there is no doubt that Chilean sulphur could compete with the American product, both in the manufacture of sulphuric acid and as an insecticide in the vineyards, as will be seen from the figures given in Table 4.

(*To be concluded.*)

United States Mineral Statistics.—The United States Bureau of Mines announces that this year it has been possible to effect earlier release of annual data on minerals, due to cumulative advances in the technique of statistical collection since the War. Thus, the Bureau of Mines will release on or about August 15 a volume entitled "Minerals Yearbook 1932-33." This new publication, designed to supply timely statistical information regarding all commercially important minerals, takes the place of various former publications, including "Mineral Resources of the United States," which will be discontinued.

MINE EFFICIENCY AND THE QUOTA SYSTEM

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

The author discusses the effect of present-day world conditions on the future of metalliferous mining other than that of gold, going on to examine the working of a well-planned quota system and its effect on mine efficiency.

INTRODUCTION.—The change-over in the leadership in and about mines from the so-called "practical" men to that of the technicians was a long affair, commencing in the time of our grandfathers and being consummated about the beginning of the present century. The old order hung tenaciously to its primitive methods and mode of thought, but the transition period would have been of shorter duration had the earlier engineers passed through an apprenticeship as miners, timbermen, pumpmen, or in some other underground occupation. The difficulty at one time was that the higher officials failed to win the confidence of the miners and junior officials as, owing to their own want of knowledge of underground detail, they were unable to put them in their place. Thus the miner continued in his rut for many years after the rough-diamond managements had been replaced by technicians. The change-over once accomplished, however, mining efficiency shot ahead in leaps and bounds. This meant, of course, that more ore was broken and raised than before, to be handed over to the metallurgist for presenting to commerce in completed form as a so-called primary product, and that labour costs and other expenditure were less. The consequent lowering of working costs brought untold areas into the ore reserves of the individual mines, areas that had previously proved to be financially unsound propositions with the crude and expensive methods that had obtained. While all this was happening mining geologists, with their growing skill and increasing experience, were discovering more and more mining areas in the accessible parts of the earth and more regions became easy of access yearly owing to the efforts of those responsible for the development of methods of tropical hygiene.

The President of the Institution of Mining and Metallurgy, Mr. G. W. Gray, in his inaugural address, this year examined the present state of affairs in the world and discussed causes and effects. Compared with his summary, these introductory paragraphs may appear to be rather elementary, but they have been included in this article the better to emphasize that which comes later.

The world is now facing the consequences of technical progress—a glut of primary products, with resultant low prices that render production no longer economical, the two main primary products being metals and foodstuffs. The solution of this problem of over-production and consequent unemployment is racking the brains of economists, financiers, philosophers, politicians, and other so-called experts. The wealth of theories with which the world is being flooded—there seems to be an over-production in theorizing as well as of commodities—promises no immediate solution of the problem—that is, in the balancing of unlimited production with limited demand. Still more difficult is it to see how to obtain the maximum utilization of the inherent wealth of the universe for the good of all.

The mining man realizes that there are many social, national, international, and racial problems to be overcome first. He might with justice think that a complete solution will not be found in his own life-time. As he is mostly well-read as well as much-travelled he will have noted that in this epoch man has advanced far beyond his civilization and that he (the mining man) as a technician belongs to a fraternity that is primarily responsible for this lack of equilibrium. He is no pessimist, however, and makes no analogies with previous civilizations and their disastrous endings, realizing that they were merely islands of law and order in a sea of barbarism. It might be true to say that the sanest opinion takes it for granted that matters will gradually straighten themselves out over a period of years rather than accept the alternative—chaos such as the world has never before witnessed.

In the present article the author attempts to add a little from his experience as an underground man to the general stock of accumulated mining lore, combined with what he hopes will prove to be, in a small way, constructive and useful suggestions for underground practice under the changed conditions.

LIMITED OUTPUT.—The present generation of mining men will continue to produce metals, but not to the full capacity of the

whole profession. The output will be limited because more can be produced than will be required.

The output of metals as carried on in the old way—that is, freedom to produce at "full steam ahead" until the unalterable laws of supply and demand cause a set-back and result in the wrecking of many financial undertakings with a disastrous trail of ruined mines—is hardly likely to be countenanced much longer. The alternative to such a policy is the "quota" system, the disadvantages of which appear to be fewer and the ability to diminish the degree of unfairness greater than is evident in any other suggested remedy.

The author had the unfortunate experience of being engaged underground on a copper mine during a period when the price of that metal fell from 24 cents to 8 cents per lb. At that time the life of an official was not pleasant, for what was pay-ore one week was not the next and product *A* to-day was *B* to-morrow and waste rock the following day. Efficient mining became no longer possible. Such is working according to the law of supply and demand when supply outstrips demand.

The Quota System.—The quota system, at present in part operation, will, in the author's view, undoubtedly become univeral for all metals of which the supply can be greater than the demand at any particular time. At the moment gold will not be affected and it is possible that engineers will continue to look to that industry for technical guidance and improved methods, it being one free to go ahead without restrictions. The present article is written, then, not for the gold-mining industry but rather as a suggestion of a method of adaptation for the benefit of other metalliferous mining men who have, or will have, to accept the quota system.

The quota system is the name by which the voluntary restriction of output has come to be known. This, to be effective, must be world-wide in its application. The task of reconciling first the claims of individual producing nations and, secondly, the task of the individual nations in reconciling the conflicting vested interests within their own borders will call for statesmanship of a high order, but what has been accomplished in this respect with tin, for example, suggests that these difficulties can be overcome and that the system will come into its own.

The man in the field, however, will be interested only academically in such theories; his business will be in the limitation of output on his own mine to the figure proportioned out to him. His opinion may and should be sought before the final figure is decided on, but even in this the head offices are completely *au fait* with all particulars relating to standing costs of the mines and a mine with heavy pumping charges, for example, should be permitted a larger output than a less wet mine.

Varying of Quotas.—In one respect the men in the field must all emphasize on the powers that be, and keep on emphasizing, that the quota figures should not be altered more often than once in six months, or rather that six months' notice should be given of any suggested augmentation or diminution of output. When the system—in its world-wide application—is operating so well that there is little fluctuation in the price of metals then the managements, relieved of their worst bugbear, need demand only three months' notice of alteration in output. To define definite periods in this manner may appear to be didactic, but, be that as it may, the man on the spot knows that work has to be planned ahead. He has attained his position in the profession by having demonstrated his ability to plan his work months in advance. The above time limits should not be excessive.

Transitional Period.—The state of the non-gold metalliferous mines to-day, when many are temporarily closed or working short time and others mining such high-grade ore that it amounts almost to "picking the eyes" from the ore-bodies, is anomalous. With the quota system in operation it may be presumed that, the prices of metals being considerably higher, it will be possible to mine ore of a less-enhanced grade, but, as standing costs cannot be reduced in direct proportion to the reduction of output that may be required by the quota figures, still further effort will be necessary to bring the ore reserve figures to anything approaching what they would be had there been no world crisis. In other words, mine managements, with higher overhead charges and amortization costs, etc., per unit mined, will have to concentrate more and more on efficiency if the lives of the mines are to run their full course. After all it would be a pity to work otherwise and have mines closing down without having completed their task, for the ore remaining would in all probability be lost to posterity.

Mining Efficiency.—It is to be concluded that mining efficiency must continue to improve yearly. The alternative is to abolish all idea of the quota system and revert to free marketing. To do this, however, we should have also to retrogress in mining practice to some of the methods of our grandfathers and this seems hardly feasible. Still greater efficiency and organization must be, then, the order of the day.

Short-time mining—*i.e.*, mining with full previous staff and labour, but reduced hours—may involve the question of reduced pay, but there can, in the author's opinion, be no efficiency in that way. One only needs to imagine the expense and wasted effort of keeping open a whole mine for a reduced output of ore. The author emphatically recommends drastic reforms in this respect and, the better to explain his case, he visualizes a mine that was organized to raise 50,000 tons of copper-cum-silver ore per month. What happened to the mine during the world depression matters not here. The quota regulation is now such that 50% only of the previous production of copper and silver is permitted. For a few years the grade will have to be a little higher than that based on the 50,000 tons of ore, so that now, say, 20,000 tons of ore will need to be mined monthly to comply with the quota. Increased efficiency will, it must be hoped, permit the lowering of the grade later to the previous level and then the quantity mined will be increased to 25,000 tons. Looking still further ahead, as other mines in the state or province become exhausted this mine may eventually be run at full capacity again. It is to be concluded that no new mine will be permitted to advance beyond the development stage while any efficiently-run and financially-sound mine is still on a quota.

Reorganization.—The mine as originally organized consisted of three mine-captains' sections, each mine captain having under his direction four shift-bosses' sections. The underground manager was in charge of all, with the help of an assistant. Now the manager is called upon to reorganize his mine in such a manner as to make the maximum profit possible out of 20,000 tons of ore per month, the grade of which is to average, within reasonable limits, so many pounds of copper and ounces of silver per ton. The personnel required under the new conditions will be: One underground manager, one mine captain, four shift bosses—in all, six officials. From the 17 officials of the previous organization the six most able and energetic men will be retained, or recalled as the case may be, for the new posts. Sentiment, naturally, will play no part in this selection. One mine-captain's section will have to produce all the ore required. The two other sections will be temporarily closed down and all track, rolling-stock, piping, cable, light machinery, trolley-wire, etc., removed and housed on surface after renovation. From the stopes timber will be removed and waste-filling completed. Main-drives and main-winzes should be left intact and a small reparation gang detailed to maintain them in good order while in disuse.

The mine will now have at hand a comfortable stock of all underground requirements. Development will be under the personal direction of the underground manager. It will be sufficient only to bring into the ore reserves monthly an amount of new ore equivalent to that mined. One shaft and its auxiliary will deal with all the ore broken. There will be no hauling in the two other shafts and their auxiliaries, but the ventilation system will be kept intact so that these shafts shall remain fresh. The other sections will each be mined in turn and abandoned, while development carries on the creation of new sections. Further details are unnecessary. The working section must be mined with twentieth-century efficiency, that is all.

It will not help to picture the empty staff bungalows, the semi-deserted clubhouse, or the difficulty about raising two fours at bridge. It will not help to read the letters from the others at home who are having a difficulty in making ends meet. The man on the spot must get on with the job—it is not his task to philosophize or to organize a Utopia.

Sir John Cass Technical Institute.—The 1933–1934 session of the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C., opens on September 25. There are evening classes in geology, metallurgy, petroleum technology, fuel technology, chemistry, mathematics, and modern languages—to mention those of principal interest to mining men—which afford excellent opportunities for refresher courses in those subjects, as well as for those wishing to proceed for London University degrees.

THE GOLD-BEARING COUNTRY EAST OF MINNA, NORTHERN NIGERIA

By W. C. GRUMMITT, B.Sc.

Basing his observations on the results of an expedition of 1931, the author deals with the geology of the area and the petrography of the solid rocks, paying particular attention to the superficial deposits and to those economic factors that may affect further development.

INTRODUCTION.—The tract of country described in the present article extends for a distance of about 40 miles east of Minna (Latitude 9° 37′ 30″ North and Longitude 6° 32′ 30″ East), in the Niger Province of Northern Nigeria, and southwards for a distance of about 15 miles as far as Paiko. This district forms but a small portion of an extensive auriferous belt stretching north-north-westwards towards Sokoto, the limits of which are as yet only vaguely known. The field observations recorded were made by the writer during an expedition carried out in the early part of 1931 on behalf of Associated Tin Mines of Nigeria, Ltd., for the purpose of exploring the superficial deposits of the region east of Minna. The principal object of the expedition being to make a rapid reconnaissance of the country and to peg areas which might seem worthy of further prospecting, a detailed geological survey of any part of the district was not possible, hence the information which follows can only be regarded as giving a general view of the main geological facts. Similarly, the geological boundaries indicated on the accompanying map (Fig. 1) are only roughly drawn.

PHYSIOGRAPHY.—The eastern portion of the area examined comprises part of the watershed between the Gurara and Dinia Rivers, at an altitude of about 1,600 ft. above sea-level. The western portion is lower, at an altitude of about 1,000 ft., and lies in the basin of the Chanchagga River, which is one of the headstreams of the Bako River, flowing into the left bank of the Niger. These districts are comparatively flat, with low, undulating features and shallow valleys carved out by the numerous streams which traverse them. The central portion, however, between Guduma and Navi, is a region of much more broken and rugged country, with deeply-dissected valleys and barren glacis slopes rising into whale-back ridges and dome-shaped hills, where exfoliation of the rock on a large scale has played an important part in the configuration of the country.

Most of the area is covered by low bush and thick grass, the coarser varieties of which remain unburnt even after the bush has been fired in the dry season, so that travelling becomes a slow, tedious, and decidedly uncomfortable process except along well-defined tracks. Heavier timber is plentifully scattered over most of the region, but it is nowhere very dense, except along the stream courses, where the vegetation is usually very rank indeed, the banks being clothed with enormous trees and thickly-matted undergrowth.

The seasons are well defined, the wet season commencing about April and ending about October and the dry season occupying the remainder of the year. The average yearly rainfall is about 50 in. During the rainy season the streams and rivers flow strongly and are liable to sudden floods; in the middle of the dry season most of the smaller watercourses are practically dried up, except for local pools held up by rock bars, although in the eastern part of the area, around Vaini and Kakuri, the flow of water in the streams continues to a later period than around Minna.

PETROGRAPHY OF THE SOLID ROCKS.—The whole of this belt of country is composed of crystalline rocks, which fall primarily into two divisions: First, a metamorphic series of phyllites, schists, and fine-grained gneisses, resulting from the metamorphism of original sediments, and, secondly, a group of igneous rocks of various types, most of which themselves have undergone metamorphism to a considerable extent.

The former series, which formed the cover into which the igneous rocks were intruded, is best preserved in the western portion of the area surveyed. In the central and eastern portions the metamorphic rocks have

been largely removed by denudation and are now represented by small, isolated masses attached to the upper surface of the intrusive rocks.

The principal member of the igneous complex is a granite, which forms the bed-rock over almost the whole of the central and eastern districts. In the western portion it flanks the metamorphic and other rocks along the east and south and again outcrops around Minna in the north-west. The granite is mainly of a gneissose character, fine-grained and very hard, and lends itself to a distinctive type of weathering involving exfoliation of the rock and producing smooth, bare surfaces of great extent. Thus, not only does the granite form typical domes and elongated ridges whose surface is mainly a barren glacis of rock, but this form of surface obviously underlies the superficial ground in many places where actual outcrops of rock are scarce.

The basin of the Chanchagga River for several miles east of Chanchagga Bridge is occupied by an intrusion of quartz-diorite, showing less evidence of metamorphism than the above granite. It is somewhat coarser than most of the granite, being a dark-coloured medium-grained rock of even texture. Locally, the quartz-diorite appears to have assimilated portions of the meta-morphic cover into which it was intruded, producing a peculiar hybrid rock of variable composition. Such rock is seen in a small exposure near Chakwoto and also in larger masses near Poggo.

The hypabyssal rocks are all of acid character. The normal, undifferentiated types are not numerous. They are repre-sented by acid intrusives outcropping in several places along the eastern flank of the ridge of metamorphic rocks south of the Chanchagga River. More differentiated types, which may be considered to be of hypabyssal character, are seen as narrow dykes of aplite traversing the granite and other rocks in places. In addition to the above, the quartz-diorite of the Chanchagga River is intruded by small irregular masses of fine-grained acid rock which appears to be essentially granitic in composition and structure. Throughout the area there are numerous veins of quartz and also tourmaline-bearing pegmatite, which may be included here. Basic igneous rocks appear to be entirely absent from the area surveyed and there is also no evidence of volcanic activity.

There is little direct evidence as to the age of these rocks or the period during which they were subjected to metamorphism. It is probable that the quartz and tourmaline veins are the youngest and that these are related to the tourmaline-bearing pegmatite dykes of Nassarawa, between this region and the Bauchi Plateau to the east. The

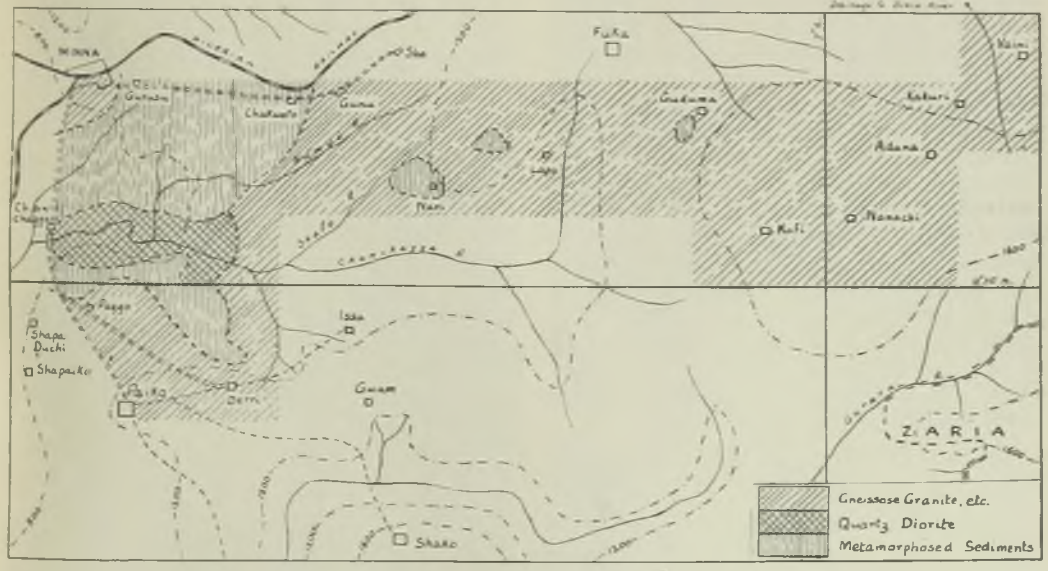


FIG. 1.—GEOLOGICAL SKETCH MAP OF THE COUNTRY EAST OF MINNA, NIGERIA. Scale 1 : 500,000 or 1·01376 in. = 8 miles.

Nassarawa dykes are considered by the Geological Survey to be older than the Plateau granite, which itself is provisionally regarded as being of Archæan age, hence it seems safe to assume an Archæan age for the whole of the solid rocks in the Minna area.

(*a*) *Metamorphosed Sediments.*—The largest area of these rocks within the region surveyed crosses the country south-east of Minna as a belt with an average width of about six miles. Actual exposures of rock are scarce, being mainly confined to small and isolated outcrops seen in drains and the stream beds, and occasionally in the bush. The only clear and more or less continuous sections observed occur in the main river at Chanchagga Bridge and in the Numui tributary, some miles to the east of Chanchagga.

The outcrops in the Numui River are about a mile upstream from its confluence with the Chanchagga River, at a spot where the former stream cuts a narrow channel, forming a small gorge with steep, high banks. The course of the Numui River is wrongly mapped about here, as actually the stream flows for a considerable distance westwards before joining the main river instead of southwards, as indicated on the map. In the bed of the river, where it flows through the gorge, a good section of metamorphosed sediments is exposed. The rock in general is blue-grey in colour, fine-grained, and compact, forming regular platy outcrops, with structural planes striking north–south and steeply inclined to the west. In places the rock is fairly massive, with rounded surfaces worn smooth by stream action. Other outcrops are thinner and more flaggy and in one place rock of this type rises up as an almost vertical wall in the middle of the river. Some bands are definitely schistose, with abundant muscovite developed along the planes of schistosity, but in general this structure is not conspicuous in the hand specimen. The rock on the whole is very free from jointing, except at the downstream end of the exposures, where it is traversed by an irregular system of small joint planes giving an angular appearance to the rock in the mass. These tiny fissures sometimes show a thin coating of tourmaline crystals.

The microscopical examination of these rocks in thin section provides an interesting study in metamorphism, revealing differences in structure and mineralogical composition which indicate to some extent the various stages of transformation through which the rocks have passed. The original sediments were probably of a fine-grained, sandy nature, with some admixture of argillaceous matter, forming thin-bedded and possibly flaggy sandstones. It is not easy to find a satisfactory name for the altered rocks other than that of metamorphosed or schistose sediments. The more platy rocks in the section may be described as flaggy schists.

The outcrops in the section at Chanchagga Bridge have also a well-marked platy character and are generally similar in appearance to those in the Numui River. Microscopically these rocks show considerable differences from the Numui River outcrops and the original sediments, whilst still containing a large proportion of fine, sandy material, were considerably more argillaceous than those farther east. They contained, in addition, some calcareous matter.

North of the outcrops in the Numui River the country consists of low hillocks with rounded contours, exhibiting a form of weathering which is very typical wherever the metamorphic rocks exist in this region. Fragments of iron-stained, weathered schists and small blocks of decomposed quartz-diorite occur on the surface, but solid outcrops are rare and, when seen, are small and poorly-exposed.

Between Chakwoto and the western boundary of this metamorphic belt the rocks are of finer texture and consist of microcrystalline schists or phyllites. The cleavage planes have a general north–south strike, with a steep dip to the east. The rocks in places show the effect of thermal super-imposed upon the regional metamorphism which produced their initial schistosity, although no actual outcrops of igneous rock were seen in connexion with them. The granite outcropping around Minna may represent the intrusion which caused the thermal metamorphism of these rocks, but it is more probable that, if actual contacts were found, the igneous rock would prove to be quartz-diorite, as is the case at Chanchagga Bridge. One of the largest outcrops noted occurs about a mile west of Gurusu, some distance south of the motor road. The rock consists of light grey, indurated phyllite with partially obliterated cleavage planes inclined about 50° to N. 80° E. magnetic. The acid veins traversing the rock at various angles to the schistosity vary from mere films to a quarter of an inch or so in thickness. Their main constituent is quartz, forming a coarse mosaic (microscopically), with loosely-fitting granules. The veins appear to be of the nature of narrow zones of replacement

in the direction of silicification along cracks in the rock.

Rocks of a similar character to the above outcrop in small isolated exposures along and in the right bank of the Numui River, between the gorge previously described and the confluence with the Chanchagga River, while south of the Chanchagga River another mass of metamorphic rocks, which is really a spur jutting out from the main mass of these rocks described above, crosses the country with a general south-easterly trend from Chanchagga Bridge to a point just north of Derri. Exposures of solid ground are extremely poor and no sections of rock similar to those seen in the Numui and Chanchagga Rivers were found. About 1½ mile south of Chanchagga Bridge, at the fork where the old road to Derri branches off from the Paiko motor road, exposures of massive banded schist form low hillocks on the east of the road. The structural planes dip at a high angle to E.N.E. The rock is dark grey in colour, hard, fine-grained, and shows much finely-crystalline biotite laminated with lighter acid bands. East of these outcrops there are small exposures of white indurated phyllite with practically vertical planes of schistosity striking N.N.E.–S.S.W. This rock is similar to that described near Gurusu and in the Numui River.

The metamorphic rocks continue south-eastwards along a rocky divide of rising ground towards Derri. On its south-western side this watershed has a more or less gradual slope towards the drainage flowing north-westwards to the Chanchagga River. On its north-eastern side the country is more broken and the schist hills sweep round in a curve from a point south-west of the Numui-Chanchagga confluence to a point north-east of Derri. Over the spurs running out from this high ground the telegraph line from Minna crosses the country in a south-south-easterly direction. The topography of this metamorphic country is similar to that described south-east of Minna, except that the typical rounded hillocks here are developed on a bigger scale.

Around Paiko the country is to all intents and purposes granite, but very small remnants of the metamorphic cover are preserved here and there on its surface, which possibly afford interesting evidence regarding the extent to which the granite has been denuded. North of Paiko the granite surface slopes with a gentle inclination towards a small creek draining north-westwards to the Chanchagga River. In places there are small patches of superficial laterite on the granite, containing fragments of schist cemented in them. These exposures are interesting in the first place as affording some evidence, scanty though it be, of the local cover into which the granite was intruded and in the second place as indicating that the granite itself has possibly suffered comparatively little from denudation. In the writer's opinion it seems probable that the present surface of the granite, not only around Paiko, but throughout the whole of the area, corresponds closely with the form of its original upper limits when the intrusion took place, subsequent denudation having affected the granite to a comparatively small extent.

In the central and eastern parts of the area the metamorphosed sediments are represented only by small masses of schist remaining on the granite. The largest of these areas exists near Navi, where it forms typical low rounded hills around the village. North-west of Navi the schists can be traced for about 1½ mile along the track leading to Gunu. Another small group of schist hills of a similar character lies at the base of the granite glacis north of a creek cutting through the country between Lapa and Navi. Again, a small area of schist exists south of Guduma and it is probable that other small masses of the metamorphic rocks exist in places on the wide stretch of granite which extends below the superficial ground for miles east of this locality. So far as the writer observed, however, there is no important development of these rocks between Guduma and the country north of Vaini. Here the crystalline schists appear to be well represented, but as this area was passed through rapidly they were not examined in detail.

(*b*) *Intrusive Rocks.*—(i) *Plutonic*—The mass of igneous rock which forms the bedrock over the greater part of the region surveyed and which obviously underlies the metamorphic rocks at no great depth, where these are preserved, must be regarded as forming, in conjunction with the latter, a part of the crystalline complex which is the basement of the continent. Hence the conception of the range of plutonic activity of which these rocks are representatives must not be confined to the region under description. Vast areas in this and other parts of Nigeria are composed of gneisses and gneissose granites, of which the rocks in this district form only an exceedingly small part. Of the mutual relations between the various types

of granite and other plutonic rocks existing in this part of Nigeria little is as yet known. From a consideration of the evidence obtained during this expedition and by later microscopical study it would appear that the various types of plutonic rock met with in the region traversed are to be regarded as essentially correlated parts of one definite stage of igneous activity rather than as separate and disconnected intrusions of widely different age.

Between Vaini and Kakuri the rock is a fine to medium grained gneissose granite, sometimes of a pinkish tint, the minerals showing rude foliation. Around Kakuri and Aduna the gneissose character of the granite, whilst obvious in the field, is less conspicuous in the hand specimen than in the case described above and the granite here has in general suffered less than the Vaini gneiss from crushing. Around Kafi the granite shows the same general appearance at the outcrop as that around Kakuri and Aduna.

The granite so far described has a more or less flat surface and occupies a stretch of gently-undulating country, with no prominent hills, along the watershed between the Dinia and Gurara Rivers, from the south of Vaini to the vicinity of Guduma. At Guduma a more rugged type of country begins, dissected by the headstreams of the Chanchagga River, and for a distance of about twelve miles to the west of this place the surface of the granite is highly irregular, producing characteristic ridges and dome-shaped hills. Around Guduma the granite is of a coarser type than usual and bears evidence of protoclastic structures which indicate that its intrusion was effected under orogenic stress. At Lapa the rock is a white, fine-grained, and very acid muscovite-biotite granite.

Around Paiko the granite is a fine-grained, very hard, and compact rock, breaking with a flaky, conchoidal fracture which reproduces in miniature the exfoliation of the rock as seen on a large scale. North of Paiko, along the course of the small creek which drains north-westwards to the Chanchagga River, there are some interesting outcrops of schistose granite. These are well seen at a spot on the old Derri road, about four miles south-east of its junction with the Paiko motor road. The old road fords the creek at this place and between the left bank of the creek and the road the granite shows a zone of schistosity several yards wide, striking N.N.W.–S.S.E., with cleavage planes dipping at a high angle to the west. The schistose granite is a brownish and rather decomposed-looking rock showing indefinite felspars, granular quartz, and streaky bands of dark mica. Along the planes of schistosity sericitic mica is developed. In thin section the mechanical effects of crushing are shown to a marked degree. The more normal granite in this locality is an indurated rock, breaking with a conchoidal fracture, and is generally similar to the rock described east of Paiko, except that the grain is somewhat coarser.

The bay of plutonic rock bounded by the metamorphosed sediments near Minna in the north-west corner of the region surveyed forms a group of low hills round the station. The area indicated on the map is merely a fringe of the wider outcrops which extend to the north and west.

South of Minna the gneiss forms low hills on the east of the motor road to Paiko. The rock here is of coarser texture, but it has suffered much from crushing subsequent to its consolidation. This rock also is of a more acid type than usual and it may perhaps be significant that in both cases where round-grained gneiss has been noted in this region—namely, at Guduma and east of Minna—coarser acid gneiss is found in the vicinity. It may well be that the liquid portion drained off from the partially crystallized magma was of large enough proportions to form, not pegmatites, but larger masses with some approach to them in composition and texture. This point is worth noting, since it may have some economic significance if verified upon a large scale. It may reasonably be inferred that any metalliferous compounds of economic value would be more likely to go with the liquid acid portion drained off than remain in the spongy crystalline residue, in which case the more coarsely-crystalline acid rock resulting from the former and any drainage associated with its outcrop should offer more favourable prospects from an economic point of view than country consisting of the earlier formed differentiation product.

For several miles upstream from Chanchagga Bridge the plutonic rock occupying the basin of the main river is a quartz-diorite. In many localities the outcrops consist of highly-altered rock. About a mile upstream from the bridge small xenoliths of a dark grey rock of much finer grain and somewhat more basic composition than the quartz-diorite are included in the latter; these appear to represent the earliest portions

of the magma to consolidate, being at a later stage caught up by and included in the main intrusion of the diorite. Along the lower reaches of the Numui River some of the smaller bodies of quartz-diorite intruded into the metamorphosed sediments are of a more acid character than usual, hence, taking into account the occurrence of the basic xenoliths, it seems probable that the early intrusions introducing this phase of plutonic activity were to some extent magmatic differentiates. That the quartz-diorite itself is also a differentiated product on a larger scale of the regional granitic magma is indicated by evidence that it graduates marginally into granodiorite. The basic xenoliths consist essentially of labradorite and uralite, with no primary biotite and practically no quartz. The original constituents were essentially labradorite and augite. With regard to the relation between this mass of quartz-diorite and the surrounding granite, the field evidence obtained, whilst somewhat scanty, indicates that the diorite passes marginally into granodiorite. It is to be noted that much of this rock is essentially similar in composition to the round-grained gneiss at Guduma and Minna and it is difficult to avoid the conclusion that both types are derived from the same regional magma. On this hypothesis we base our argument that the plutonic rocks of this region represent various phases of one intrusion rather than distinct and separate intrusions which occurred at different periods.

(ii) *Hybrid Rocks.*—We may briefly mention another type of rock where differentiation by assimilation is indicated, although the results produced are on an insignificant scale compared with the foregoing types. In the vicinity of Chakwoto, by the side of the motor road, there is a small exposure of hardened schist or hornfels and opposite this there is a small outcrop of igneous rock which in part is fairly typical, though highly-decomposed, quartz-diorite. In another part of the outcrop the igneous rock is of an abnormal type and appears to be a hybrid rock produced by the assimilation of schist. Larger outcrops showing the same phenomena form a low ridge west of the old Derri road at Poggo.

(iii) *Hypabyssal Rocks.*—Intrusions of a true hypabyssal character are not well represented in this region, which probably indicates that the region has not been subjected to any further important stage of igneous activity subsequent to the one considered. There are no representatives of the younger granite, with its differentiates and hypabyssal types, which invaded the Plateau area to the east of this region.

The small bodies of fine-grained acid rock intruded into the quartz-diorite of the Chanchagga River may be considered here. The chief interest of these acid intrusions is the evidence they afford as to the time of consolidation of the diorite. They are essentially similar in general character to the main intrusions of abyssal granite existing to the south and also presumably under the quartz-diorite. The main intrusion of granite may reasonably be assumed to have consolidated after these minor intrusions and therefore after the diorite. The remarkable thing, however, is that the diorite is the rock least affected by the contemporaneous or subsequent metamorphism. In comparison with much of the surrounding plutonic rock of a more acid type it shows little of the crush effects to which the latter has been subjected ; it is not gneissose, nor is there any indication of the powerful shearing stress which produced the Minna gneiss to the north, the granodiorite gneiss south of Gunu, and the schistose granite north of Paiko. The reason for this may lie in the fact that the diorite, being the first to consolidate and therefore to lose heat, was less liable to show the influence of stress than the rock in surrounding areas which was at a higher temperature or still only partially crystalline. This explanation, however, is not entirely satisfactory, and another suggestion is that the ruling condition of the regional metamorphism in its neighbourhood was not stress but equality of pressure, operating in what may be considered as a metamorphic " shadow."

In the central and eastern portions of the area, where the cover of metamorphosed sediments has been almost entirely removed, there is but little evidence of true hypabyssal rocks and the only indication noted in this connexion was seen on a schist hill north of Navi village. No solid outcrop of the rock was found, but one of the fragments picked up on the hillside is a light-coloured, pinkish granite porphyry with quartz and felspar phenocrysts in a fine-grained base.

In addition to the types already described, there are also small bodies of the aplite and pegmatite class outcropping in various localities within this region.

(*c*) *Quartz Veins and Tourmaline Pegmatites.* — The closing stages of igneous

activity within this region were characterized by the disposal of the residual products of the regional magma in the fissures and cavities formed both in the cooling plutonic rocks and in the broken overlying cover. The main product of this waning period of activity is quartz, either in the form of more or less pure quartz veins or as pegmatitic rocks in which tourmaline and muscovite also occur. The greatest development of quartz is found within the metamorphosed sediments of the western area, especially along the northern boundary as surveyed. Between Gunu and Minna the country within this belt is, so to speak, saturated with quartz, the outcrops varying in size from small veins a foot or so thick to masses which form low ridges at surface, where the quartz probably exists in the form of huge lenses. There are also acid pegmatite veins containing quartz, tourmaline, and muscovite in this area ; no actual outcrops were noted here, but their occurrence is to be inferred from the presence of fragments of pegmatite containing these minerals on the surface in places.

In contrast with the great development of quartz in the area mentioned above is the general absence of the mineral in similar form within the quartz-diorite of the Chanchagga River, at any rate for several miles upstream from the bridge, and this suggests the view that there may be some genetic connexion between the quartz-diorite and the quartz masses in the neighbouring metamorphic rocks. It is to be expected that after the consolidation of the diorite the residual portion of the magma would be abnormally rich in silica as compared with that of the main magma which consolidated as granite and the disposal of this excess of silica may therefore have resulted in the formation of the massive bodies of quartz in the overlying metamorphic cover. Higher up the Chanchagga valley, approaching the confluence of the Numui River on the right bank, there is more evidence of these rocks. Thus a thin band of pegmatite dipping north-east was noted in one place and the quartz-diorite in the lower reaches of the Numui River contains some fairly big quartz veins.

In the country south of the Chanchagga River the schists are veined in places with quartz and pegmatite. Small exposures can be seen along the telegraph track on the eastern flank of the metamorphic ridge between the Chanchagga River and Derri. The granite on the western side of this ridge also contains quartz-tourmaline veins. One was noted on the old road north-west of Derri, not far from the village, and others strike across the same road about a mile south-east of its junction with the Paiko motor road.

Geology of the Superficial Deposits.—One of the chief characteristics of the deposits mantling the solid rocks of this region is their shallowness. Even along the courses of the larger rivers, such as the Chanchagga, deep alluvial deposits do not exist and there is no ground to compare in depth with the deposits of 50 to 100 ft. and more which are found in the tin-bearing alluvial ground of the Bauchi Plateau to the east. The reason for this lies partly in the nature of the underlying solid rocks, but mainly, perhaps, in the geological history of the region. The softer metamorphic cover has been largely denuded from the underlying igneous rocks, leaving the latter as bedrock over the greater part of the area. The igneous rocks of this region are considerably harder than the younger granite and associated rocks of the Plateau, owing to the metamorphism which they have undergone and also to the fact that they have escaped the kaolinization which has affected the Plateau granite to a great extent. This fact is effective in more than one way. In the first place, there is the obvious result that the rocks are rendered more resistant to disintegration and, in the second place, the original channels carved out by the rivers are not so deep and otherwise favourable for the accumulation of alluvium as in areas where the bedrock is softer. Again, the Minna region is an ancient land surface which has remained stable for a vast period of time, during which such superficial deposits as may once have existed have been largely removed. The Plateau, on the other hand, has had a much more complicated history, including at least two stages of volcanic activity, and its comparatively recent elevation has produced types of drainage and superficial accumulations which are not found in the Minna area. On the whole, it would appear that the volcanic activity of Tertiary age affecting the Plateau and represented there by the Fluvio-Volcanic Series has been the most potent factor in determining the difference in character between the surface of the two areas.

The superficial deposits of the Minna country are simple in character and consist of the two classes, residual and alluvial.

The former type of accumulation varies appreciably from place to place, its nature depending mainly on the character of the bedrock, but in general it forms a comparatively thin mantle of detrital material covering the solid rocks. Over areas where a granite bedrock exists, the superficial deposit is generally of a typical light-coloured, loose, gritty nature, consisting of the unclassified mineral components of the rock broken down by normal processes of weathering. In places, however, on the granite surface, a different and more compact type of deposit exists, in the form of scoriaceous cappings of ferruginous rock. Whilst the immediate origin of these lateritic patches is to be explained by what may be termed a diffused concentration of iron oxide throughout the rock in a manner and by processes peculiar to tropical weathering, the exact nature of the material from which they have been formed is not always the same. In some cases the capping merges imperceptibly downwards into granite and the latter itself has offered the original matrix for the concentration of the iron. In other cases the material consisted of residual patches of ferruginous schist left on the granite surface. In the eastern part of the area, around Kakuri and Aduna, a different type of lateritic deposit is frequently met with, containing numerous subangular pebbles of granular quartz. A low ridge of this nature forms a definite feature for some distance along the left bank of the K'Sha River between Vaini and Kakuri and similar rock forms low hillocks on the watershed near Aduna. These deposits appear to have resulted from the diffusion of the iron content through ferruginous conglomerates, hence they are more correctly to be regarded as being of alluvial origin.

The residual material in those areas where the softer schists and phyllites of the metamorphic rocks form the bedrock is of a more argillaceous nature than in the granite areas and is generally of a darker and more brownish colour, owing to the oxidation of the iron-bearing minerals in the weathered rocks from which it has been formed. The distinctive appearance of the soil together with the typical rounded form of weathering to which these rocks lend themselves are features which are sometimes visible from a considerable distance. Thus the patch of schists on the north flank of the valley between Lapa and Navi is clearly discernible from the track which runs along the south side of the valley, a mile or so away. The smooth brown hillocks of the metamorphic rocks are rather strikingly outlined against the lower slopes of the barren granite hills.

In areas where the rocks are traversed by veins of pegmatite and quartz there is always an accumulation of the latter mineral occurring as float at surface. In the vicinity of large quartz outcrops, such as those which exist in the country between Gunu and Minna, detrital quartz is locally abundant, forming deposits a foot or so thick on the bedrock. In the eastern part of the area also there is frequently a deposit of float quartz at surface, but much of this has a different origin, consisting of pebbles which have been set free by the weathering of the conglomeratic laterite previously described. The only economic interest of these eluvial deposits lies in the possibility of their containing detrital gold and in this respect they appear to be disappointing.

The alluvial deposits of the area are of a straightforward nature and with the exception of the high level conglomeratic laterite around Aduna they are all directly related to the present drainage system. Relics of ancient buried channels and so-called " deep-leads," such as are typically developed on the Bauchi Plateau and which have no connexion with the course of the present streams, do not exist in this area. The nature of the material constituting the alluvium is also fairly simple, consisting in general of a lower bed of pebbly gravel overlain by sandy clay. As previously stated, the geological history of the streams has been unaffected by recent earth movements or by volcanic activity, consequently their waters have had a clear course for the removal of debris and there has been no blocking of channels to provide conditions favourable for the accumulation of the finer sediments. Hence bands of stiff, plastic clay are not found in the alluvium.

The conditions obtaining at the present day with regard to rainfall, drainage, and erosion have, of course, not always been the same and there is definite evidence that at no remote period they were indeed very different. This evidence is not so obvious in the Minna country as on the Bauchi Plateau, where the nature of the alluvial deposits clearly indicates that after the elevation of the Plateau, which is considered by the Geological Survey to have occurred probably in Mio-Pliocene times,

the rainfall and consequently the transporting power of the streams were very much greater than they are to-day. These conditions must have extended over a wide area, including the Minna country, but the net results were not the same. On the Plateau active erosion of the solid rocks was accompanied by deposition of much of the detrital material in the drainage channels, whereas in large parts of the region around the Plateau, including the country around Minna, erosion was the dominant process, the resulting debris being mostly carried away by the streams. It is interesting to note, however, that the present drainage of the country is on a very much smaller scale compared with its former volume.

The country around Kakuri may be described as typical of the eastern part of the area. This district is drained by small streams flowing into the K'Sha or Vaini River, which itself flows northwards to join other tributaries emptying into the Dinia River. The Kakuri stream flows over a rocky bed of gneissose granite, its present channel being rarely more than 20 to 30 ft. wide, with low banks up to perhaps 10 ft. high. The alluvium in the bed of the river itself consists of a foot or so of sand underlain by pebbles and small boulders resting on bedrock. The course of the stream is more or less rockbound, but in places it opens out into small alluvial flats containing a thin layer of pebbles beneath several feet of sandy clay. Probably most of this ground is shallower than 10 ft. from surface to bedrock.

The courses of these creeks are well defined by the belts of luxuriant vegetation which clothe them. The surrounding country is traversed by smaller tributaries and in addition there are numerous less well-defined drainage channels which are conveniently described as "wash-outs," all of which contain water-classified detritus to a greater or less extent. The most interesting point about this alluvial ground is the prevalence of gold in small quantities in it. This applies not only to the particular district around Kakuri, but to the whole tract of country examined, and it is no exaggeration to state that practically every drainage channel within the region examined carries gold. The indications, naturally, were found to be more favourable in some localities than others but, as systematic prospecting of the deposits was neither intended nor carried out, little more than this can be said here as to their exact economic importance, except that for the most part they are of low grade.

The scarcity of the iron ore minerals in the solid rocks of this region is reflected in the nature of the concentrates obtained by washing samples of the alluvial ground. Heavy black minerals, such as ilmenite and magnetite, which in some other parts of Nigeria are abundant in the concentrates of alluvial deposits derived from the degradation of metamorphic rocks, are generally found in insignificant quantity in this area, although in the larger streams such as the Shafo and the Chanchagga a certain amount of black concentrate is found when calabashing. The washed concentrates consist mainly of sand, generally light in colour, derived from the heavier minerals of the solid rocks. Locally, a certain mineral may preponderate in the concentrate, in which case the presence of rocks rich in that particular mineral may be seen or inferred in the neighbourhood. Thus tourmaline is rather abundant in some of the alluvial ground around Aduna and Kafi. Actual outcrops of pegmatite are rare, but the float quartz contains nests and needles of tourmaline. Again, around Derri the creeks contain garnet sand, doubtless derived from pre-existing rocks similar to the garnetiferous pyroxene schist outcropping in the hills north of Derri. Apart, however, from the gold content the minerals in these concentrates do not appear to be of economic interest.

In the hilly country around Lapa and Navi the alluvial deposits show an even scantier development than those of the eastern area. The stream courses are mainly rockbound, even in the case of the larger tributaries such as the Shafo and the Numui, consequently there is no great volume of ground available for sluicing and any concentration of gold would have to be fairly rich to justify the deposits being worked on anything but a small scale.

In the metamorphic country south of Gurusu the alluvial ground is somewhat deeper, owing to the smaller degree of resistance offered by the softer schists and phyllites of this area to erosion. In addition, the degradation of the numerous quartz veins outcropping in this vicinity has resulted in the deposition of fairly thick pebble beds within the drainage channels. Along the motor road between Gunu and Minna the creeks are merely the headstreams of the drainage flowing southwards into tributaries

of the Chanchagga River. Their narrow channels contain much subangular pebbly wash, but lower down their courses the banks often show consolidated beds of pebbles several feet thick, overlain by a deposit of sandy clay.

The alluvial deposits show their greatest development, naturally, along the course of the main river, the Chanchagga. East of Chanchagga Bridge the river flows for several miles over a bedrock of quartz-diorite, in which it has carved out a broad channel practically down to the base line of erosion. There is very little fall in the ground and in the middle of the dry season, when the traverse described here was made, the river itself consists of long reaches of almost still water, with a small flow over rock bars where these cross its channel. The actual bed of the river is sandy, but outcrops of solid rock are numerous and it is obvious that a hummocky, uneven bottom lies everywhere at no great depth below stream level. Thus there is no alluvial ground of the "valley flat" type of deposit, consisting of a considerable thickness of interbedded clays and sands, with bedrock many feet below stream level.

The banks of the river consist of more or less consolidated sand. The flats are extensive on either side of the river, but the ground is probably rarely more than 20 to 25 ft. deep, although actually it varies considerably in depth. In some of the wash-outs draining into the main river pebbly gravel a foot or so thick on bedrock is found under about the same depth of sandy clay. In others the depth to bedrock may be 10 ft. or over. To these depths must be added the height of the banks of the wash-out itself, which varies but may reach another 10 ft. or so. These marginal deposits mark ancient channels of the river and may be classed as "low terrace" deposits, with bedrock approximately at the same level as that of the present stream. In some places along the banks there are accumulations of rounded quartz pebbles at surface. In one of these localities a pit sunk on the sloping bank showed about 18 in. of tightly-packed quartz gravel underlain by weathered lateritic rock which merged gradually downwards into bedrock. These deposits are high and dry above the present level of the stream and represent "high-terrace" deposits marking former levels of the stream.

From an economic point of view the alluvial flats along this stretch of the river are uninteresting. Small colours of gold can be obtained by washing the lower gravel resting on bedrock, but the results as seen were not encouraging, although the sampling of sand-banks in the bed of the river itself was unsatisfactory, as it was generally found impossible to reach bedrock owing to water and caving sand. As previously mentioned, vein quartz is only sparsely developed in the diorite here and hence there has been but little concentration of local quartz, the pebbles in the gravel, which are mostly small and well-rounded, mainly having been transported from considerable distances upstream.

The metamorphic country north of Derri has little to show in the way of alluvial deposits. The watercourses form narrow ravines which wind between the steep slopes of the enclosing rounded hills and the alluvium, apart from that which occurs in the beds of the streams themselves, is confined to narrow strips along the banks. A typical section of the ground along one of these creeks is as follows :—

Chocolate-Coloured Soil . .	4 ft.
Grey Sandy Clay . . .	1 ft.
Heavy Wash of Quartz and Schist	2 ft.
Soft Green Schist Bedrock	

The Gwari pagan village of Derri is built on the top of a high dome of exfoliated granite. East of this the country is fairly flat and featureless for a considerable distance. The soil is of the loose, sandy nature typical of a granite bedrock, which obviously lies with a more or less level surface at no great depth below. This district is traversed by several small streams flowing northwards to the Chanchagga River ; these are essentially similar to those described in the eastern part of the area, and there is no alluvial ground of any depth.

West of Derri the granite forms more rocky and broken country to within a mile or so of Paiko town, where there is an abrupt descent over a steep face of the granite to a flat stretch of "fadama" or swamp forming part of the watershed between the Chanchagga basin and the Shako River. The superficial ground here consists largely of rain-wash and residual material derived from the surrounding country and has probably not been transported from any great distance. The deposit is shallow, as pits sunk through it reach the granite bedrock under about 7 ft. of sand, with a lower layer of thin wash.

South of Paiko the country stretches for a long distance in gentle undulations, with a generally level surface which is unbroken by any prominent hill features. This district to the south was not traversed. The creeks north of Paiko are small and almost entirely rockbound in their upper courses, with no flats to speak of, the alluvium being mainly confined to the actual beds of the creeks themselves. Lower down their courses, however, the rocks are not so prominent, the banks open out more and small alluvial flats are developed which increase in size as the main river is approached.

Some Economic Aspects of the Deposits.—It is not possible to state any very definite conclusions regarding the economic value of the deposits which have been described. The work carried out was merely in the nature of a reconnaissance and no attempt at systematic prospecting or valuation of any part of the area was made. Similarly, the question of the origin of the gold must remain a matter of speculation unless and until more detailed geological work is carried out. The region has been subjected to various phases of igneous activity and to consequent processes involving pneumatolytic and hydrothermal action and its early history, whilst not so complicated as that of the Bauchi Plateau, was by no means simple. It is impossible, however, from the evidence available to indicate any one particular stage as being directly concerned with the origin of the gold. The numerous quartz and pegmatite veins would seem to be the most obvious rocks inviting investigation in this connexion. A detailed study of these, both by intensive work in the field concentrated upon a particular area and by microscopical examination, would most certainly be interesting, but such work is hardly likely to be carried out by public companies unless some rich find, either in this or adjoining districts, attracts more attention to the region. Practically all that can be said at present is that over a great tract of country in Northern Nigeria there is gold to the value of millions of pounds lying within a few feet of the surface. It is possible that this widespread distribution represents a general dissemination of the metal in the superficial deposits, as a result of the erosion and removal of vast masses of rock in which it was present in minute quantities. In this case detailed work on the solid rocks will reveal little but negative information and, further, rich local concentrations of the gold may not generally be expected in the alluvial deposits. This can only be proved one way or the other by further geological investigation. The proposition as it stands is not attractive to financial people on account of the low-grade nature of the deposits as so far known and in this connexion it must be noted that the mining laws of the country are unfavourable for inducing private enterprise and development work in regions such as this. The expenditure involved in preliminary prospecting, pegging leases, attendant survey fees, etc., is considerable under the present regulations. The leases granted are of restricted size and large sums might easily be spent before a lease rich enough to justify the outlay could be located.

At the same time the gold is there and it should not be impossible to devise some method of amending the regulations in order to turn this potential wealth to advantage. Like many other low-grade areas, not only where gold is concerned, but in connexion with other economic minerals, the greater part of this region is such that profitable mining on a lease system cannot be carried out unless the individual or company concerned has rights over a comparatively large area and payments to Government are mainly limited to royalty on the value of the metal or ore won. It has even been suggested that such low-grade areas should be thrown open so that anyone could buy gold on a tributing basis from the natives, giving them permission to wash for the metal. If this were done some result might be obtained. The deposits would be searched over thoroughly, in the manner whereby the average tributor shows his efficiency in his own particular line of prospecting, and any promising areas which might be located could still be pegged as leases in the ordinary way. Conditions similar to the above apply to certain low-grade tinstone deposits fringing the Bauchi Plateau, but here we have this distinction, that tin is one of the commodities which the world possesses in excess at the present time. Nobody particularly wants more tin, but most people would be better off by the production of a little more gold.

The writer is indebted to Major E. Seaborn Marks, managing director of Associated Tin Mines of Nigeria, Ltd., for permission to publish these notes.

LETTERS TO THE EDITOR

"The Rotary Pan for Diamond Concentration"

SIR,—There are some points in Mr. Walker's criticism of my article which appeared in your June issue that can be subjected to mathematical analysis.

The first concerns the question of centrifugal force. A body of mass M when falling in water is attracted by the earth with a force which is equal to the product of its mass and its hydrostatic acceleration. The same body, if it be carried round in forced vortex motion, will possess a centrifugal force $\frac{MV^2}{R}$, where V is its peripheral velocity in ft. per second and R the radius in ft. As the mass remains unchanged in both cases the two forces can be compared by examining the values of the hydrostatic acceleration and the expression $\frac{V^2}{R}$. The former is the greater for all conditions in the machine under discussion.

The second point is slightly more complicated. I cannot subscribe to the belief that a body will drift towards its axis of rotation when its centrifugal force falls below a certain value; I know of no law of hydrodynamics which would permit it. The problem is best approached by examining the possible existence of a negative centrifugal force. The centrifugal force of a body of weight W lb., moving in water with a peripheral velocity V ft. per second at a distance R ft. from its axis of rotation, is—

$$\frac{(W - w)V^2}{gR}, \qquad (1)$$

where w is the weight of an equal volume of water. It is perfectly evident that if w be greater than W the expression is negative in value. The same condition obtains when the hydrostatic acceleration of a mineral is examined. If g_h be the hydrostatic acceleration, g the acceleration due to gravity, and d the density of the mineral, then—

$$g_h = \frac{g(d - 1)}{d}. \qquad (2)$$

If d be less than 1 the body must rise as the value for g_h becomes negative. In the same way it would seem from expression (1) that a body would drift towards its axis of rotation if it were moving in a fluid of greater density than itself. An oil in water emulsion is a case where a negative centrifugal force could exist. Actually oils are dehydrated in machines which rotate on their centres of mass, since the rotational speeds are above their critical speeds. There is nothing in the design or method of operation of these machines, however, which will answer this question—Is the separation effected by a negative centrifugal force or is it brought about by the reaction of the water?

That is the problem of the possible existence of a negative centrifugal force. If expression (1) be examined it is easy to see that such a state of affairs can never be brought about by any alteration in value or sign of the velocity. A quicker way of arriving at the same conclusion is as follows:

A body rotating in a fluid is under the influence of four forces. They are—

(1) Its weight vertically downwards.

(2) The upthrust of the water.

(3) The centrifugal force, by virtue of its velocity, radially outwards.

(4) A viscous drag, tangentially backwards.

If (3) cease (4) must cease, and the body must rise or sink; nothing else can happen.

I do not think that centrifugal effects could ever be described as capricious. I would say that they were altogether definite.

J. SIM.

Montrose.
August 2.

"Alluvial Gold"

SIR,—An abbreviation at one point in my discussion of the deposition of alluvial gold in your August issue appears to require amplification. At the bottom of p. 82 it is stated that "with particles which require about 150 or more to make a grain the gravitational tendencies still are strongest and the gold concentration will increase with the permeability of the wash." At this point I wished to bring out the fact that under the conditions stated the gold concentration would increase with depth in the wash, provided the wash was sufficiently permeable to permit penetration by the gold particles.

H. L. HOLLOWAY.

London.
August 30.

BOOK REVIEWS

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

This little book contains practical hints on prospecting and testing gold placer deposits. The various methods of working them—by panning, rocker, long tom, sluicing, dry blowing, and mechanical appliances—are described, with dimensional drawings and photographs. Hints are also given on cleaning up, amalgamating, and on locating and selling placer deposits, and a useful bibliography is included. The book is, however, merely intended for the small operator with little or no capital and hence confines itself to a description of the working on a small scale of placer deposits accessible above water level. For this rather limited scope it should prove useful. The difficulty, sometimes impossibility, of sinking test pits in water-logged ground is not touched upon.

F. A. W. THOMAE.

Earth Lore: Geology without Jargon. By S. J. SHAND. Cloth, octavo, viii + 134 pages, illustrated. Price 5s. London: Thomas Murby and Co., 1933.

As a popular outline of modern ideas on certain fundamentals in one branch of geology this scholarly volume provides delightful and instructive reading—easy, lucid, and almost conversational in style, there is not a dull or trivial page in it. The author reveals his general purpose in an introductory pen-sketch of primitive "Adamson . . . on a great raft of earth floating in nothingness," who sometimes lies on his back and puzzles his head about "the raft and the lights and the nothingness." This Adamson is deftly merged into the general reader, who is conducted towards a rational interpretation of the earth—its status in space; its surface features and the processes which have evolved them; the nature of the earth's crust and interior; vulcanicity, mountain-building, valleys of "rift" (or, conceivably, "ramp") origin, and continental drift. Every chapter is a masterly essay-review, embodying first-rate and well co-ordinated material; even the one devoted (needlessly, we think) to a critical review of the "creation saga" and the early chapters of the Book of Genesis is entertaining and informative.

The sub-title is a little provocative. If by "jargon" is meant the specialized nomenclature adopted in particular branches of geology (in common with other sciences) to ensure both precision and brevity, then a text which laboriously avoids technical terms may be too "popular" to be of much scientific value. This little volume, however, deals mainly with the one branch (physical geology) in which technicalities can be most easily avoided. It presents sound science and, though it puts forward no claim to rank as a text-book, it has the qualities of an excellent one.

A. BRAMMALL.

Phase Rule Studies: An Introduction to the Phase Theory. By J. E. WYNFIELD RHODES; with an introduction by E. L. Rhead. Cloth, octavo, x + 131 pages, illustrated. Price 6s. Oxford University Press.

In this lucid and well-conceived introduction to the Phase Rule fundamental principles are explained in a progressive study of about forty well chosen systems, mainly chemical, but including some instructive examples culled from mineralogy and metallurgy. The treatment is tutorial and should overcome the beginner's main difficulty—that of constructing (or, indeed, interpreting) a conventional diagram for the "behaviour" of a system (the significance of points, lines, and areas in such a diagram is adequately explained in the first four chapters). The later chapters deal with poly-component systems, modes of graphical representation, and experimental methods employed in phase-rule work. References to more extended treatises on the subject are given in an appendix.

Errors and obscurities are commendably few in this "first edition." This unpretentious, stimulating little book will prove most acceptable to the general student of pure and applied chemistry.

A. BRAMMALL.

☛ 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

BRISBANE

July 27.

Mining in 1933.—The output of gold in Australia during the past half year has continued to show a substantial increase. Returns for the full period in Western Australia, the chief among the producing States, are not yet available, but the improved yield for the first quarter of the year indicated that the rise in 1932 has been more than maintained in the past six months. Records just completed show that the output of gold in Victoria for the first half of 1933 (27,593 fine oz.) is substantially higher than in any similar period for some time. The yield for the corresponding half of last year was 19,225 oz.; in 1931 it was 19,581 oz. and in 1930 10,972 oz. The yield for June in that State (4,850 oz.) was twice as great as that for the same month of last year. From Queensland, which has lately ranked third amongst the Federal States in gold production, the yield for the past half year was 40,422 oz., while that for the like period of 1932 was only 5,404 oz., an increase of over 35,000 oz. These figures are a striking illustration of the satisfactory results that have followed energetic prospecting and increased activity generally in the gold-mining industry. Amongst the goldfields in Queensland that in the past six months added to the improved gold production the best contributor, thanks mainly to the enterprise of a company in which British capital is concerned, has been Mount Coolon, now the principal goldfield of the State. The field's output for last month, for instance, was 4,434 oz. and this compares with only 110 oz. in the corresponding month of 1932. In minerals other than gold the value of these, apart from coal, for the period was £525,212, or £109,570 more than for the 1932 half year. The greater portion of this increase is due to the large output of lead and silver from the Mount Isa mine.

Mount Isa.—A special inquiry has been made during the past month by the Queensland State Insurance Commissioner (Mr. J. A. Watson) and Dr. J. V. Duhig into the matter of plumbism, or lead poisoning, at the Mount Isa mine. A complete inspection of the mine and smelting operations occupying four days was made. The fullest information was received from the management and responsible officers as well as from the industrial council and the plumbism committee at Mount Isa and by this means the viewpoints of both the management and the employees were obtained. The report of Mr. Watson and Dr. Duhig, submitted to the Government a few days ago, states that it was evident lead hazards of a high order definitely exist at certain points in the process of smelting and that the typical experience for six months from July to December last revealed that of 33 cases the incidence of lead intoxication was 22·49. In the inquiry committee's report many recommendations are made for improving conditions at the mine in an endeavour to limit the incidence of such poisoning and these have been considered by the Cabinet with the view, as far as possible, to carrying out the recommendations. The Minister for Mines is satisfied that the Mount Isa company has done wonderful work in an effort to minimize the incidence of the disease and he hopes, as a result of the present inquiry and report, the position will be still further improved.

Work and Production at Mount Isa.—Underground work at Mount Isa is, as usual, progressing well. During June the ordinary output was fully maintained and the normal amount of development work on the Black Star, Black Rock, and Rio Grande lodes was kept up.

Cracow Goldfield.—A report by a Government geologist demonstrates concerning Cracow, the most recently-discovered Queensland goldfield, that the development work recently carried out has shaped much more definitely the prospects of the field. It seems that, while there have been several new discoveries that promise a lengthened period of economic operations, the general tendency, so far as established, is for gold values in the known shoots to decrease or die out at more or less shallow depths. The impending problem of the field, therefore, promises to be the likelihood of a recurrence of further enrichment of ore-bodies in depth and, because there is no known reason for superficial concentration only of gold in these lodes, this is not to be considered an improbability at present.

Mount Morgan.—At the Mount Morgan mine, Central Queensland, during June the output of ore was increased to a point which now enables the plant to handle weekly 2,350 tons, which is 78·3% of the full tonnage originally planned. It is now

expected by the management that the full capacity of 3,000 tons a week should be reached during the present month. The open-cut has continued to yield all the ore called for by the mill. Sir Herbert Gepp, the Commonwealth Consultant on Development, who has lately visited Northern and Central Queensland, states that work generally at Mount Morgan is proceeding according to plan and he is satisfied that the forecast he made in a report to the Government a year ago, after consultation with Mr. A. A. Boyd, the general manager for the company, will be substantially achieved. The report referred to was one in which Sir Herbert recommended that assistance be given to the Mount Morgan Company for new operations at the mine. Sir Herbert likewise affirms that the work being done is of a high order; also that the future magnitude of the operations will depend on industrial good will, mutual confidence in the management, and general efficiency.

Mount Wandoo Mine.—At the Mount Wandoo gold mine, North Queensland, the east winze in the main (Hardman) shaft has been deepened a further 25 ft. to 100 ft. Sinking continues in the footwall formation, where values are fairly regular. The west drive off the cross-cut has been advanced 20 ft. to a total of 40 ft. from the point of commencement. This drive is in a low-grade mineralized ore-body. During the month the quantity of ore railed from the mine to the Chillagoe State smelters was approximately 30 tons, containing 19,853 oz. of gold, 99 oz. of silver, and a small quantity of copper.

Mount Lyell.—According to a statement made at Burnie, Tasmania, by Mr. B. M. Murray, manager of the Mount Lyell company, had it not been for the recent improvement in the price of copper, operations at the mine would probably have ceased. This is the only company in Australia that has continued to produce copper throughout the period of depression. The company's work during the first six months of its last financial year resulted in a very substantial loss. The price of copper, Mr. Murray said, was a constant source of anxiety to the directors, particularly in view of an increase of wages that has been ordered by the Arbitration Court. Even with the present price of metals, it was affirmed, the mines of the company are being depleted with little or no return to the shareholders.

Oil from Coal.—From Sydney it is learned that everything will be ready before the end of the year for the exploitation of the Ellalong coal leases for the production of oil by the hydrogenation of coal. This prediction is made by the representative of a financial group interested in the enterprise. The group is said to be in association with the German Dye Trust, the Dutch Shell Company, the Standard Oil Company of America, and other important companies. The leases cover an area of about 32,000 acres. According to expert opinion they are stated to contain 500,000,000 tons of coal. Development work is expected to begin about Christmas.

JOHANNESBURG

August 3.

Far East Rand Areas.—A new company—Far East Rand Areas, Ltd.—is carrying out surveys by up-to-date methods of a large area lying some miles to the east of the big mines on the Far East Rand basin. This area has for many years been presumed to contain an outlying syncline of the Witwatersrand reef conglomerates and the company is now engaged in effectively testing the theory that the extension of the Main Reef Series lies at an economic depth under a big block of farms—in extent about 100,000 acres—on which it has secured options. It is officially stated that the results of the geophysical survey work completed to date show that the various anomalies that were obtained in the original traverse run in a westerly direction from the basement granites to the sub-outcrop of the Main Reef Series at Government Areas agreed remarkably closely with the anomalies that were registered in the traverse in an easterly direction from the basement granites towards Leslie. In other words the company's technical advisers have found along the main section line extending from Government Areas to Leslie that the sequence of strata from the granites in a westerly direction up to Government Areas is identical with the sequence that the geophysical survey indicates exists from the granites in an easterly direction towards Leslie. The west to east line is now completed and the north to south line was started recently by two teams of geophysicists.

Union Gold Production.—During the six months ended June 30, 1933, the Trans-

vaal mines crushed 18,079,760 tons of ore for a total yield of 5,555,799 oz. of fine gold. Compared with the figures for the corresponding period of 1932 the tonnage milled shows an increase of 747,760 tons, but the gold output is 129,483 oz. less, owing to the decline in the average yield per ton from 6·479 dwt. to 6·061 dwt. Working costs per ton were 3d. higher. Reflecting the increased price obtained for the metal, working revenue has risen from £23,941,920 (27s. 7d. per ton) to £32,839,902 (36s. 4d. per ton), working profit shows an advance of £7,995,408 (8s. 6d. per ton), and dividends declared represent an improvement of £2,124,910. The following figures show the decline in the average yield, revenue, and profit per ton since the beginning of the year :—

	Yield per ton. *dwt.*	*Revenue per ton.* *s. d.*	*Profit per ton.* *s. d.*
January .	6·285	37 10	18 6
February .	6·184	37 0	17 3
March .	6·034	36 1	16 6
April .	6·019	36 1	16 4
May . .	5·910	35 8	16 3
June .	5·846	35 4	15 10

Rhodesian Tin.—A reservation over an area of about 60 square miles in the Victoria district, Southern Rhodesia, to permit a mining company fully to examine the alluvial tin deposits therein has been granted by the Government. The reservation will be for three months. It is stated that the Government wanted to have the deposits fully tested, but no company would prospect the ground unless it was protected against pegging by other prospectors. The recent discovery of ancient tin workings in the Rusape district of Southern Rhodesia, notably in the Cornucopia ruins, has served to focus attention on their scientific value. Several ingots of tin were found in the vicinity of the Queen's smelters and a ring made of almost pure tin was found in the area and is, with the other relics, in the keeping of the Salisbury Museum. It is reported that the area is pegged and development is proceeding.

Rhodesia's Copper Refinery.—A site has been cleared at N'kana for the construction of Rhodesia's copper refinery and work will commence in earnest next month when the engineer, Mr. Almar Ek, who was responsible for the construction of Rhokana Corporation's mills at N'Kana Mine arrives from the United States. The erection of this refinery will, in addition to other benefits, to a great extent relieve unemployment in the copper belt. Would-be employees at N'Kana are being told to return next month.

Vogelstruisfontein Areas.—A company is being formed to work lease claims on the Near West Rand situated on the farm Vogelstruisfontein and adjoining the properties of the Consolidated Main Reef Mines and Estate and the New Steyn Estate Gold Mines. Three companies responded to the Government's call for tenders for the lease of the whole or portions of this ground. The Consolidated Main Reef company and the New Steyn Estate company applied for portions adjoining their respective properties, while the Anglo-Transvaal Exploration Co. (Pty.), Ltd., which was formed a few months ago by Mr. N. S. Erleigh and his friends, tendered for the whole area, considering that it is ample for the requirements of a new and large individual mine. The New Steyn Estate's tender was withdrawn. Negotiations have taken place between the Government and the other tendering companies, with the result that the Anglo-Transvaal Exploration Co.'s tender has been accepted in respect of 1,583 claims and the Consolidated Main Reef company will receive on lease a strip of ground containing 155 claims.

Nigel Gold Mining Company.—Only one tender has been received by the Government Mining Engineer for the lease of the Varkensfontein and Bultfontein areas adjoining the properties of the Nigel Gold Mining Co., Ltd., and the Sub Nigel, Ltd., on the Far East Rand. This tender was submitted by the Nigel Gold Mining Co. and is now under consideration. If it is accepted the company's mining area will be increased to 3,156 claims.

" Boksburg Gap " Areas.—The Government has received two tenders for the lease of the areas comprising a block of 2,363 claims in the " Boksburg Gap " area, adjoining the properties of the New Kleinfontein Co., East Rand Proprietary Mines, and Van Dyk Proprietary Mines. These tenders were sent in by the East Vogelfontein Exploration (Pty.) Co., Ltd., and the New Kleinfontein Co., Ltd., and will be considered by the Mining Leases Board in the near future. The East Vogelfontein Company holds a block of claims in the " Boksburg Gap."

TORONTO

August 18.

Gold Production.—Bullion to the value of $3,636,754 was produced by the gold mines of Ontario for July, as compared with $3,648,692 for the previous month, a decline of $11,938. Ore milled amounted to 462,635 tons, being higher than June's total of 457,886 tons and revealing a lower average grade. During the seven months ending with July Ontario's total gold output was $25,801,489, exclusive of premium, as against $26,840,413 for the same period last year. Canada's gold production for the year 1932 totalled 3,051,676 fine oz. valued at $63,083,740, according to a report of the Dominion Bureau of Statistics. This constitutes a new high record for the third consecutive year and compares with 2,693,892 fine oz. valued at $55,687,688 in 1931. Canada was the world's second largest gold-producing country for the year, being exceeded only by the Union of South Africa.

Porcupine.—July production in this area totalled $1,712,065 from 277,475 tons, a sharp drop from the June figure of $1,829,775 from 277,930 tons. Dome Mines produced bullion having a total value of $359,520, which was $40,782 less than June's production of $400,312, but in excess of the $311,846 recorded in July of last year. Production for the first seven months of the present year totalled $2,737,839. The reduced output for July is attributed to the treatment of lower-grade ore. The company is carrying forward development on a large scale and the mineral zone around the 23rd level is being rapidly opened up, with the general grade running well above average for the mine. Drives from the winze are expected to reach the new ore within a month, while more exact information regarding the deposits will be available in two months. For the first quarter of its fiscal year, ending June 30, McIntyre Porcupine Mines had a net income of $800,468, compared with $557,737 for the corresponding quarter of last year. Large tonnages of ore of good grade and width have been revealed by developments on the north contact zone from east to west end of the company's property from surface to 1,000 ft. Development is being pushed on the McIntyre property in the Platt-Veteran section, where diamond drilling has shown the continuation of good values around the 4,300-ft. horizon, and shaft sinking is going forward. Milling is being maintained at a rate of approximately 2,000 tons a day. Vipond Consolidated Mines report production of $129,300 from 27,246 tons milled for the quarter ended June 30. The average yield of $4·75 per ton compares with $4·37 for the previous quarter. For the first six months of the current year gold and silver production of Hollinger Consolidated Gold Mines totalled $6,133,573 from the treatment of 847,519 tons of ore, an average recovery of $7·36 a ton. This compares with $5,558,507 from 842,819 tons for the first half of 1932, an average recovery of $6·59. The present output of ore is at the rate of about 5,000 tons a day.

Kirkland Lake.—Production in the Kirkland Lake belt increased considerably during July, reaching a total of $1,819,331, as compared with $1,698,400 for June. From last September, when it commenced milling operations, to July 1 Ashley Gold Mining Corporation treated a total of 23,823 tons of ore averaging $12·09 per ton, gold shipments amounting to $232,757. The mill is treating between 140 and 145 tons of ore daily. Macassa Mines is rushing the construction of a new 200-ton mill at the western end of the Kirkland Lake belt. Driving east on the 2,000-ft. level has encountered the extension of the ore shoot opened up on the 2,175-ft., 2,350-ft., and 2,475-ft. levels. The new mill is expected to be ready for operation in October. Development work is being commenced shortly on a new block of territory 800 ft. in depth at the Wright-Hargreaves mine. Lakeland Gold Mines is carrying on an active programme of drilling and a series of flat holes are being put out to intersect ore-bodies from the 575-ft. level. The drill will be moved later to the 700- and 825-ft. levels, where stations were cut recently. Construction of a mill will begin immediately, equipment having been purchased and a site prepared. This property is located some miles north of the main Kirkland Lake camp. The No. 1 shaft of Canadian Kirkland Gold Mines has been unwatered and preparations are being made for an active programme of shaft-sinking and underground development. Dominion Kirkland Gold Mines is carrying out an active exploration programme on its property in Teck Township, about a mile south of Macassa Mines. Stripping and trenching on the No. 2 vein has revealed encouraging results and will be followed by diamond drilling. For some weeks men have been employed in making preparations for

extensive development work. Operations on the Bidgood Consolidated property are being resumed by Bidgood Kirkland Gold Mines, recently formed to take over the property. Plans include the immediate installation of a 150-ton mill and the sinking of No. 2 shaft from its present depth of 550 ft. to 1,000 ft., with establishment of levels at 125-ft. intervals. Three veins have been discovered by Glenora Gold Mines, adjoining the Toburn property. One of these has been traced for 2,500 ft., yielding good returns over moderate widths. The mill of Toburn Gold Mines is being increased to 300 tons. Extensive development work is being carried on and a rich strike was reported recently. Development work on new levels from 3,000 to 3,900 ft. at the Wright-Hargreaves mine is yielding good results, with the vein showing a width of 5 ft. carrying values of $20 per ton.

Sudbury.—Falconbridge Nickel Mines had a net income of $505,247 for the six months ended June 30. Production for the period amounted to 4,308,222 lb. of nickel matte and 1,879,932 lb. of copper matte from 104,514 tons of ore. Refined nickel output totalled 2,969,890 lb. and refined copper 1,164,727 lb. The second quarter showed an improvement over the first, with an increase of $37,663 in net income. A slag disposal plant which will handle some 600 tons of converter slag a day has been added to the company's equipment. Production is being maintained at the rate of between 800,000 and 900,000 lb. of nickel and about 400,000 lb. of copper monthly. Production is being increased by the International Nickel Company, which recently blew in a third blast furnace at Coniston, bringing smelter operations at that plant to about 65% of capacity. This has resulted in a corresponding increase of production at Creighton mine. Production at the Frood mine remains at about 100,000 tons a month. Buffalo-Ankerite Gold Mines is producing gold to the value of approximately $65,000 a month, including exchange compensation. Since beginning operations in May of last year the mill increased its rate from about 150 tons daily to about 300 tons in June last. During that period recovery was increased from $2 to $4·40 a ton. Development work at the Kenty Gold mine is being attended with important results. At the No. 1 shaft the cross-cut south to No. 1 vein is nearing its objective, the vein lying some 80 ft. from the shaft at the 500-ft. level. Several free gold showings have been revealed and the vein is of exceptionally good character. Good progress is also being made in sinking operations at No. 2 shaft, with a 550-ft. objective. Dewatering of the shaft at McMillan Gold Mines is being completed and preparations are being made to deepen the shaft. More than $500,000 in ore reserves has been blocked out above the 525-ft. level. Surface exploration at the property of Lee Gold Mines, in the Swayze gold area, has yielded samples indicating high grade in many places and a programme of underground exploration is contemplated. The shaft at the Halcrow-Swayze Gold Mines, in the same area, is being carried downward to a depth of 210 ft. and its completion will be followed by extensive underground work. An intensive campaign of diamond drilling is being carried out on the Swayze Allen Lake and Swayze-Huycke properties. An ore-body composed of greenstones and intrusives has been encountered, while free gold has been found in several places. A selected sample from the No. 3 zone assayed $74 to the ton. A number of claims are being staked in Mallard Township, on the Opeepeesway River, following news of a discovery in that district.

Quebec.—Production of gold in Quebec for July totalled 30,974 oz., as compared with 35,316 oz. in June, a decrease of 4,342 oz. The total for the three months ending with June was 89,459 oz., as against 113,116 oz. for the corresponding three months of last year. Silver production was also lower, amounting to 39,640 oz., compared with 46,701 oz. in June of last year, the total for the three-month period being 147,562 oz., as against 171,528 oz. for a year ago. During July Siscoe Gold Mines produced bullion valued at $98,634 from 9,467 tons, recovery being $10·75 a ton. This figure is slightly lower than the June total of $99,908, but higher than the $89,055 recorded in July of last year. The company made a new all-time record for tonnage milled during the month, but, as a larger percentage of mill feed came from development faces, the average grade and recovery was below that of June. The main ore-body on the property of McWatters Gold Mines has been cut at 150 ft. and three rounds taken showed the cross-cuts still in the vein, with considerable gold showing. During the first six months of the current year Noranda Mines produced 30,712,154 lb. of anodes, with a total recovery of $5,365,306. The concentrator is operating

at capacity, with a daily production of approximately 400 tons of copper-gold concentrates. Considerable attention is being given by the management to the refinement of milling processes, with a view to increasing gold recovery. Surface work on the property of Chibougamau Prospectors, in the Pascalis district, has uncovered a vein for a distance of 500 ft., having a width from 2 to 15 ft., and first assays returned values as high as $4·80 per ton in gold. Exploration and diamond drilling will be proceeded with. Granada Gold Mines has completed the sinking of the incline shaft on its property. Work will commence shortly on the sinking of an exploratory shaft from the 1,300-ft. level to the 3,000-ft. horizon. Ore reserves are sufficiently large to supply the 200-ton mill for some time. Work is proceeding on the construction of a mill on the Greene Stabell property in Dubuisson Township and a standard gauge railway from Kienwisik Lake to the property has been completed. Work on the Vicour property of Teck-Hughes, in Louvicourt Township, is meeting with encouraging results and assays have run as high as $75. Canadian Pandora Gold Mines has awarded a contract for the continuation of the shaft on its property in the Cadillac district from 250 to 500 ft., with levels at 375 and 500 ft. Good mineral conditions at 500 ft. have been revealed by diamond drilling.

North-Western Ontario.—Howey Gold Mines programme of expansion is going steadily forward and it is expected to have the mill addition operating at a daily capacity of 1,400 tons by the first of October. For the first six months of 1933 Moss Gold Mines had a bullion recovery of $115,837·57 from 17,987 tons of ore treated, an average recovery of $6·44 per ton before premium. The mill is now operating at about the same capacity. An important strike has been made on Central Patricia's Springer group of claims, some 2½ miles from the company's main property, and samples show high gold values. Two pits have been started on vein No. 6. A quartz vein 50 ft. wide has been opened for a distance of 700 ft. by trenching and test pitting on the property of Siville-Ferrier Syndicate, in the Jackfish area of the Thunder Bay district. Samples from one of two pits put down showed average assays of $92·01 in gold per ton. Development of the old Regina mine, which was recently reopened, has disclosed a block of about 1,500 tons of ore of commercial value between the 8th and 9th levels, while samples running as high as $23 a ton were taken from other parts of the mine. An extensive development programme is being commenced by Wendigo Gold Mines, in the Lake of the Woods district, and a plant is being installed. Sampling on No. 1 vein, both surface and underground, yields values of $11·26 a ton over a 3-ft. width. St. Anthony Gold Mines has made a discovery on its Sturgeon Lake property which has returned assays averaging $3·50 per ton. Preparations are being made for production on a schedule of at least 125 tons a day.

Manitoba.—Highly encouraging results are being obtained from development work at the property of God's Lake Gold Mines, in the God's Lake area. Extensive diamond drilling on the easterly part of the property over a length of 3,600 ft. revealed exceptional continuity of vein and mineralization. At the Smelter Gold Mines property, in the same district, the No. 1 vein has been stripped for 1,300 ft. and has been traced for another 900 ft. Its average width is approximately 7 ft. A fracture of about 60 ft. in width was encountered containing three well-mineralized veins. Oro Grande Mines, in the Bulldog Lake section, has completed its mill and is starting production immediately. The main working shaft, which is down to 140 ft., has broken into the drive on the first level. Excellent values have been encountered in sampling in the shaft. Elbow Lakeshore Gold Mines Syndicate, which has been organized to develop a group of 14 claims at Elbow Lake, in The Pas district, is preparing to instal a 25-ton mill.

VANCOUVER

August 10.

Bridge River.—Another important strike has been made at the Bralorne mine. The new ore-body, which is said to be 50 ft. wide at the point of intersection, was encountered in cross-cutting on the 7th level, east of the fault which has figured prominently in the recent developments. Ore-bodies of major importance have now been found on both sides of this fault and the structural problems affecting the ore deposition are being rapidly solved as a result of the efficient exploration that is being carried out. Further lateral development is required before the average width of the newly-discovered vein can be established, but a highly-encouraging aspect is represented by the report that the whole

body of this mass of quartz carries values of higher than average grade. With these successive discoveries development has outstepped milling capacity and it is understood that immediate steps are to be taken to add more units to the treatment plant, with a view to an ultimate capacity of 500 tons per day and enlargement of the scale of operations generally. Production from the Pioneer mine for the month of July is calculated at $20-4,000, making a total for the year to date of about $1,380,000. Operating expenses for the past month amounted to about $61,000, being higher than usual owing to additional work involved with the enlargement of the hydro-electric power plant. Details of operations that are being carried out by B.R.X., Ltd., are covered in a recently-published progress report, in which it is stated that the entire project is based on the premise that since conditions geologically similar to those at Pioneer and Bralorne exist on the B.R.X. ground there is reason to hope that as depth is gained commercially-valuable ore-bodies will be developed. The main feature of attraction is in connection with the California vein, which is described as a mineralized shear zone of brecciated quartz. Two other veins were cut by the lower level cross-cut, both of which are understood to be converging towards a point ahead of the present face of the drive, which has been advanced to a distance of over 320 ft. on the vein and is vertically below the portal of the upper tunnel. Grull-Wicksne Gold Mines, Ltd., has been formed with a capital of $2,500,000 to acquire and develop a group of properties lying to the north and west of the Bralorne on which certain outcrops of diorite occur and a considerable amount of work has been done in exploring quartz veins in the Bridge River schist formation. A feature that is stressed in connexion with this promotion is the natural facility for obtaining considerable depth by tunnel approach. W. A. McKenzie, formerly Minister of Mines for the Province, is on the board of directors.

Lillooet.—A group of 18 claims has been acquired by the Lakeview Syndicate in the Anderson Lake area, where it is reported that a gold-quartz vein 9 ft. wide has been discovered. A considerable amount of interest is being taken in this section of the country from the divide between Cadwallader and McGillivray creeks to Birkenhead lake, where geological survey work is being continued under Dr. J. F. Walker. Work is in progress on several properties in the McGillivray section, in addition to that of National Gold Mines, Ltd., upon which 300 ft. of tunnelling has been completed this year. On the Gold Hill group a quartz vein 35 ft. wide has been uncovered, from which a sample yielded $2·40 per ton. Wide bodies of low-grade or barren quartz are characteristic of this area, but occasional pockets of rich gold ore occur and hopes are entertained that commercial values may be discovered.

Cariboo.—Prospects of discoveries of commercial bodies of lode-gold in the Hixon Creek area have been brought into prominence by the initiation of some new activities. In addition to the Senator Reid property, where developments are in progress by Quesnel Quartz Mining Co., an adjoining area covering 72 claims has been acquired from the owners—Starbac and Hahn—by the Brotgold company. Several gold-quartz veins are reported to occur on this property, having the general characteristics of the Barkerville area deposits, and some high assays are said to have been obtained. Toronto and New York interests are stated to have acquired large holdings in Hixon Creek (Cariboo) Gold, Ltd., covering creek and bench leases, on which it is proposed to carry out extensive hydraulicking operations next season. No further developments of importance are reported from the Barkerville area, but it is stated in the recently-published bulletin of the Department of Mines that present appearances underground at the Cariboo Gold Quartz properties are distinctly healthy and exposures of ore gratifying. In addition to Newmont Mining Corporation, Premier Gold Mining Co., Ltd., Britannia Mining and Smelting Co., Ltd., and Burns Mountain Gold Quartz Mines, Ltd., which are already established, the Government bulletin mentions Shamrock Gold Mines, Richfield Cariboo Gold Mines, Ltd., and Cariboo Mountain Gold Quartz Mines, Ltd., as having been incorporated to acquire extensive holdings. It is reported also that B.C. Cariboo Gold Fields, Ltd., for which Dr. Victor Dolmage is acting as consulting geologist, has commenced operations on Burns Mountain.

Salmo.—It is stated in a recent progress report that the ore-body which is being opened up from the No. 5 level of the Reno mine has been followed for a distance of 170 ft. and maintains an average width of about 3 ft. The ore shoot continues of the

same width in the winze that has been sunk to a depth of 60 ft. from the level. It is estimated that ore reserves having a value of about $450,000, at the current price of gold, have been added to the previous estimate as a result of the deep-level work that has been carried out during the past two months. Up to the present time mill-feed has been supplied largely from development headings and net earnings have been at the rate of about $25,000 per month. Some additional crushing machinery has been installed in the mill and with the enlargement of stoping work it is said that a marked increase in production may be anticipated in the near future. The Gold Belt and Golden Belle properties have been amalgamated under one control, with Arthur Lakes as general manager. Certain veins in the same general system pass through both properties and the prospects are considered to be materially benefited by this arrangement. The deep-level exploration on the Gold Belt property has not yet been productive of conclusive results in regard to the main " C " vein, which formed the chief objective of the work, but it is reported that the first vein that was encountered in the cross-cuts has shown considerable improvement in the driving work that has been done on it. A large amount of work is in progress on the Queen property, where the Queen vein workings are being unwatered, and development work is being carried out on the Alexandria vein, with the proof of a good ore shoot. The old mill is being thoroughly reconditioned and new machinery installed. The Kootenay Belle mine is showing up well under the active development that has been commenced. The Vancouver property adjoining the Queen and Kootenay Belle has now been amalgamated with adjoining claims under options secured by the Midnight Mining Syndicate. Work has been started with a view to continuing the tunnel on this vein into the adjoining Midnight ground, where it is anticipated that further ore shoots may be developed. H. G. Nichols has been retained as consulting engineer for the syndicate.

Coast.—Active work has been commenced on the holdings of Princess Royal Gold Mines, Ltd., which was incorporated recently to acquire the old Surf Inlet and Pugsley Mines on Princess Royal Island, together with the adjoining Wells group. It is reported that a drive is being carried on $90 ore on the 700-ft. level. The improvement in the price of copper has been reflected in increased activity at the Britannia Mines, where operations have been speeded up and the working force has been substantially increased, and at Anyox, where an all-round increase in wages has been made effective. Work has been commenced on the property of Haida Gold Mines, Ltd., on Moresby Island, a contract having been let for driving a 300-ft. tunnel. This property represents the first discovery of lode gold in the Province, having been located by representatives of the Hudson's Bay Co. in 1852.

Boundary.—Following quickly upon the resumption of operations at the Beaver Silver Mine, at Beaverdell, the optimism that was expressed by Major Angus Davies, when work was suspended owing to shortage of funds, has been fully justified by developments. The ore-body that has been encountered ranks among the highest grade of any in the camp and has been followed already for over 50 ft. There appears to be every indication that this ore-body represents the continuation of the step-faulted ore shoot that has been worked on the Bell property right up to the Beaver Silver boundary. Interesting developments have also been effected in the Wellington mine workings, which have penetrated the Sally mine ground and have exposed exceptionally high-grade silver-lead ore at a considerable depth below the Sally workings. It is understood that a mutual arrangement in regard to this operation has been arrived at. At the Hedley camp some very encouraging developments have occurred on the Pollock group, which is being operated by Gold Mountain Mines, Ltd. The Maple Leaf vein, which is said to show a maximum width at surface of 40 ft., is expected to be reached in another 40 ft. of driving. In the Fairview camp several operations are in progress. The first carload shipment of gold ore from the Morning Star property has been held up pending repair of the spur railroad track at Oliver. In this camp Mac-Siccar Gold Mines, Ltd., has acquired the Tiger Group of 12 Crown-granted claims near the Morning Star and work has been commenced.

East Kootenay.—A strike of rich gold ore is reported from an area at an elevation of about 8,000 ft. at the head of Sawmill Creek, a tributary of Perry Creek, where placer mining has been in progress all this season. A number of claims have been staked and it is reported that the occurrence

is receiving the attention of the Consolidated Mining and Smelting Co. Recent reports of progress at the properties of Meridian Mining Co., at Camborne, are to the effect that an ore-body 30 ft. wide has been exposed on the Oyster-Criterion ground assaying about $6·40 per ton. With developments on the Eva and other properties held by the company it is believed that there is an assurance of ore supply for a 100-ton mill and the estimate of operating cost given by A. G. Langley, consulting engineer to the company, is around $3 per ton.

Nicola.—Steady progress is being made at Stump Lake, where Nicola Mines and Metals, Ltd., have acquired the Planet and Donohoe properties and are carrying out an extensive programme of development. The old workings from the Joshua shaft, which were carried out originally many years ago by an English company, have been unwatered to a depth of 400 ft. and assays of from $12 to $40 per ton are reported to have been obtained from several shoots of ore that have been exposed. It is planned to continue sinking to a depth of 1,000 ft. and connect all workings with a view to unified development.

PERSONAL

W. H. Beak has returned from Sierra Leone.
C. B. Brodigan has left for the Gold Coast.
Boris Bryner has left for Manchukuo.
Alan Cawby has returned from Germany.
F. H. Cothay has returned from Nigeria.
H. W. Halton has returned to Burma.
J. A. Heppel has left for the Gold Coast.
P. K. Horner has returned from Siam.
C. J. Inder has left for Penang.
H. S. Munroe has left for Northern Rhodesia.
James W. Park has left for the Gold Coast.
Ernest Parsons has left for Kenya.
R. W. Scott has returned from the Gold Coast.
R. S. G. Stokes has returned to South Africa.
F. L. Thomas has returned from Abyssinia.
G. W. Thomson is here from New Zealand.
J. F. Thorn is here from Western Australia.
S. R. Tonkin is returning from Southern Rhodesia.

Stephen J. Lett died recently in Johannesburg, where he had lived for some years. Mr. Lett was a Member of the Institute of Mining and Metallurgy.

E. G. Thompson, for some years past the Johannesburg correspondent of The Mining Magazine, died on August 13. Mr. Thompson was a well-known journalist in South Africa and finance and mining editor of the *Rand Daily Mail*.

David Currie died on August 11, at the age of 62. Mr. Currie was a graduate of Edinburgh University and became a partner in the firm of Lake and Currie in 1897, having previously been engaged in coal mining and the oil-shale industry in Scotland. For 18 years he was actively engaged in reporting and inspecting work in many parts of the world, his name being particularly associated with the Briseis Tin Mine, in Tasmania, and the Eastern Smelting Company, at Penang. He retired from the firm in 1915 and was appointed Director-General of National Salvage, Ministry of Munitions, during the War, receiving the C.B. in 1919. Latterly Mr. Currie was associated with Messrs. G. D. Peters and Co., Ltd., of Slough, of which he was chairman. He was a Member of the Institution of Mining and Metallurgy and of the American Institute.

TRADE PARAGRAPHS

Renold and Coventry Chain Co., Ltd., of Renold Works, Didsbury, Manchester, have recently issued their revised price list for 1933, which also gives particulars of various new features.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, announce that they have appointed Lt.-Col. K. G. Maxwell, M.I.E.E., publicity manager in succession to the late Mr. A. E. du Pasquier.

Murex Welding Processes, Ltd., of Ferry Lane Works, Forest Road, Walthamstow, London, E. 17, in the August issue of the *Welder*, publish extracts from two Malayan journals on electric arc-welding as applied to tin mines.

United Steel Companies, Ltd., of 17, Westbourne Road, Sheffield, issue a new booklet describing the recently-introduced "Phœnix" (standardized) rapid machining steel, which is manufactured by their affiliated company, Steel, Peech, and Tozer.

George Cohen, Sons, and Co., Ltd., of 600, Commercial Road, London, E. 14, are sending out a catalogue descriptive of their stocks of mining and quarrying plant, including air-compressors (various drives), ball-mills, conveyors, elevators, haulages and winders, hoists, rock-drills, and screens, which are for disposal at their depots at Leeds and Neath.

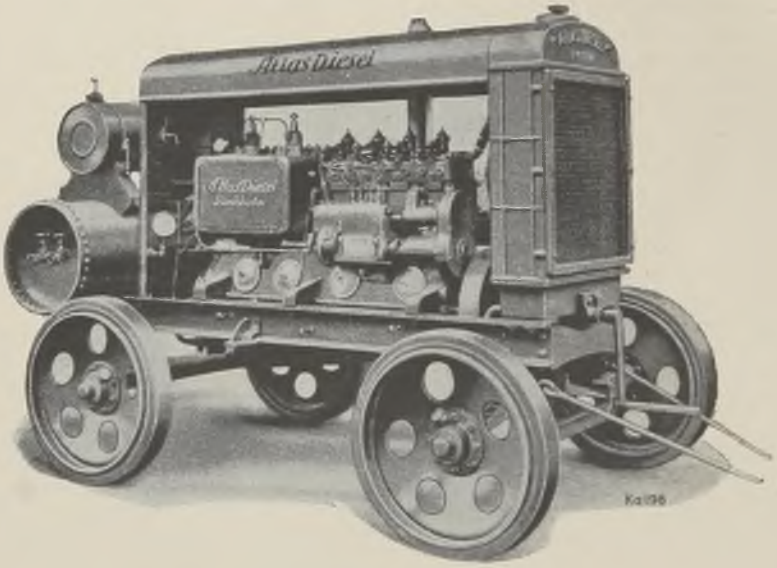
Ransomes and Rapier, Ltd., of Ipswich, have issued an illustrated leaflet setting out the salient features of their type 4140 3½-cu. yd. electric excavator, which has already been described in these columns. The excavator is intended for use where suitable electric power is available. Another leaflet describes gang trolleys driven by a petrol engine for the transport of workmen on light railway systems.

Sir Isaac Pitman and Sons, Ltd., of Parker Street, Kingsway, London, W.C. 2, have published parts 23 and 24 of their *Engineering Educator*. Part 23 contains the conclusion of the section on outlines of locomotive engineering, including the subjects of auxiliary apparatus and lubrication, and a chapter on the balancing of engines. Part 24 is devoted to steam turbines and the introduction to the section on steam condensing plant.

Hadfields, Ltd., of Sheffield, entertained members of the Iron and Steel Institute at their works on September 14 on the occasion of the Institute's Annual Meeting, which took place this year at Sheffield. It is 28 years since a similar visit was paid—in the year when Sir Robert himself was president of the Institute. That occasion was a memorable one because Viscount Hayashi, the Japanese Minister, was also present and announced at lunch the treaty just concluded between this

country and Japan. Since those days many metallurgical advances have been made—notably, the invention of manganese steel and silicon steel, the importance and applications of which were demonstrated to the visitors, as were the non-corroding and heat-resisting steels. Other well-known products of the firm in the form of crushing machinery, dredging plant, and railway trackwork also received attention.

Atlas Diesel Co., Ltd., of New Oxford House, Hart Street, W.C. 1, announce a new Diesel engine driven air-compressor—type C4DKV—the essential features of which are: Operating cost lowered by about 85%, solid and simple construction, easy and safe starting, automatic unloading device effecting speed reduction in light load, and reliable and easy operation. The Diesel engine and compressor are built into a single unit, incorporating a small number of moving parts, which, although totally enclosed, are easily accessible for inspection. The compressor is built to deliver 132 cu. ft. of air per minute at 100 lb. per sq. in. working pressure. The unit is shown in the accompanying illustration.

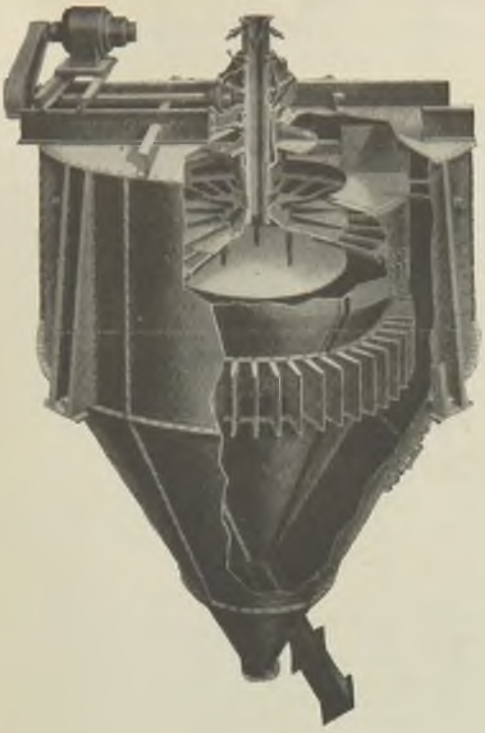


DIESEL-ENGINE AIR-COMPRESSOR.

Henry Wiggin and Co., Ltd., of Thames House, Millbank, London, S.W. 1, announce that they are at present executing at their Zenith Works, Thornliebank, Glasgow, an order for several tons of cold-drawn stainless iron tubes. These tubes are for delivery to a South African steelworks for insertion in rock-drill steel billets prior to rolling down. By this method a hollow drill is lined with a corrosion-resisting material, which is found to minimize the tendency hitherto shown by unlined drills of developing corrosion cracks when the circulating water is impure. These lined drills are said to be very advantageous for use in the Rand mines where the waters used for circulation through the drills are corrosive.

Ruston-Bucyrus, Ltd., of Lincoln, have forwarded leaflets describing the Bucyrus-Armstrong blast-hole drills, of which they have recently undertaken the sale. Two kinds of drill are referred to—the 26 and the 29 T. The former is designed to carry drill stems of 3½ to 4½ in. in diameter by 20 ft. in length, with bits for drilling 4 to 8 in. holes; the latter will handle a string of tools weighing 3,000 lb. or more with 6-in. by 20-ft. drill stem and 600-lb. bit for drilling 9, 10, or 12 in. diameter holes and is recommended for extremely hard rock drilling in quarries and open-pit mines of large tonnage capacity. Both drills are mounted on caterpillar tracks and the smaller is equipped for electric power driving with a 15-h.p. motor, while the larger is equipped either with a 20-h.p. electric motor or with a 6-cylinder 40-45-h.p. petrol engine. The firm also state that they have just received their fifteenth order from Stewarts and Lloyds, Ltd., for an excavator, the new machine being a 3-cu yd. electric shovel operated by Ward-Leonard (variable voltage) direct current control.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, issue pamphlets with reference to the Raymond No. 00 screen pulverizer and the Raymond mechanical air-separator. The first named is a mill of the revolving hammer type, with a screen at the bottom, and is suitable for grinding soft materials at the rate of from 500 to 1,000 lb. per hour. The separator is suitable for large dry-grinding installations and is illustrated in the accompanying cross-sectional diagram. The principal feature of this is the "whizzer," consisting of a set of radial blades revolving above the distributing plate at shaft speed. By their whirling these blades knock the coarse particles from the air current at a much faster rate than is accomplished in ordinary separators by gravity alone. Their function is important, as they prevent the oversize from passing upward with the fines and help to maintain the uniformity of the finished product no matter whether the feed is fine or coarse, fast or slow. Inasmuch as the whizzers automatically make the selection of the proper size material, the machine is not dependent upon the speed of the air current for controlling the fineness



of the product. The firm also report having received the following orders :—For England : One 60 in. by 36 in. Hardinge ball-mill for abrasive grains, two 3 ft. by 5 ft. type 31 Hum-mer electric screens for bone charcoal, one 3 ft. by 5 ft. Hum-mer electric screen for screening partly-ground cement clinker, and Ro-Tap testing sieve shakers for laboratory use. For Wales : One 5 ft. by 36 in. Hardinge ball-mill for unnamed ore. For Italy : One 3 ft. by 18 in. Hardinge ball-mill for grinding pyritic ore. For Cyprus : Two 8 ft. by 60 in. Hardinge ball-mills for grinding a heavy sulphide ore. For West Africa : One 7 ft. by 48 in. Hardinge ball-mill for grinding hard quartz.

METAL MARKETS

Copper.—The standard copper market was fairly steady during August on balance, although business was restricted owing to holiday influences. In the United States commercial sentiment was dominated by hopes and fears centring round the Recovery Programme. Progress was made towards evolving a Code for the copper industry there. The domestic price of electro was steady at 9 cents per lb. delivered Connecticut Valley, but for export the quotation tended to recede until stimulated by the renewed depreciation of the dollar. From 8·35 cents c.i.f. Europe on August 1 it fell to 7·97½ cents on August 16, closing at 8·15 cents on August 31.

Average price of Cash Standard Copper : August, 1933, £36 2s. 3d. ; July, 1933, £37 19s. ; August, 1932, £31 9s. 1d. ; July, 1932, £26 2s. 5d.

Tin.—Prices fluctuated last month within a moderate compass, but closed higher owing to favourable sentiment engendered by the conclusion of the Wheat Agreement and the anticipation of excellent tin statistics for the month, whilst the fresh fall in the dollar also helped to push values upwards. The International Tin Pool is believed to be releasing its holdings steadily, though it is uncertain how much of this metal has so far been sold. There is an impression abroad that the present restriction regulations may be relaxed in the not distant future.

Average price of Cash Standard Tin : August, 1933, £215 5s. 10d. ; July, 1933, £216 15s. 7d. ; August, 1932, £142 2s. 4d. ; July, 1932, £125 19s. 5d.

Lead.—Prices of lead moved somewhat jerkily during August, sentiment being swayed by outside factors to a large extent. Actually the statistical position of the metal remains very far from brilliant and although there has been an improvement in American consumption and demand in Britain and Germany is fairly satisfactory on the whole it is clear that so far very little progress has been made towards basically healthier conditions.

Average mean price of lead : August, 1933, £12 6s. 4d. ; July, 1933, £13 10s. 2d. ; August, 1932, £11 9s. 4d. ; July, 1932, £9 19s. 8d.

Spelter.—Although the undertone was easier at times this market nevertheless recorded an advance on balance last month. Sentiment has been sustained by the fact that the Cartel members do not appear to be increasing output further to any extent despite their greater freedom of action under the latest decisions, whilst in America the statistical position has at last begun to improve. The current rate of industrial demand is sufficient to eat progressively into world stocks, but that it cannot yet be described as thoroughly satisfactory is obvious when it is remembered that this is still only made possible by a continued heavy curtailment in operations at the smelters.

Average mean price of spelter : August, 1933, £16 19s. ; July, 1933, £17 15s. 10d. ; August, 1932, £13 14s. 4d. ; July, 1932, £11 15s. 6d.

Iron and Steel.—Despite holiday interruptions the British pig-iron market remained cheerful throughout August, with prices steady. No. 3 Cleveland foundry g.m.b. was unaltered at 62s. 6d. per ton for local delivery. Hematite East Coast Mixed Numbers remained at 59s. The position of the British rolling mills was still patchy, but optimism was expressed in view of the difficulty which Continental producers are now experiencing in competing on the home market, owing to tariffs and exchange movements. The outlook for the shipbuilding industry has definitely improved, a fact which should eventually be reflected in busier times at the mills. The Continental market was dull during August, partly owing to holiday reasons.

Iron Ore.—The holiday period has interfered with business, but the outlook is a little brighter again, especially as some old contracts appear to be coming to an end. Prices are well maintained at 15s. 6d. per ton c.i.f. for best Bilbao rubio and 14s. to 14s. 6d. c.i.f. for good North African ores.

Antimony.—The market has been quietly steady. Sales have been few and far between, but, rather unusually, Chinese sellers have upheld quotations at about £23 to £23 10s. c.i.f. for forward shipment. English regulus remains at £37 10s. to £40 per ton ex warehouse.

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.		Electrolytic	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	Forward.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
Aug.												
11	36 14 4½	36 19 4½	41 5 0	39 5 0	215 17 6	215 16 3	16 17 6	12 5 0	13 15 0	17 15/16	18 1/16	124 8½
14	36 3 9	36 8 1½	40 12 6	—	215 10 0	215 2 6	16 13 9	12 2 6	13 10 0	17 13/16	17⅞	124 8
15	35 16 3	36 0 7½	40 10 0	38 10 0	214 11 3	214 1 3	16 15 0	12 1 3	13 10 0	17⅞	17 1/16	124 10
16	36 0 7½	36 4 4½	40 10 0	—	214 18 9	214 15 0	16 16 3	12 0 0	13 10 0	17⅞	17 1/16	125 3
17	35 8 1½	35 11 10½	40 0 0	—	213 7 6	213 7 6	16 12 6	11 15 0	13 5 0	17⅞	17⅛	125 3
18	36 3 1½	36 6 10½	40 10 0	38 15 0	215 8 9	215 7 6	17 0 0	12 1 3	13 10 0	17⅞	18	125 0
21	35 13 9	35 18 9	40 10 0	—	213 2 6	213 2 6	16 15 0	11 18 9	13 10 0	17 15/16	17 1/16	125 2
22	35 13 1½	35 18 1½	40 2 6	38 5 0	213 3 9	213 6 3	16 16 3	11 17 6	13 5 0	17 15/16	17 1/16	125 3
23	35 11 10½	35 16 3	40 0 0	—	213 3 9	213 2 6	16 16 3	11 17 6	13 5 0	17 15/16	18 1/16	125 5
24	35 4 4½	35 8 1½	39 10 0	—	213 8 9	213 2 6	16 16 3	11 17 6	13 5 0	17⅞	18	125 9
25	35 12 6	35 16 10½	39 12 6	38 5 0	214 12 6	214 7 6	16 17 6	12 2 6	13 10 0	17⅞	17⅞	126 2
28	35 18 9	36 3 1½	40 5 0	—	217 2 6	216 18 9	17 1 3	12 3 9	13 10 0	17 15/16	17 1/16	128 8½
29	36 3 1½	36 8 1½	40 5 0	38 15 0	219 18 9	219 16 3	17 7 6	12 8 9	13 15 0	18	18⅛	129 4½
30	36 1 10½	36 6 10½	40 5 0	—	219 8 9	219 8 9	17 10 0	12 10 0	13 15 0	18⅛	18 1/16	128 9½
31	36 2 6	36 7 6	40 0 0	—	220 3 9	220 1 3	17 8 9	12 11 3	13 15 0	18	18 1/16	129 7
Sept.												
1	36 1 3	36 5 7½	40 0 0	38 15 0	220 8 9	220 8 9	17 1 3	12 5 0	13 15 0	18 1/16	18⅛	130 8½
4	35 18 9	36 3 1½	39 15 0	—	219 1 3	219 1 3	16 18 9	12 0 0	13 10 0	18⅛	18 1/16	131 0
5	36 5 7½	36 10 0	39 15 0	38 15 0	219 6 3	219 3 9	17 5 0	12 5 0	13 10 0	18 1/16	18 1/16	130 4
6	35 15 7½	35 19 4½	39 7 6	—	217 8 9	217 11 3	16 18 9	12 2 6	13 10 0	18 1/16	18⅛	130 7
7	35 11 10½	35 16 3	39 7 6	—	216 6 3	216 8 9	16 13 9	12 0 0	13 10 0	18 1/16	17 15/16	131 0
8	35 9 4½	35 13 1½	39 2 6	37 15 0	215 3 9	215 3 9	16 13 9	11 15 0	13 5 0	18⅛	18⅛	130 11
11	35 6 3	35 11 3	39 2 6	—	214 13 9	214 13 9	16 15 0	11 15 0	13 5 0	18⅛	18⅛	128 9½

ARSENIC.—Mexican high-grade is quoted at about £16 per ton c.i.f. with Cornish white £16 10s. f.o.r. mines.

BISMUTH.—A quietly steady business continued during August at the official price of 4s. 9d. per lb. for merchant quantities. On September 1 the price was raised to 5s. 3d.

CADMIUM.—Although the turnover is only moderate, the undertone is quite steady, about 1s. 2½d. to 1s. 3d. per lb. being the current value.

COBALT METAL.—Only limited quantities have been changing hands, but the official price remains at 5s. per lb. for cwt. lots.

COBALT OXIDES.—Quotations for oxides have come more into line with the lower level of metal, black now being quoted at about 4s. 6d. to 4s. 8d. per lb., and grey at 4s. 9d. to 4s. 11d. Business, however, remains slow.

CHROMIUM.—About 2s. 8d. per lb. delivered is still quoted for commercially carbon-free metal.

TANTALUM.—In the absence of new developments, prices remain at around £15 per lb.

PLATINUM.—Very quiet conditions have prevailed in this market during the past month, but prices are without alteration at £7 12s. 6d. to £7 15s. per oz.

PALLADIUM.—There is but little moving, but prices are upheld at £3 12s. 6d. to £4 7s. 6d. per oz.

OSMIUM.—Quotations are steady at £12 to £13 per oz., although business is small.

IRIDIUM.—About £9 to £10 per oz. is quoted for sponge and powder, but interest in this metal has been trifling.

TELLURIUM.—Demand is improving somewhat prices being about 15s. to 16s. per lb. for ingots in fair-sized lots.

SELENIUM.—High-grade black powder continues to be quoted at about 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse.

MANGANESE ORE.—The outlook seems a little brighter as the steel output increases, but new business so far has not been on a very large scale. Prices remain at about 9½d. per unit c.i.f. for best Indian and 8½d. to 9d. c.i.f. for washed Caucasian ore.

ALUMINIUM.—The market remains steady at the unaltered prices of £100 for ingots and bars and £102 for rolling billets, both less 2%, delivered.

SULPHATE OF COPPER.—English makers continue to quote about £16 10s. to £17 per ton, less 5%.

NICKEL.—Business is well maintained, with prices unaltered at £225 to £230 per ton, according to quantity.

CHROME ORE.—A little more activity is reported, but demand is still unimpressive. Prices are without change at 80s. to 85s. per ton c.i.f. for first quality 48% Rhodesian and 100s. to 105s. c.i.f. for 55 to 57% New Caledonian.

QUICKSILVER.—Demand has not attained very large proportions, but prices are steady at £9 to £9 5s. per bottle, net, for spot.

TUNGSTEN ORE.—The Chinese Central Government has formulated plans for instituting a sales monopoly in China, but strong opposition has been encountered from the Canton Government and other shippers and it is now doubtful whether the monopoly will operate. For some weeks, however, the uncertainties in this connexion have practically brought business to a standstill. Prices are now quite nominal at about 17s. to 17s. 6d. per unit c.i.f. for forward shipment.

MOLYBDENUM ORE.—New business is small, but prices are maintained at 40s. to 42s. 6d. per unit c.i.f. for 80 to 85% concentrates.

GRAPHITE.—There is only a limited business passing, but prices are without change at £19 to £21 duty paid for 85 to 90% raw Madagascar flake and £15 to £17 c.i.f. for 90% Ceylon.

SILVER.—August was an uninteresting month so far as the silver market was concerned and price movements were within narrow limits. On August 1 spot bars were 17⅞d. and, after moving up to 18 1/16d. on August 10 on some Chinese and American buying, quotations eased to 17¾d. on August 15. In the second half of the month there was very little business, but some bear covering from China offset the limited sales from other directions, and spot bars closed at 18d. on August 31.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
August, 1932	943,174	48,148	991,322
September	912,870	48,631	961,501
October	926,686	48,279	974,965
November	930,085	48,631	978,716
December	931,749	48,869	980,618
January, 1933	919,125	48,332	967,457
February	835,931	47,214	883,145
March	896,728	50,135	946,863
April	845,099	49,998	895,097
May	893,464	51,140	944,604
June	868,834	49,799	918,633
July	872,695	50,976	923,671
August	882,587	52,127	934,714

TRANSVAAL GOLD OUTPUTS.

	July.†		August.*	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	117,000	£220,295	121,500	£230,012
City Deep	108,000	21,725	110,000	22,383
Cons. Main Reef	83,000	23,096	83,000	23,567
Crown Mines	300,000	88,514	300,000	88,528
Daggafontein	57,700	£125,821	57,200	£128,644
D'rb'n Roodepoort Deep	53,500	14,601	53,300	14,678
East Geduld	73,500	24,999	76,000	25,652
East Rand P.M.	169,500	41,001	171,500	40,904
Geduld	91,500	27,507	93,000	27,657
Geldenhuis Deep	82,000	15,372	82,400	15,321
Glynn's Lydenburg	7,500	2,755	7,750	3,046
Government G.M. Areas	208,000	£521,863	216,000	£546,764
Kleinfontein	53,100	9,922	53,600	9,769
Langlaagte Estate	79,000	£136,963	83,000	£128,737
Luipaard's Vlei	36,900	8,310	37,100	8,384
Modderfontein New	177,000	50,467	180,000	51,417
Modderfontein B	77,500	17,540	80,000	17,701
Modderfontein Deep	45,200	19,024	46,800	19,237
Modderfontein East	78,000	20,537	81,000	21,471
New State Areas	90,000	£258,146	94,000	£252,036
Nourse	72,000	17,815	72,000	17,827
Randfontein	275,000	£443,286	275,000	£446,358
Robinson Deep	101,000	26,969	101,000	27,295
Rose Deep	65,000	11,959	65,000	12,615
Simmer and Jack	92,200	20,880	90,200	21,065
Springs	84,500	£223,409	84,500	£227,275
Sub Nigel	42,300	36,764	42,300	36,772
Transvaal G.M. Estates	20,700	5,078	20,700	5,495
Van Ryn	53,000	£59,522	53,000	£64,382
Van Ryn Deep	79,000	£125,412	80,000	£128,375
West Rand Consolidated	98,000	£150,567	98,000	£152,646
West Springs	86,000	£104,547	87,000	£102,902
Witw'tersr'nd (Knights)	75,000	£76,292	76,000	£79,590
Witwatersrand Deep	51,000	14,259	50,000	14,086

* Gold at 125s. per oz. † Gold at 123s. per oz.

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
May, 1932	2,964,100	27 6	19 2	8 4	1,228,198
June	2,927,200	27 9	19 3	8 6	1,241,392
July	2,993,600	27 5	19 0	8 5	1,260,744
August	3,027,700	27 6	19 1	8 5	1,277,923
September	2,940,800	27 6	19 1	8 5	1,234,584
October	2,994,500	27 5	19 0	8 5	1,263,274
November	2,949,050	27 8	19 2	8 6	1,256,717
December	2,972,000	27 10	19 5	8 5	1,255,797
January, 1933	3,029,000	37 10	19 4	18 6	2,802,754
February	2,802,600	37 0	19 9	17 3	2,414,758
March	3,087,860	36 1	19 7	16 6	2,549,179
April	2,922,200	36 1	19 9	16 4	2,381,971
May	3,144,600	35 8	19 5	16 3	2,556,066
June	3,093,500	35 4	19 6	15 10	2,453,205
July	—	—	—	—	2,568,899

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
August 31, 1932	217,658	11,727	—	229,385
September 30	216,398	11,642	—	228,040
October 31	216,298	11,353	—	227,651
November 30	219,024	11,207	—	230,231
December 31	221,008	11,310	—	232,318
January 31, 1933	222,005	11,292	—	233,297
February 28	222,589	11,472	—	234,061
March 31	223,490	11,626	—	235,116
April 30	225,279	11,611	—	236,890
May 31	227,178	11,562	—	238,740
June 30	229,751	12,059	—	241,810
July 31	230,306	12,269	—	242,575
August 31	231,341	11,947	—	243,288

PRODUCTION OF GOLD IN RHODESIA.

	1930	1931	1932	1933
	oz.	oz.	oz.	oz.
January	46,121	45,677	42,706	48,656
February	43,385	42,818	45,032	47,661
March	45,511	42,278	47,239	49,929
April	45,806	43,776	46,487	53,559
May	47,645	43,731	46,854	53,358
June	45,208	44,118	48,441	54,442
July	45,810	44,765	47,331	54,561
August	46,152	43,292	49,254	—
September	46,151	42,846	50,198	—
October	45,006	44,260	50,416	—
November	44,351	44,516	48,082	—
December	46,485	50,034	52,096	—

RHODESIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,800	9,272	25,800	9,272
Globe and Phœnix	6,078	5,436	6,084	5,437
Lonely Reef	12,500	1,908	13,500	1,86 0
Rezende	6,500	2,166	6,500	2,156
Sherwood Star	7,000	1,880	7,000	1,887
Wanderer Consolidated	16,000	3,613	15,900	3,489

WEST AFRICAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	8,577	£24,990	8,803	£26,907
Ashanti Goldfields	13,613	14,829	13,647	14,832
Taquah and Abosso	10,935	3,577	11,168	3,785

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
August, 1932	51,536	—	1,026
September	54,427	—	1,160
October	51,236	—	2,169
November	53,956	—	4,386
December	52,282	38,612†	4,602
January, 1933	45,755	9,133	4,005
February	47,281	—	4,365
March	47,105	5,747	4,758
April	52,909	—	12,460
May	53,300	—	7,135
June	53,451	—	—
July	54,455	—	—
August	56,147	—	—

† Period Jan.–Nov. 1932.

AUSTRALASIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,132	4,337	5,362	5,784
Blackwater (N.Z.)	4,182	1,878*	4,108	1,858*
Boulder Persev'ce (W.A.)	7,248	8,947p	7,337	7,553p
Grt. Boulder Pro. (W.A.)	7,008	5,110*	6,475	5,326*
Lake View & Star (W.A.)	43,559	82,871	43,016	84,930
Sons of Gwalia (W.A.)	12,302	15,549	12,016	15,933
South Kalgurli (W.A.)	9,584	13,996	9,531	12,710
Waihi (N.Z.)	17,928	{ 5,044* 32,918†	—	{ — —
Wiluna	38,510	10,128*	—	—

* Oz. gold. † Oz. silver. p Profit.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	July.		August.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Champion Reef	9,470	5,555	9,470	5,503
Mysore	14,870	7,676	14,900	7,688
Nundydroog	18,654	10,642*	18,797	10,019†
Ooregum	13,000	4,613	12,502	4,593

* 1,895 oz. from 1,535 tons Balaghat ore.
† 1,314 oz. from 924 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	July.		August.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	8,230*	—	8,045*
Chosen Corp. (Korea)	13,295	16,161	13,250	16,508
Frontino Gold (C'lbia)	4,950	20,915	4,830	20,023
Fresnillo	76,174	65,672*d*	—	—
New Goldfields of Venezuela	13,364	3,755*	14,563	3,490*
Oriental Cons. (Korea)	—	81,290*d*	—	91,419*d*
St. John del Rey (Brazil)	—	41,500	—	40,500
Santa Gertrudis (Mexico)	14,495	6,683*d*†	—	—
Viborita	—	—	—	—
West Mexican Mines	2,260	21,700*d*	—	—

* Oz. *d* Dollars. † Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1933	2,312	July, 1933	2,446
February	2,154	August	1,816
March	1,506	September	—
April	2,589	October	—
May	1,917	November	—
June	1,092	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	June.	July.	Aug.
Ayer Hitam	—	—	—
Batu Caves	—	49	—
Changkat	58	28	28
Gopeng	68*	—	—
Hongkong Tin	85½*	—	—
Idris Hydraulic	—	21½	8½
Ipoh	51	23½	37½
Kampar Malaya	—	—	—
Kampong Lanjut	—	—	—
Kamunting	118	137	83½
Kent (F.M.S.)	—	—	—
Killinghall	64½*	—	—
Kinta	32*	—	—
Kinta Kellas	32½	—	—
Kramat Tin	67	50	40
Kuala Kampar	—	13	33
Kundang	—	—	—
Lahat	6	9⅝	12½
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	—	71½	62½
Malim Nawar	—	5	26
Pahang	72	78	78
Penawat	50	32	43
Pengkalen	62½*	—	—
Petaling	—	—	89
Rahman	—	—	—
Rambutan	—	—	—
Rantau	—	33	—
Rawang	32	35	30
Rawang Concessions	28	27	30
Renong	—	40½	—
Selayang	—	—	—
Southern Kampar	—	130	—
Southern Malayan	50	59½	71½
Southern Perak	—	57½	—
Southern Tronoh	17	15	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	59½	—
Taiping	15½	16	—
Tanjong	—	—	—
Tekka	36*	—	—
Tekka Taiping	61*	—	—
Temoh	—	26	22
Tronoh	37	33	—
Ulu Klang	—	—	—

* 3 months to June 30.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June.	July.	Aug.
Anglo-Nigerian	14½	16	16
Associated Tin Mines	109¾	101½	100
Baba River	3	2	6
Batura Monguna	—	—	—
Bisichi	5	20	—
Daffo	—	—	—
Ex-Lands	15½	24	21
Filani	—	—	—
Jantar	10	10	10
Jos	8½	7½	—
Juga Valley	5½	5½	5½
Kaduna Syndicate	12¾	10	—
Kaduna Prospectors	7	6	—
Kassa	4¾	5	4
London Tin	74	70	73
Lower Bisichi	3½	3	—
Naraguta Extended	—	—	—
Nigerian Consolidated	5	—	5
Otfin River	—	—	—
Ribon Valley	9	10	7
Tin Fields	—	—	—
United Tin Areas	8¾	9	7
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June.	July.	Aug.
Anglo-Burma (Burma)	32	37½	42
Aramayo Mines (Bolivia)	96	90	110
Bangrin (Siam)	43½	56¼	87½
Beralt	26½*	26*	27*
Consolidated Tin Mines (Burma)	67	98	118
East Pool (Cornwall)	44	46	46
Fabulosa (Bolivia)	26	27	25
Geevor	67	66	61
Kagera (Uganda)	25	25	28
Kamra	32½	25⅝	26
Malaysiam Tin	13½	14½	14½
Mawchi	224½*	226½*	240¾*
Patino	—	—	—
Pattani	55	67	68
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	109⅜	130	219
South Crofty	54⅜	53½	54⅜
Tavoy Tin (Burma)	43½	51	65
Tongkah Harbour (Siam)	26	35	39
Toyo (Japan)	70½	65½	68
Zaaiplaats	12½	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		July.	Aug.
Britannia Lead	Tons refined lead	5,302	4,703
	Oz. refined silver	289,918	297,729
Broken Hill South	Tons lead conc.	8,726	—
	Tons zinc conc.	8,771	—
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	514,000	510,000
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	400	400
	Tons yellow metal	460	450
Messina	Tons copper	757	612
Mount Isa	Tons lead bullion	4,170	4,930
Mount Lyell	Tons concentrates	3,393‡	3,011*
North Broken Hill	Tons lead conc.	7,550	—
	Tons zinc conc.	6,590	—
Rhodesia Broken Hill	Tons Zinc	1,600	1,650
	Tons V_2O_5 conc.	—	—
Roan Antelope	Tons blister copper	—	—
Sulphide Corporation	Tons lead conc.	2,761‡‡	—
	Tons zinc conc.	4,023‡‡	—
Trepca	Tons lead conc.	4,778	5,214
	Tons zinc conc.	7,381	7,621
Zinc Corporation	Tons lead conc.	8,448†	—
	Tons zinc conc.	7,435†	—

* To Aug. 9. † To Aug. 19. ‡ To July 12. ‡‡ To Aug. 12.

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

		June.	July.
Iron Ore	Tons	214,037	229,023
Manganese Ore	Tons	12,690	8,759
Iron and Steel	Tons	69,019	63,434
Copper and Iron Pyrites	Tons	16,373	28,778
Copper Ore, Matte, and Prec.	Tons	1,936	5,729
Copper Metal	Tons	10,986	13,000
Tin Concentrate	Tons	2,356	2,376
Tin Metal	Tons	100	175
Lead Pig and Sheet	Tons	26,666	23,995
Zinc (Spelter)	Tons	6,843	8,185
Zinc Sheets, etc.	Tons	1,656	2,147
Zinc Oxide	Tons	550	54
Zinc Ore and Conc.	Tons	21,625	—
Aluminium	Cwt.	75,838	50,962
Mercury	Lb.	79,469	112,850
White Lead	Cwt.	6,986	7,375
Barytes, ground	Cwt.	27,799	31,718
Asbestos	Tons	2,184	2,384
Boron Minerals	Tons	952	819
Borax	Cwt.	10,410	10,690
Basic Slag	Tons	—	—
Superphosphates	Tons	—	180
Phosphate of Lime	Tons	25,820	34,432
Mica	Tons	187	99
Tungsten Ores	Tons	249	568
Sulphur	Tons	7,191	8,028
Nitrate of Soda	Cwt.	100	20
Potash Salts	Cwt.	48,535	122,405
Petroleum: Crude	Gallons	38,202,765	42,667,317
Lamp Oil	Gallons	5,582,129	17,032,268
Motor Spirit	Gallons	99,211,048	111,278,469
Lubricating Oil	Gallons	10,220,530	9,143,396
Gas Oil	Gallons	5,993,910	9,054,758
Fuel Oil	Gallons	45,851,139	37,857,365
Asphalt and Bitumen	Tons	8,423	11,221
Paraffin Wax	Cwt.	106,868	82,261

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	June.	July.	August.
Anglo-Ecuadorian	17,386	18,168	18,208
Anglo-Persian	—	—	—
Apex Trinidad	44,130	42,870	44,120
Attock	1,135	1,106	1,113
British Burmah	4,810	4,819	4,513
British Controlled	31,155	27,773	—
Kern Mex	808	835	856
Kern River (Cal.)	2,881	2,926	2,248
Kern Romana	172	126	222
Kern Trinidad	3,985	3,447	3,571
Lobitos	21,315	22,170	22,208
Phœnix	64,623	62,275	60,484
St. Helen's Petroleum	4,006	4,090	4,756
Steaua Romana	87,703	94,298	—
Tampico	2,220	2,292	2,312
Tocuyo	1,052	1,023	1,108
Trinidad Leaseholds	32,150	33,050	33,700

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Aug. 10, 1933.	Sept. 9, 1933.
	£ s. d.	£ s. d.
Anglo-Ecuadorian	14 0	16 0
Anglo-Egyptian B	1 8 9	1 10 0
Anglo-Persian 1st Pref.	1 10 0	1 11 0
" " Ord.	2 1 3	2 6 9
Apex Trinidad (5s.)	1 4 6	1 7 0
Attock	12 6	11 9
British Burmah (8s.)	4 3	4 9
British Controlled ($5)	5 0	5 3
Burmah Oil	4 0 0	4 5 6
Kern River Cal. (10s.)	5 0	5 9
Lobitos, Peru	2 5 0	2 8 9
Mexican Eagle, Ord. (4 pesos)	9 3	12 0
" " 8% Pref. (4 pesos)	9 6	12 0
Phœnix, Roumanian	12 3	12 6
Royal Dutch (100 fl.)	21 2 6	22 10 0
Shell Transport, Ord.	2 11 3	2 15 0
" " 5% Pref. (£10)	11 10 0	11 15 0
Steaua Romana	12 0	11 0
Trinidad Leaseholds	2 13 9	2 19 3
United British of Trinidad (6s. 8d.)	5 0	5 6
V.O.C. Holding	1 15 0	2 2 6

PRICES OF CHEMICALS. Sept. 11.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.	1	0	9
" " 80%	"	1	18	5
" " Glacial	per ton	59	0	0
Alum	"	8	7	6
Aluminium Sulphate, 17 to 18%	"	6	15	0
Ammonium, Anhydrous	per lb.		1	1
" 0·880 solution	per ton	15	10	0
" Carbonate	"	27	10	0
" Nitrate (British)	"	16	0	0
" Phosphate (Mono- and Di-)	"	58	0	0
" Sulphate, 20·6% N.	"	6	15	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
" Sulphide, golden	"			9
Arsenic, White (foreign)	per ton	18	0	0
Barium, Carbonate (native), 94%	"	4	10	0
" Chloride	"	10	0	0
Barytes	"	8	5	0
Benzol, standard motor	per gal.		1	5
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	"	16	10	0
Boric Acid	"	26	10	0
Calcium Chloride, solid, 70/75%	"	5	5	0
Carbolic Acid, crude 60's	per gal.		2	8
" " crystallized, 40°	per lb.			9½
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.			9½
Copper Sulphate	per ton	16	5	0
Creosote Oil (f.o.b. in Bulk)	per gal.			4
Cresylic Acid, 99–100%	"		1	3½
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine Resub. B.P. (28 lb. lots)	"			9 3
Iron, Nitrate 80° Tw.	per ton	6	0	0
" Sulphate	"	1	15	0
Lead, Acetate, white	"	30	0	0
" Nitrate (ton lots)	"	27	10	0
" Oxide, Litharge	"	28	0	0
" White	"	37	10	0
Lime, Acetate, brown	"	9	10	0
" " grey, 80%	"	15	10	0
Magnesite, Calcined	"	9	10	0
Magnesium Chloride	"	6	10	0
" Sulphate, comml.	"	5	0	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	0
Nitric Acid, 80° Tw.	per ton	21	10	0
Oxalic Acid	per ton	47	15	0
Phosphoric Acid. (Conc. 1·750)	per lb.			10
Pine Oil	per cwt.	2	7	6
Potassium Bichromate	per lb.			5
" Carbonate, 96/98%	per ton	30	0	0
" Chlorate	per lb.			4½
" Chloride, 80%	per ton	9	10	0
" Ethyl Xanthate	per 100 kilos	7	8	0
" Hydrate (Caustic) 88/90%	per ton	39	0	0
" Nitrate	"	30	0	0
" Permanganate	per lb.			8½
" Prussiate, Yellow	per ton	75	0	0
" " Red	per lb.		2	0
" Sulphate, 90%	per ton	10	10	0
Sodium Acetate	"	22	10	0
" Arsenate, 45%	"	23	0	0
" Bicarbonate	"	10	10	0
" Bichromate	per lb.			4
" Carbonate (Soda Ash), 58%	per ton	6	0	0
" " (Crystals)	"	5	2	6
" Chlorate	"	32	0	0
" Cyanide, 100% NaCN basis	per lb.			8
" Ethyl Xanthate	per 100 kilos	7	0	6
" Hydrate, 76/77%	per ton	14	0	0
" Hyposulphite, comml.	"	9	2	6
" Nitrate (refined)	"	7	15	0
" Phosphate, comml.	"	12	0	0
" Prussiate	per lb.			4¾
" Silicate	per ton	9	10	0
" " (liquid, 140° Tw.)	"	8	10	0
" Sulphate (Glauber's Salt)	"	2	15	0
" " (Salt-Cake)	"	3	3	6
" Sulphide, Conc., 60/65%	"	10	15	0
" Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	9	10	0
" Roll	"	9	10	0
Sulphuric Acid, 168° Tw.	"	4	5	0
" " free from Arsenic, 140° Tw.	"	3	0	0
Superphosphate of Lime (S.P.A. 16%)	"	3	4	0
Tartaric Acid	per lb.			11¾
Turpentine	per ton	52	0	0
Tin Crystals	per lb.		1	0
Titanous Sulphate (Stabilized)	"			9
Zinc Chloride	per ton	9	10	0
" Dust, 90/92%	"	20	0	0
" Oxide (White Seal)	"	30	0	0
" Sulphate	"	9	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

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

COPPER:		
Bwana M'Kubwa (5s.), Rhodesia	5 6	5 3
Esperanza	6 3	6 3
Indian (2s.)	2 3	2 3
Loangwa (5s.), Rhodesia	2 0	3 0
Mason and Barry	18 0	1 2 0
Messina (5s.), Transvaal	10 6	11 3
Mount Lyell, Tasmania	17 9	17 6
Namaqua (£2), Cape Province	3 6	3 6
Rhodesia-Katanga	11 6	12 3
Rio Tinto (£5), Spain	21 2 6	20 15 0
Roan Antelope (5s.), Rhodesia	1 7 0	1 8 6
Tanganyika Concessions	15 0	15 9
Tharsis (£2), Spain	3 12 6	3 16 3

LEAD-ZINC:	Aug. 10, 1933. £ s. d.	Sept. 11, 1933. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	8 3	8 3
Broken Hill Proprietary, N.S.W.	1 9 3	1 10 0
Broken Hill, North, N.S.W.	3 7 6	3 7 6
Broken Hill, South, N.S.W.	2 5 0	2 7 6
Burma Corporation (10 rupees)	13 6	13 9
Electrolytic Zinc Pref., Tasmania	1 4 3	1 5 0
Mount Isa, Queensland	8 9	8 6
Rhodesia Broken Hill (5s.)	1 9	2 0
San Francisco (10s.), Mexico	13 6	13 9
Sulphide Corporation (15s.), N.S.W.	7 9	8 9
ditto, Pref.	13 9	15 0
Trepca (5s.), Yugoslavia	13 6	13 9
Zinc Corporation (10s.), N.S.W.	1 7 6	1 8 9
ditto, Pref.	4 3 9	4 7 6

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

DIAMONDS:		
Consol. African Selection Trust (5s.)	1 10 6	1 15 0
Consolidated of S.W.A. (10s.)	6 0	6 0
De Beers Deferred (£2 10s.)	6 10 0	6 16 3
Jagersfontein	1 10 0	1 8 9
Premier Preferred (5s.)	1 15 0	1 18 9

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

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.

OPEN-CAST MINING AT FLIN FLON

A description of the Flin Flon open-pit by M. A. Roche appears in the *Canadian Mining and Metallurgical Bulletin* for July, 1933. The property belongs to the Hudson Bay Mining and Smelting Co., Ltd., and the author points out that it is located at Flin Flon Lake, 85 miles north-west of The Pas, Manitoba, on the Manitoba-Saskatchewan boundary. The area is at latitude north 54° and is approximately 1,000 ft. above sea-level. The ore-body occurs in amygdaloidal greenstones, which are to be referred to the earliest basic volcanic flows in the district. It was discovered in an outcrop on a point of land jutting into Flin Flon Lake and subsequent diamond drilling proved that it extends under the lake both to the north and south of the point of discovery. After the taking of soundings from the ice during the winter months, it was estimated that 1,000,000 tons of overburden, mainly mud and clay, would have to be removed to expose the underlying ore. Flat diamond-drill holes indicated that the ore-body was separated into more or less independent lenses by horses of unmineralized greenstone and that in places the overall width, including horses of waste, reached 450 ft. These several conditions were the main factors influencing the management in their decision to adopt an open-cut method for the mining of the upper portion of the ore-body.

Before it was possible to commence stripping operations, it was necessary to dam-off the eastern portion of Flin Flon Lake, instal pumps, and dewater the dammed-off area. Dams for this purpose were constructed of mine waste-rock and clay filler from nearby hillsides. Material for the bottoms of the dams were taken across Flin Flon Lake in hopper-bottom barges. Trestles were then built on the dam bottoms and dams were complete by the time trackage was available.

Dewatering commenced in April, 1930, and was completed by the latter part of May of the same year. Estimated pump output for the period was roughly four billion gallons. Two Morris 10-in. dredging pumps were used, direct-connected to 250-h.p. electric motors. Individual pump capacity was rated at 3,000 g.p.m. against a 150-ft. head. Average head for the operation was 50 ft., which increased the total output considerably. The pumps were mounted on floating barges in cribbings of piling driven at the lowest points in the lake bottom. Barges were raised and lowered independently of water-level by means of chain blocks. Piling had been driven from the ice during the latter part of the previous winter and the barges were built inside the cribbing before break-up. Pumps and motors were mounted before the break-up also and pumping commenced immediately ice conditions would permit.

While dewatering was in progress, a secondary line of dams was constructed along the lake bottom. These served to prevent the soupy material from running into the pit and necessitating additional pumping. To remove the clay and mud overburden remaining within the secondary dams, one of the dredging pumps, located in the manner already noted, was used with a 16-in. wood-stave line, supported on pontoons, discharging over the secondary dams. Dredged material from here ran by gravity flow to the second pump and was discharged into Flin Flon Lake proper.

Clay and mud was brought to the dredge by V-type scrapers operated by 35-h.p. electric slushers mounted on the barge. Water was pumped from Flin Flon Lake and was added to the clay to facilitate scraping. The material was agitated by the scraper action and further agitation was obtained in the sump by using water at high pressure in fire hoses and nozzles. Tail sheaves for scraper units were mounted on moveable A-frames, which were shifted from time to time as necessary. Three slusher units, all located on the barge, were used. Material removed in three seasons of dredging totalled 750,000 tons, at an average cost of 15 cents per ton. This performance is remarkable, considering the short dredging season for each year's operations.

As dredging continued and the scrapers neared bed-rock, large boulders were uncovered and scraped to the barge, filling up the sump and slowing up operations. A separate scraping unit was therefore installed to keep the sump clear of such boulders and thereafter dredging was only infrequently interrupted. Overhead trolly cables were utilized to service the equipment on the barge and discharge line and barge were held securely in place by cables anchored to the rock on the lake shore. High-pressure monitors were used in places to sluice the mud and clay off the ore surface where it was particularly rough and uneven. The clay, if allowed to mix in the ore, gives considerable trouble in the crushing plant and concentrator.

Large blast-hole drilling was adopted in the open pit, eight No. 29 Armstrong electrically-driven rigs being used to drill the ore and waste. These machines have proved very efficient and satisfactory and over a three-year period have averaged from 15 to 17 ft. of 6-in. hole per ten-hour shift. In some places the ground to be drilled is very hard, but in others drilling is comparatively rapid. The bulk of the footage drilled is in sulphides, where drilling speeds are low. The greenstones, also, do not drill easily, but holes are put down in the disseminated-ore areas with ease. The spacing of holes, an important factor in successful blasting, has received considerably study during the 2½ years' operation and the present practice is the spacing of holes on 16-, 18-, or 20-ft. centres. Variations are

made, however, when drilling hard ribs of interbanded material. The depth of the holes also varies. In 1930 and 1931, holes were drilled to a depth or from 20 to 25 ft. which was increased in 1932 to from 25 to 40 ft. During the latter part of 1932 and early in the present year the blasting of 50-ft. benches was attempted. Results were satisfactory and all holes, when practicable, are now drilled to 50-ft. or deeper. Large groups of holes are prepared for blasting and are, as a rule, shot simultaneously. Drill crews are worked on eight- or ten-hour shifts, as necessary, and, in addition to the drilling, are used for bailing, springing, and loading of holes and for the repairing of the drill rigs.

The method of loading and wiring is shown in Fig. 2. This method has been adopted locally due to the conductivity of the solid sulphide-ore and to its breaking with ragged edges on the sides of the holes. Single blasts with total load ranging from 60 to 145 tons of 50% dynamite have been successfully carried out. Results obtained from the larger blasts point to savings in load per ton broken and to better fragmentation at lower cost when a large number of holes are shot simultaneously.

The ore to be shovelled in the open-pit is divided into two types—namely, solid sulphide and disseminated. The solid sulphide, which is very heavy, approximately 7 cu. ft. to the ton, occurs in the centre of the ore-body and toward the hanging-wall and generally, but not invariably, there is a selvage of disseminated ore between it and the hanging-wall. The great bulk of the disseminated ore is found on the foot-wall. Horses of unmineralized greenstone separate the ore-body into somewhat independent lenses, as previously noted. Due to the weight of the solid sulphide and to the necessity for segregation of the waste rock and the two varieties of ore there was some question as to the type of shovel most suitable for the work. Two Marion Type 4160 4-yd. electric shovels were purchased. It is found that, in the hands of experienced operators, these can classify the two ores and segregate the waste with surprising accuracy. They have loaded, on the average, 1,000 to 1,500 tons of material per ten-hour shift. Periods between shifts are utilized for the bulldozing of boulders and for miscellaneous work. Repairs to the shovels are effected in the pit by the operators, with the exception of jobs which require shop work. Repair and operation costs have been lowered by the redesigning of dippers, dipper bails, dipper tooth-tips, and bases to meet the requirements of digging in the heavy and abrasive sulphides. One of the most difficult problems and the source of probably the greatest expense in shovel operation is the excessive breakage of parts during sub-zero temperatures. Shipper-shaft bolts, bull-gears, pinions, shafts, side-crawler frames, and dipper-bails and tooth-bases snap off in the frosty weather, with high replacement expense and the added cost of lost time of equipment and crews. Manufacturers have been requested to design heavier replacement parts and, if possible, to use materials calculated to stand up in low temperatures.

Due to the limited tonnage of ore available by open-cut methods and to the high ratio of waste to ore long flat approach-tracks were out of the

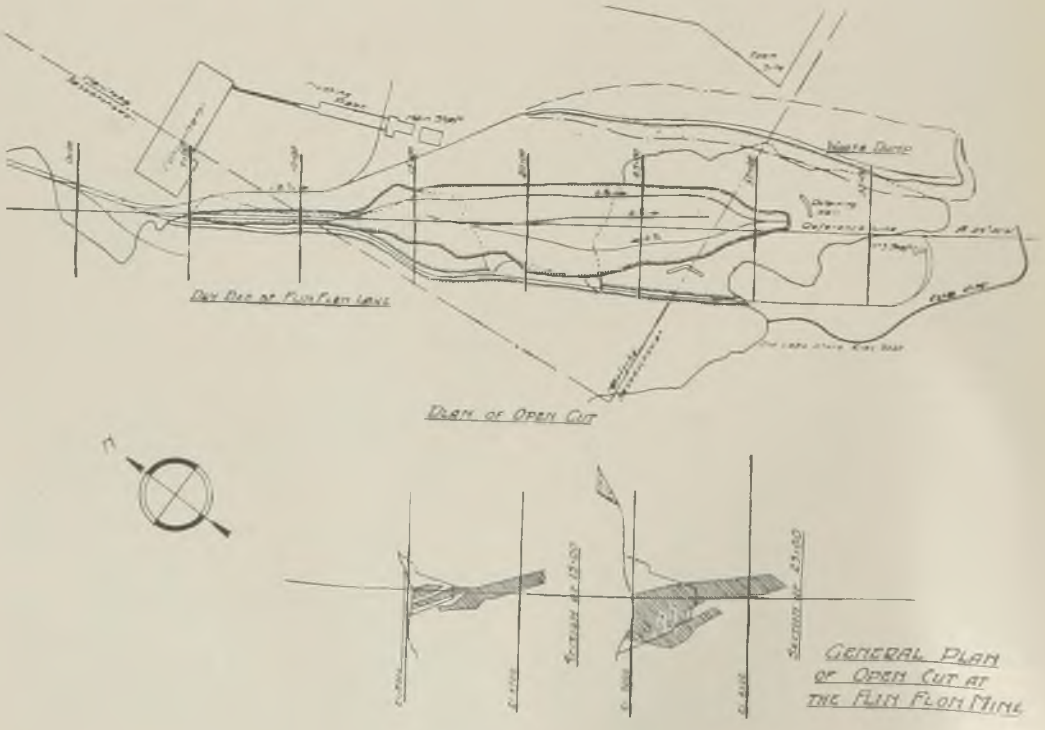
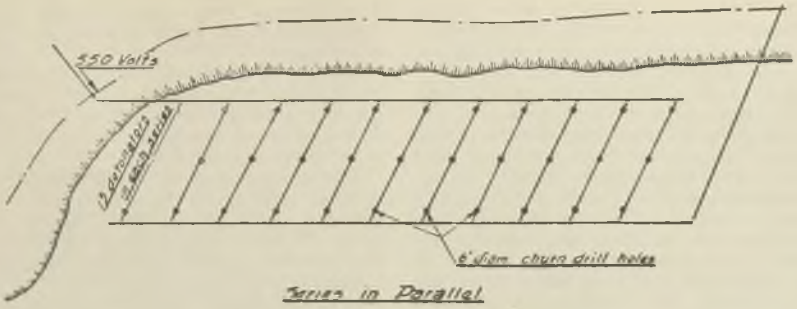
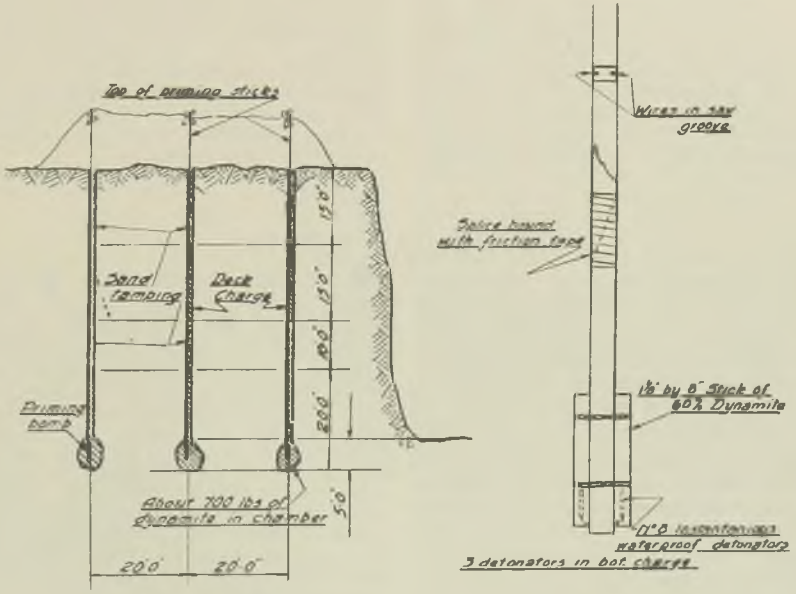


Fig. 1.



Series in Parallel

TYPICAL WIRING-UP DIAGRAM



CROSS SECTION SHOWING LOCATION OF CHARGES.

PRIMING BOMB.

MAIN BLASTS

BLASTING METHOD AT THE FLIN FLON MINE

FIG. 2.

question and a 6% track-grade with a series of switchbacks was adopted. Entrance to the pit is from a through-cut on a 6% grade following along the narrowest portion of the surface outcrop. The pit proper starts at Section 13, widens gradually, and attains a maximum width at Section 23 from where it again narrows down toward the southern limit at Section 30, where the outcrop disappears. The approach track follows down the hanging-wall and is in greenstone waste. The removal of this rock is necessary to provide adequate railway berm and to give proper slope to the hanging-wall side of the pit. The second and third switchbacks will be on the foot-wall side of the ore-body. 85-lb. steel is used in open-pit trackage throughout. Two 85-ton C.G.E. electric locomotives are now operating efficiently on the steep grades, handling from 100 to 120 tons of ore per train. As high as 3,000 to 3,500 tons of material has been hauled a distance of two miles by a single locomotive in one ten-hour shift; the average, however, is slightly over 1,000 tons. Haulage has now been carried on over the steep grades for 2½ years and, although some delays are experienced in the most severe winter weather and during snow-storms, performance has been most satisfactory and efficient. When final levels are mined in the pit there will be approximately 8,000 ft. of track in the pit itself, not including trackage for waste disposal and switch yards.

Pumping in the pit does not present a serious problem, excepting on occasion during the summer season when sudden downpours may cause a

serious tie-up. The normal influx of water drains down the prospect shaft into the underground mine, where bulkheads and valves are installed to control the flow. Various flumes and ditches around the outline of the pit serve to dispose of a large volume of the run-off water and plans are now under way for further addition to the drainage-system to prevent possible shut-downs from flooding. Due to the contour of the drained lake bottom, it has been necessary to construct reinforced concrete retaining walls to guard against a possible slide of clay and mud into the pit from areas immediately adjacent to the pit outline.

Power for plant operation is generated at the Hudson Bay Mining and Smelting Company's Island Falls power plant on the Churchill river, 56 miles from the mine site. Power for pit operation is brought in on lines along the hanging-wall and for shovel operation is taken off the 2,300-volt a.c. feeder in two 4-conductor armoured trail-cables to the M.G. sets located on the shovels. The Armstrong drill rigs are run off a 550-volt a.c. feeder with individual trail cables tied-in to a central supply-station on the floor of the pit. The trolley system operates on 550-volt d.c. with rotary converters located in the main plant sub-station. Portable steel towers carry trolley lines on waste dumps and in the pit, where frequent track shifting is necessary.

Air for the Ingersoll-Rand jack-hammers used for block-holing is supplied by a 6-in. main paralleling the east side of the pit. The X-59 machines are also used for trimming operations on the pit walls, following the large blasts.

The location of the plant, far removed from other mining centres or operations, has rendered it extremely difficult to procure trained men for train crews, drill crews, etc., and it has been necessary to recruit men from the prairies and train them for the various occupations. This procedure has at times proved very costly, due to mistakes made through lack of experience and judgment. Night classes and special instruction have done much toward perfecting an efficient organization and the present personnel will compare favourable with that of mining companies which have been operating for a number of years. Particular attention has been paid to the training of crews for the loading of large blasts and very satisfactory loading costs are now noted, with the added asset of experienced men handling explosives, which reduces the likelihood of mishaps to the minimum.

MINING AT DEPTH

Addressing the Royal Cornwall Polytechnic Society, on the occasion of its centenary celebrations held in July, Professor S. J. Truscott dealt with problems of mining at greath depth. The author said : The heights of mountains and the depths of oceans are measured from sea-level ; depths in mining are measured from the surface at the particular spot. The mineral won has to be raised to that surface ; there is the cost of raising. The water met has generally a vertical distribution bearing some relation to that surface ; there is the cost of pumping. The rock temperature increases with depth from the surface ; there is the consequent cost of ventilation. Finally, the rock pressure increases with depth from the surface ; there is the consequent cost of support.

Great depth in mining may nowadays be taken to be 6,000–8,000 ft. below the surface, depths which, being out of reach of a winding engine situated at the surface, require other winding engines underground. Outstanding cases of mining at great depths and at the same time the deepest mines in the world to-day are : The Morro Velho mine in Brazil, the lowest level of which is 8,040 ft. below the surface ; the Robinson Deep mine in the Transvaal, the lowest level of which approaches 8,000 ft., while the lowest point reached is deeper ; and the Champion Reef mine on the Kolar goldfield, Mysore, the lowest level of which, where development is proceeding, is 7,580 ft. All of these mines, which started thousands of feet above sea-level, are now working below sea-level.

It is of interest that all these mines are gold mines and all are situated in Archæan or pre-Cambrian country—that is, in rocks of very great age. Though they have that much in common, they work entirely different types of deposit. The Robinson Deep is one among many mines working a very extensive conglomerate bed moderately inclined. The Champion Reef is one of a small number of mines along a steeply-inclined quartz reef ; while the Morro Velho is a lonely mine working a relatively short, heavily mineralized ore-shoot pitching at an angle of about 45° upon a plane roughly vertical. Of additional interest is the fact that, situated in such widely separated regions as they are, these mines are all British enterprises ; this being also true of most other mines approaching their depth.

The problems to be reviewed are those arising in the technical operations of primarily the four which have been mentioned. Raising or winding is only possible by means of wire rope. The best wire ropes will, however, not serve with safety and economy for a greater depth than about 4,500 ft., the rope then becoming too heavy and the winding engine excessively large. Below that depth or even before it is reached, a second winding stage will be necessary or will have been judged desirable, this second stage, not generally so deep as the first, being equipped with shafts and electric winders of its own. Again there may be a third stage. The Morro Velho has seven stages, each short, though greatly daring in view of the relatively small horizontal extent of the deposit. The Robinson Deep has a first vertical stage, a second main-incline stage, and a third sub-incline stage. The Champion Reef has a primary vertical, a secondary vertical, and then bottom inclines. Though such stage-winding with the unavoidable transfers from one shaft to the next is more expensive than winding at such depths as permit a single stage, it may be said that the problem of raising the mineral causes no more than ordinary concern. Greater mechanical efficiency has largely offset the greater number of units of work to be done.

Pumping is normally no problem at great depth. The water-table or ground-water level marks the

upper limit of a zone saturated with water, but this saturation becomes less with increasing compactness of the rock beneath and normally at no great depth a dry zone is entered. At Morro Velho there is little water below 2,500 ft. and none below 3,500 ft.; deeper than that such water as is required for men and machines must be sent down. On the Witwatersrand, fissures reaching up to saturated ground above occasionally cause a troublesome amount of water to be met in depth but, speaking generally, the amount of water to be raised is relatively small. Pumping is done by electrically-driven centrifugal pumps in stages each of about 2,500 ft. The Champion Reef and neighbouring mines are dry below about 1,000 ft. so that service water must be sent down. It is interesting here to recall that steam engines came into being to enable mining to be carried on below adit or drainage level; in those early days mine drainage was the major problem.

Ventilation—that is, the coursing of air through the workings in manner suitable and in quantity sufficient to maintain it in good physiological condition—is one of the two main problems in mining at great depth, largely because of the increase of rock temperature with depth. The rate of this increase of temperature, known as the geothermal gradient, varies from region to region on the crustal sphere; it is lowest where the country has long been a land surface and long free from igneous intrusion. Of the three districts mentioned the Witwatersrand has the lowest gradient—namely, a rise of 1° F. for every 212 ft. or of 4·7° for every 1,000 ft.—starting from an average surface temperature of 60° the rock temperature at the present lowest level of the Robinson Deep will be about 97°. The gradients in the other two districts are about 1° for every 150 ft. of depth or 6·6° per 1,000 ft. The recorded rock temperature at the 7,380-ft. level of the Champion Reef is 129°, the average surface temperature being about 75°. Starting from a somewhat lower surface temperature, the rock temperature at the present bottom of the Morro Velho is about 125°.

Differing as they do in respect to temperature gradient and to surface air temperature, there is one essential factor practically constant for all regions—namely, the rise in temperature of the air due to the heat expressed from it by the compression it experiences as it passes from surface into depth, this rise being about 5·5° F. per 1,000 ft. On the Witwatersrand the resultant air temperature at the present lowest level of the Robinson Deep would be 104°—that is, 7° higher than rock temperature. At the 7,380 ft. level of the Champion Reef it would be about 115° and at the bottom of the Morro Velho about 110°, these two being lower than the respective rock temperatures.

Fortunately air temperature is not the index to the physiological condition of the air. The position with respect to temperature underground is not dissimilar to that at surface in some tropical regions; indeed in going underground we pass from a relatively cool climate to a hot one. Take for illustration the air condition at the military station at Quetta, the Aldershot of India; in the dry summer season the temperature in the sun is well above 150° and for periods shade temperatures of 100° and more are registered, yet military exercises are carried out without interruption in the open. This activity is possible because the air is dry, the relative humidity being 10–20%, equivalent to a wet-bulb temperature of, say, 70°. Wet-bulb temperature is the most ready index to the condition of the air. The body is in effect much like a wet-bulb thermometer in that at high air temperatures it is cooled by evaporation and evaporation is always possible so long as the air is not saturated with moisture. There is this difference, however, that the body generates heat which the wet-bulb thermometer does not. To keep the body temperature from rising above normal—that is, 98·4°—the wet-bulb temperature must be below body temperature and all the more so when the wet-bulb approaches the air temperature.

The measures taken for mine ventilation start by conducting the surface air directly as possible to distributing stations at depth by downcast shafts kept as free as possible from water or moist surface. By so doing the air arrives at a temperature determined by auto-compression and little affected by that of the rock. It also arrives drier than at the surface since, though the wet-bulb temperature rises, it does so at a substantially lower rate than the air temperature. Indeed even at such depths as 8,000 ft. the air can arrive in good condition. From the distributing stations the air passes along horizontal roads where, though there will no longer be any heating by auto-compression, there will be heating from the rock if the temperature of the rock be higher than that of the air or if there be water present; in the first case both air and wet-bulb temperature rise; in the second the wet-bulb temperature will rise while the air temperature may or may not.

At normal air velocities the condition in respect to cooling can still be fair even at considerable distances from the downcast. Then the air begins its upward movement through the working places where the air velocity is lower, the contact with freshly-exposed rock is greater, oxidation in one form or another generates heat, air pressure drops, humidity rises. Here are the severest conditions; it is here that the ventilating system is tested. Critical working conditions are reached in dry mines such as Morro Velho and Champion Reef when the wet-bulb temperature approaches 95°, and in saturated air as at the Robinson Deep when that temperature is above 90°; before then, working efficiency will have fallen off. Fatal heat stroke has occurred and does occasionally occur on all these mines. Finally, the air moves upward out of the working places into definite and well-maintained upcast shafts or airways and eventually passes out of the mine saturated at a temperature well above that at which it entered.

Taking average temperatures, the greater weight of the downcast air column over that of the upcast column would maintain natural ventilation, particularly when after the lapse of time the downcast had cooled off and the upcast had warmed up; but such a ventilation would be too precarious, and in summer might even stop. It is obvious that, where normal working conditions may quickly change for the worse, the ventilation must be under such mechanical control as fan ventilation only can give. Technical control likewise must be in the hands of a responsible official, who on the Witwatersrand is actually designated the "ventilation officer." In this control, temperature readings, humidity calculations, velocity and volume measurements, pressure surveys, and dust counts where necessary, become routine work.

The management of the Robinson Deep considers

that the present ventilating procedure on the Witwatersrand, which takes winter and summer air as it comes and accepts the poorer ventilation which summer brings, will suffice not only for sinking but also for mining down to a depth of 8,500 ft. and on that field that mine will be the first to put the matter to the test. Other engineers there consider that mining at such a depth will not be possible unless the air be reconditioned by artificial cooling, at least during the summer months. Some artificial cooling is achieved in ordinary working by the exhaust from rock drills or auxiliary hoists using compressed air and this is particularly useful in cooling development ends. Sometimes underground pumps have been worked by compressed air with the same intention and even main underground hoists. But if cooling of the main stream is to be an essential part of the ventilating scheme, it must be by means of special cooling plants.

Some special cooling of the air along a main level by a cold water circuit has been attempted at a German colliery, but the Morro Velho is the only mine which has fully adopted cooling of the main stream. There an ammonia refrigerating plant on the surface, commissioned in 1920, reduces the average air temperature entering the mine from 73° and 65% humidity to 42° and saturation, the air being dehumidified in the process. With continued advance into depth and because of the indirect course of the downcast through the several winding stages, an underground cooling plant became necessary and was put into commission in 1930. This plant, situated about three parts of the way down, uses ethyl dichloride as refrigerant since this liquid, while non-poisonous and non-inflammable, requires low and even negative pressures in the operation. By it the air temperature at that depth is reduced from 100° to 75° and the wet-bulb temperature from 75° to 64°, the heat being abstracted by water which is pumped to the upcast to be cooled by evaporation for re-use.

Reviewing the three ventilating procedures, the Robinson Deep, in common with all mines on the Witwatersrand, uses water to lay the dust and a moist atmosphere to keep it laid; in consequence, cooling in the working places must depend mostly upon air movement, large volumes roughly equivalent to five tons of air per ton of ore being required. The Morro Velho relies upon cooling the air to dehumidify it to such an extent that it remains sufficiently dry right through the working places, the volume of air being relatively small. The Champion Reef relies upon a direct downcast kept dry, so that the air remains dry throughout the workings; ventilation in depth is also promoted by shutting off the bottom part of the mine from the upper part, except for the airways.

The second main problem in depth is that of support. In the undisturbed crust there is equilibrium; the weight of the superincumbent ground is borne by reaction from the rock beneath, that rock resisting further compression. If an excavation be made—that is, if a portion of the rock be removed—then the load which it originally supported is diverted to the sides, to become an additional load upon them. Moreover, free faces having been made, there is a tendency for the rock, since it is elastic, to close in upon the excavation; a pressure arch is formed in the rock above, a pressure invert in that beneath, and lateral arches at the side. At shallow depth the tendency of the back of the excavation to scale or flake and to assume an arched shape is common to see; the pressure invert underfoot, however, is obscured and the lateral arches remain undeveloped. But in mining at great depth, which it may be said is only possible in hard, strong rock, the tremendous pressure of the superincumbent ground reveals much in the nature of fluid pressure; the tendency for the rock at the sides to close in upon the excavation becomes noticeable, as also does that of the floor to lift. The rock which thus moves into the excavation is that which, being released from compression, shears itself from the solid.

A road left untimbered at such depths, unless it collapses entirely, will gradually assume a round or oval shape as equilibrium by arching becomes established. What takes place in respect to a road develops to a larger extent around the working places; the arching noticed in roads becomes doming in respect to working places. Doming follows the settlement or collapse of the roof and the upward shearing of the floor, or, as the case may be, the sag or collapse of the hanging-wall and the inward shear of the foot-wall. At great depths the necessity of controlling these inward movements is as great with steep deposits as with flat deposits. No large span can be left open or there will be abrupt failure such as will close the working place. Routine support must see to that and this support must be sufficiently yielding that it be not destroyed by the pressures which it cannot wholly resist but can at best only control. On the moderately-inclined Witwatersrand, this support is by waste broken with the ore; on the steep Champion Reef it is by dry walls of granite bricks; at Morro Velho it is by waste filling.

As the excavation gets larger, doming will reach farther from the excavation, in roof, in floor, or in wall, by gradual settlement mostly, but sometimes by sudden failure of particular thicknesses. These sudden failures, though the actual movement be small, send a concussion wave through the country; this occurrence, when noticeable and causing falls of ground and damage, being termed a rockburst.

Equally and almost as unavoidably, when one excavation approaches another and the mineral pillar between them becomes smaller, this remnant pillar will eventually yield under the pressure accumulating upon it and a rockburst will occur again, though careful and cautious work may minimize its effects. Domes which had their abutment upon this pillar will then become merged in a wider doming extending farther from the excavation, further tremors continuing until doming is complete. As already explained, doming involves both hanging-wall and foot-wall, or roof and floor, as the case may be; consequently it involves any roads existing within the distance to which it extends. Thus shafts and roads put in the foot-wall or floor for safety's sake, but not far enough away, will suffer.

Accidents set down to falls of ground are much more frequent than those ascribed to any other single cause. It is, however, an interesting fact that on the Witwatersrand sudden uplift of the foot-wall is considered to be the cause of the majority of fatal spinal injuries that occur in the working places. Support also costs more than ventilation. Greater accident rate and greater cost may be reasons for considering that mining in still greater depth will be limited by the problem of support rather than by that of ventilation.

GOLD MINING IN NEW GUINEA

An account of the development of gold mining in Morobe, New Guinea, by H. Taylour and I. W. Morley appears in the *Bulletin* of the Institution of Mining and Metallurgy for August, the paper having been offered and accepted for approximately simultaneous publication in the Institution and the Australasian Institute. In their introductory remarks the authors say that in the year 1926 Edie Creek, in the Morobe district of the Mandated Territory of New Guinea, saw the greatest gold rush of recent years. Situated 35 miles inland from the coast and at an altitude of over 6,000 ft. Edie Creek presented to the original prospectors a wet, jungle-clad, uninhabited, and inhospitable region. There were no roads and the only means of approach from the equally inhospitable coast was by an eight to ten days' tramp through coastal swamps and gorge-scarred mountains. All food supplies and equipment had to be carried on the backs of " kanakas " and in many cases through country occupied by hostile natives. Since the first discovery of payable gold at Edie Creek mining on the Morobe goldfield has shown remarkable progress and, in spite of the tremendous natural difficulties, the field to-day ranks as one of the most important in Australasia. Aeroplanes, more than any other factor, have been responsible for this rapid development. They provide the only means of transport from the coast and at present serve the needs of over 600 Europeans and 3,000 indentured native labourers engaged in the industry. An endeavour is made in the paper to give some account of the history, production, and present status of gold mining in the district, together with such other notes as may be useful to engineers unacquainted with conditions in New Guinea. The authors believe that it is the first connected account to be published that deals with the field as a whole ; consequently certain matters of non-mining but general economic interest have been included.

The first recorded evidence of the presence of gold in the island of New Guinea is that of Alvaro de Saavedra, a Spaniard, who sailed along the northern shores in 1528. In places he found traces of gold and gave it the name of " Isla del Oro." Gold, in payable quantities, was not found until 1877, when discoveries were made in Papua and the Louisiade Archipelago. In German New Guinea (the present Mandated Territory of New Guinea), there was little active prospecting until 1896, when the German New Guinea Company organized a party, under the leadership of Dr. Lauterbach, to prospect in the western tributaries of the Ramu River. Areas were subsequently taken up about nine miles up this river in latitude 5° 30′ south. Later, by arrangement, the German Imperial Government granted a concession to the New Guinea Company and supervised the operations. The venture was fruitless and after about ten years the concession was withdrawn. The expedition, in 1899, of Lauterbach, Radalzt, and Klink, these latter gentlemen having reported the existence of gold on the Ramu River, like the earlier one of Lauterbach, was without result and the Ramu Goldfields Station was closed in 1902. The discovery and production of the Yodda and Gira fields in Papua, near the southern border of the Morobe District, encouraged prospecting in the neighbouring Waria River and in 1906 a number of miners crossed the border and worked with fair success in German territory. In 1909 concessions were granted in this area to A. Kempf and proposals were made for large-scale operations. The area was reported on by Paul Schulze, Bergrat (Director of Mines) of Hindeburg, Silesia, who inspected properties on the Waria River in March–July, 1914. He estimated that there were some 900,000,000 cu. yd. of wash available for hydraulic sluicing operations worth 4d. per cubic yard. Up to the present there has been no attempt to work these gravels on a large scale. The natives of the Waria River were apparently encouraged to work the beaches on the river for gold, which they sold to the New Guinea Company at Morobe. A German expedition into the Markham and Watut Rivers in 1913 was also reported to have found gold. A. Darling, a Papuan prospector, also penetrated across the border, prior to the World War, and made discoveries of payable gold on the Bulolo River, near Koranga Creek. It was on the basis of Darling's report that W. (" Shark-Eye ") Park made his find on the Koranga in 1922. Gold was also reported in the Sepik River area and New Britain during the German régime.

The Morobe goldfield has almost exclusively provided the gold production of the Territory. Prior to December 31, 1926, it is variously estimated that between £50,000 and £100,000 worth of gold was produced. This does not include the production from the Waria River previous to 1914. From January 1, 1927, to June 30, 1932, the production was worth £1,352,479 (Australian currency). The field comprises the south-easterly portion of the Morobe district, an area of about 4,400 sq. miles. For the most part it is covered with heavy forest and situated at an altitude of between 2,000 and 8,000 ft. Subsequent to the War, and the establishment of the Mandate in 1921, interest was renewed in the Waria River area. A number of dredging leases were tested by Messrs. J. C. Coldham and B. V. Barton, mining engineers, who represented influential Australian interests. The comparatively low values and the transport difficulties at that time prevented further development. Recently work has been commenced again on the Waria River, but until the last few years the richness of the Edie Creek—Bulolo River area has attracted most attention.

In 1921–2, W. Park re-located A. Darling's discovery on Koranga Creek. After making several trips up the rugged jungle-covered Francisco and Bitoi River valleys, he crossed the Kuper Range, which runs up to an altitude of some 10,000 ft., and came into the Bulolo valley. The cost of transport and supplies, the time taken to reach Morobe, which was then the nearest port, and the inaccessible nature of the country, prevented much notice being taken of this find, although parts of the Koranga Creek bed were very rich. Park is said to have recovered an average of some 20 oz. per day with a few native labourers. By the end of 1923, there were seventeen miners on the field. Work was confined to the washing, by primitive methods, of the rich alluvial gravels of the Koranga and Bulolo, and desultory prospecting of the surrounding area. The difficulties of transport and communication were so great that nothing less than 10 oz. per day was considered payable. All supplies had to be carried in by natives. The tracks from the coast were exceedingly rough and,

although only 32 miles air-line intervened between the sea and Koranga Creek, from eight to ten days were required to cover the journey on foot. Animal transport was out of the question, as no suitable track existed. The administration centre was still at Morobe. During the years 1924 and 1925 activities on the field increased considerably and a large number of " dredging or sluicing " leases were taken up. By the end of the latter year there were some 50 miners and prospectors with their native labour teams on the field and prospecting and some alluvial mining was in progress at intervals along the course of the Watut and Bulolo Rivers and their tributaries. Not many of the miners were obtaining profitable returns, owing to the high costs, and much alluvial ground that was then abandoned is now being worked.

The find that first caused world-wide notice was made in February, 1926, when W. G. Royal and R. M. Glasson, two Australian prospectors, succeeded in reaching the upper waters of Edie Creek, a tributary of the Bulolo River, and at an altitude of some 6,500 ft. (the Bulolo River is at an elevation of from 2,000 to 3,500 ft.) they discovered very rich auriferous gravels in the creek bed and banks, running up to, in patches, £200 per cubic yard. This find caused a rush to this part of the field and by the middle of 1926 there were some 100 miners and their native labourers on Edie Creek. The influx to the field at this stage was reminiscent of the early Australian " gold rushes." Profiting by the disastrous experiences of pre-War-gold rushes in Papua the New Guinea Administration required those proceeding to the field to deposit a cash guarantee, which was sufficient to reimburse the Administration for their return to Australia in the case of their failure to locate payable gold ; also the prospectors were required to have a sufficient number of indentured native labourers, whose maintenance had to be guaranteed. The richer portions of the Edie, Merri, and Midas Creeks (tributaries of the Edie) had been taken up by W. G. Royal, R. M. Glasson, and their partners—A. A. Royal and A. Chisholm—as leases. Some confusion arose regarding the granting of these leases, but the matter was eventually settled, and many of the miners secured some alluvial ground as claims or leases, obtaining profitable returns. An outbreak of dysentery amongst the natives in September, 1926, retarded the advancement of the field for some months. The conditions at Edie Creek at this time are difficult to realize. The ground was heavily timbered and covered with moss, the weather intensely cold, by comparison with the coastal climate, wet and miserable. The men and natives were living in rough sapling shacks or tents. Rice cost up to £4 a fifty-pound bag (one bag of rice would last twenty-five natives for one day). Nevertheless, the richness of the ground was still attracting more prospectors. The new port, Salamaua, was established as the Administration centre, and a wireless station erected there in November, 1926. In September, 1926, a wireless station was erected at Edie Creek. In December, a Mining Warden arrived from Australia to control the field and established his headquarters at Edie Creek.

The end of 1926 saw the first operating companies formed to exploit portions of the alluvial gravels. The late C. J. Levien formed, with Adelaide associates, Guinea Gold N.L., which took control of a large group of leases in the Koranga and Bulolo areas and commenced active mining and testing operations. The leases of the Royal-Glasson group were also formed into a company, later to become Edie Creek Proprietary, Ltd., and hydraulic sluicing and elevating plants were installed.

On April 18, 1927, the initial aeroplane flight to the goldfields (from Lae to Wau) was made by Lieut. E. A. Mustar in a D.H. 37 aeroplane, owned by Guinea Gold N.L. This was the pioneer of the present aeroplane service to the field by Guinea Airways, Ltd., which is now the largest aerial freight-carrying organization in the world. The first trip cost passengers £33 per head—at present the cost is £5.

In May, 1927, another phase of mining was entered on, when a gold-bearing vein of quartz, associated with the oxides of manganese, was discovered on the Royal Lease, Upper Edie Creek. This vein is now known as Edie Lode No. 1. This was soon followed by the finding of the now well-known Day Dawn vein, near the Merri Creek-Edie Creek junction. These discoveries resulted in intensive prospecting and by the end of the year several hundred gold mining leases had been applied for. Most of these were optioned to London interests. Testing of the Bulolo leases was continued during the year, but, in view of the high transport costs, dredging proposals were not proceeded with.

During 1928 and 1929 prospecting and work by alluvial miners was continued on a smaller scale and the development of the veins and dredging areas continued. A large operating company, New Guinea Goldfields, Ltd , was formed under the aegis of the Mining Trust, Ltd., to work the greater part of the Edie Creek, Koranga Creek, Namie Creek, and Upper Bulolo River areas, both for alluvial and veinstuff. Placer Development, Ltd., a Canadian company, took options over Guinea Gold N.L.'s Bulolo dredging areas and tested them, showing 40,000,000 cubic yards of an average value of 2s. 4d. (gold at normal prices) per cubic yard.

The year 1930 saw the commencement of construction for dredging operations on the Bulolo River by Bulolo Gold Dredging, Ltd., a subsidiary of Placer Development, Ltd. The same year saw the proving of 100,000 tons (2,240 lb.) of 10dwt. (gold at normal prices) ore by New Guinea Goldfields, Ltd., at Golden Ridges, near Namie Creek. Day Dawn (New Guinea), Ltd., was formed to work the Day Dawn vein. A new find was reported at Black Cat Creek, on the coastal fall of the Kuper Range, and a mild rush resulted. Payable alluvial gold was also discovered in the Upper Ramu River area and this was declared a provisional goldfield. Elsewhere on the field alluvial mining and prospecting continued on a limited scale.

In May, 1931, the first ore was milled at Day Dawn, whose mill has been in continuous operation since that date. Three-engined (G. 31) Junkers aeroplanes, with a pay load up to 7,000 lb. were introduced. New Guinea Goldfields, Ltd., and Bulolo Gold Dredging, Ltd., continued to install power plants, dredges, and other machinery (all transported from the coast by aeroplane). The gold production increased considerably as a result of the exchange premium received.

On March 21, 1932, the first dredge commenced operations at Bulolo. In August, 1932, the first cyanide mill in the Territory started up at Golden Ridges. The success of the operations conducted by Bulolo Gold Dredging, Ltd., and Day Dawn

(New Guinea), Ltd., attracted considerable attention and large areas were taken up as dredging claims or gold-mining leases in all parts of the field. The month of November provided the record production to date of the field, for any one month, being 18,610 oz. of bullion, valued at £88,792 (Australian currency)

The authors then go on to deal with the geography and geology of the area, with mining legislation and labour, mining and metallurgical practice, power, and transport, going on to discuss the present state of the industry. They say that in the Morobe district much of the known rich and easily won alluvial gold has been extracted, principally by the "box and dish" miner and the stage has now been reached where the placers are being actively worked by modern machinery methods. It is estimated that, at the present rate of extraction, upwards of ten years will elapse before the known alluvial gold deposits are worked out. It is reasonable to assume, with the better opening-up of this rugged and partially explored jungle country, that further payable alluvial areas will, from time to time, be discovered by prospectors, and so add to the life of this class of mining.

The mining of the ore deposits is so far confined to the oxidized zone and while work is in progress to determine the extent and characteristics of the lodes at depth, no forecast can be made as to the probable life of the field, until this information is available.

The mining industry in North-East New Guinea is unique in so far that it is dependent upon aerial transport for supplies and equipment. Although the costs are high compared with those met with on Australian mining fields they are more or less offset by an adequate supply of native labour and ample water for the generation of hydro-electric power. The working of many of the lower-grade deposits is directly dependent upon transport costs and the construction of roads and graded mule tracks from the inland aerodromes to the mines will do much towards reducing these costs.

Government patrols are progressively penetrating further inland and are bringing under Government influence country now occupied by hostile natives living in the "uncontrolled areas." As this work proceeds, much untried but probably auriferous land is being made safe for the prospector and miner, who establish aerodromes at convenient centres and work from these as their bases.

The industry is now in a healthy and progressive condition in New Guinea and there is every indication that it will remain so for some time to come.

THE SCOTTISH ALUMINIUM INDUSTRY

(*Concluded from the August issue, p. 125.*)

The generators are designed to run safely at the runaway speed of the turbines, namely at 86% above the maximum normal speed of 267 r.p.m. The combined efficiency of the turbines and generators is approximately 84%.

Apart from the five main units two auxiliary a.c. units are provided, each giving an output of 1,500 k.w. at 440 volts, three-phase, 50 cycles per second. This power is used for lighting, general power, village supply, pier cranes, and for customers within the area of supply.

The power house is some 20 ft. lower than the level of the furnace room in order to obtain the maximum water head possible, and the "bus" chamber is placed on a gallery where the aluminium busbars are so arranged that by means of short link sections various combinations of generating units can feed one or other of the series of furnaces. The busbars are extruded in lengths of over 30 ft. and have each a cross-section of 6 in. by $\frac{5}{8}$ in. They are bunched together, but with distance pieces to allow of adequate heat dissipation and work at a low current density to keep the losses as low as is economically possible. Thirty-six tons of aluminium were used in the power house "bus" circuit. Had copper been used the weight would have been about 60 tons.

The furnace room is 700 ft. long by 120 ft. wide and has a maximum height of 47 ft. It is divided into two bays in each of which are placed the furnaces. Three 2-ton overhead cranes work in each bay and are used for the movement of the electrodes into and out of the furnaces, for the lifting away of molten aluminium, and for the miscellaneous work in connexion with the erection of furnaces, etc. Two 3-ft. gauge tracks run down each bay and are connected with the other buildings and with the general railway system, which includes some 25 miles of track running right through to Lochs Treig and Laggan, and a 1·8-mile track running to the specially built pier. All internal factory transport is hauled by electric battery locomotives, petrol and steam locomotives being used for outside work.

The L. & N.E. Rly. sidings run into the factory at three points—namely, at the fitting shops, power house, and to the alumina handling plant. The latter receives the tank wagons from Burntisland, the alumina discharging from the valves of the wagons into a receiving hopper below rail level, from which the material is conveyed horizontally to the boot of an elevator. This elevator discharges on to a horizontal belt conveyer some 120 ft. in length. Thence the material can be discharged at various points into the storage bunker which runs across the furnace room in the middle of its length. This large overhead bunker holds up to 1,500 tons of alumina. The alumina reaches the furnaces by means of walking cranes running behind the furnaces in each bay. These are fitted with small hoppers so that the operator bringing the crane under the main alumina hopper can fill it easily and proceed when required to any furnace to feed a fixed quantity of alumina. Light signals are fitted to each furnace which automatically indicate that a supply of alumina is required.

The electrolytic process by which aluminium is made depends on the solution of alumina in an electrolyte. A furnace is made of a rectangular reinforced steel plate box 14 ft. long by 12 ft. broad by 3 ft. high. It is lined on the bottom and the sides with heat-insulating material and with either carbon blocks or carbon mixture, which is rammed in by pneumatic hammers in such a manner as to form a rectangular bath. If carbon mixture is used then a prebaking operation has to take place before

the furnace can be put into circuit. In the carbon of the bottom are embedded steel bars which issue from the sides of the furnace and are connected to flat aluminium bars carrying away the current to the next furnace. A furnace can be short-circuited quickly by dropping lengths of flat bar into the top of the rising conductors. A total of 280 tons of aluminium are used in the furnace room.

In operation the bath is filled with molten electrolyte and the anode blocks, which are the electrodes referred to earlier in the paper, are immersed in this electrolyte. The electrolyte used is cryolite. Theoretically no decomposition or consumption of this material takes place, but in actual practice there is a loss of the order of 6% of the weight of aluminium produced, and this loss has to be made good by addition of cryolite in powder form to maintain a constant volume of electrolyte. The anode carbon electrodes have vertical flat aluminium stems, which are clamped to an anode beam or chassis, and by means of gearing the beam can be moved up or down so as to maintain the correct distance between the under side of the anodes and the layer of molten aluminium which will be deposited on to the carbon bottom and which will lie as a layer under the molten electrolyte. The current passes in through the anodes and the carbon bottom of the bath forms the cathode.

The heat necessary to keep the contents of the bath molten is supplied by the ohmic resistance of the anode and cathode carbon and more particularly by the resistance of the electrolyte. It will be clear that variations in power input, of alterations in the height of the layer of electrolyte, will cause changes in the heat conditions of the furnace and particularly in the electrolyte. The temperature at which the furnaces work is controlled, according to electrolyte and other conditions, between 930° and 1,000° C. These temperatures are some 50° only above the point at which constituents of the electrolyte start to freeze. The over-all voltage of a furnace is between 5 and 6 volts and the large units take 40,000 amperes.

The reaction which takes place consists in the oxygen of the alumina combining with the carbon of the anode electrodes to form CO and CO_2, which pass off to the atmosphere, whilst simultaneously the aluminium is deposited as mentioned above in a molten condition on the carbon bottom. The anodes are therefore consumed at a relatively fast rate, since they take part in the reaction. At fixed intervals of time the supply of Al_2O_3 in the bath becomes exhausted, resulting in the "anode effect," when the resistance of the bath increases greatly and voltages of 20 to 30 are reached. This is the voltage change referred to in describing the generating plant. When a fresh supply of Al_2O_3 is given to the bath the voltage drops to normal. There is always one charge of alumina lying on the crust of electrolyte between the anodes and this is broken into the bath when the anode effect takes place, a further charge being placed on the new crust which quickly forms.

The number and quality of the anodes are arranged so that the rate of consumption in inches corresponds as far as possible to the rate of deposition of the aluminium in inches in order to maintain a constant thickness of electrolyte in which the electrolytic reaction takes place. Adjustment of the anodes takes place as described above when the control staff receive indications by voltmeter and otherwise that conditions are not normal. The output from a furnace is from 80 to 85% of the theoretical amount, which should be produced by electrolysis, and the yield will decrease as a furnace ages. The life of a furnace will be from two to four years, after which it is taken out of circuit and rebuilt with a new carbon lining.

The furnaces described above are the largest in the world used on the regular production of aluminium. The British Aluminium Company has always taken a lead in this direction and has progressed from a size corresponding to 8,000 amperes per furnace to the present size in the course of 18 years.

A sample of aluminium is taken by dipping every 24 hours and a quick analysis made, so that the tapping of the furnaces can be regulated in such a manner that the desired purity of aluminium can be arranged by blending in mixing furnaces to which the aluminium is transferred. The tapping of the reduction furnaces, which takes place either daily or bi-weekly, is carried out by drilling a hole through the plug in the tuyère; the molten aluminium as it flows out is run into a large pot. The difference in the densities of the electrolyte and the metal is very small, but is sufficient to ensure that the molten aluminium lies as a layer under the electrolyte to a depth of several inches, and the amount drawn off into the pot is regulated to prevent electrolyte from coming out with the metal, and is fixed by the knowledge of the amount which the furnace will have produced since it was tapped previously. When the tapping is complete the pot is lifted out by crane from the recess in the floor in front of the tuyère, placed on a truck, and the metal delivered in molten condition to the mixing furnaces.

The purity of the aluminium produced will be from 99·2% to 99·8% dependent on the quality of the electrodes, alumina, and cryolite, and on the care taken in the furnace room, since impurities can be picked up easily. Apart from the production of pure aluminium, certain alloys, such as those containing 13% of silicon, 8% of manganese, etc., are produced in the reduction furnaces, and, by suitably blending in the mixing furnaces, other alloys are produced ready for use by the customer or are sold in the form of hardener alloys. The latter are diluted with other alloying material and with pure aluminium to form some of the more complex alloys whose use is growing.

Although the shop where remelting and casting into solid form takes place is known as the refinery, yet, generally speaking, refining of aluminium does not take place. It can be refined, but it is neither economical nor necessary for commercial purposes. The degree of purity of aluminium produced to-day is ample for all purposes, but particular care is taken to ensure that the purity is in keeping with the purpose for which the metal is required.

The mixing and blending furnaces in the refinery, which each hold six to eight tons of metal, are fired by semi-producers using coke and are of the reverberatory type. As the metal after weighing is transferred to the mixing furnaces in a molten condition, the heat necessary for these furnaces is only that required to compensate for the various heat losses from the furnaces. In practice the metal tapped from the reduction furnaces at a temperature in the neighbourhood of 950° is allowed to cool somewhat as the casting operations are carried out at 720° C. The casting takes place only after the metal has been suitably treated and

allowed to drop slowly to the casting temperature, and after a predetermined settling period.

All temperatures are most carefully controlled by recording pyrometers and, when the metal is drawn from the mixing furnaces, further check temperatures are taken in the crucibles before actual casting into rolling blocks, wire bars, notched bar, etc. The crucibles used are supported from an overhead travelling crane during the filling of the moulds, which is one of the most delicate operations in the process. In order to ensure satisfactory material the rate of pour, etc., has to be very carefully laid down and careful "feeding" takes place to compensate for shrinkage as solidification occurs. When the cast material is cold a very thorough inspection is made in case any defect has developed. The material is then loaded into wagons for sea transport from the pier or is sent by rail to customers and to the rolling mills.

The fitting shops, carbon stores, and carbon mixing department all contain plant for which the mechanical engineer has been responsible, but the plant is mostly of standard type as found elsewhere and presents no special features.

Research laboratories exist at Warrington, Kinlochleven, and Burntisland, and routine laboratories at all the works. To give an idea of the work entailed in the routine control of the process it might be mentioned that some 38,000 individual tests are carried out in an average year by the chemical routine laboratory at Kinlochleven.

The total cost of the Lochaber works will be in the neighbourhood of £4,500,000 when finally completed. This hydro-electric development is the largest in Scotland, followed by the Grampian scheme, Kinlochleven, and by the Galloway development now under construction, in the order of kilowatt-hours generated per annum.

SHAFT SINKING AT A UTAH MINE

In *Mining and Metallurgy* for August there is a description of shaft sinking at the United States mine in Bingham Canyon, Utah, by N. S. Christensen. The author says that operations at this mine are carried on through one main vertical underground shaft the collar of which is 5,550 ft. from the portal of the Niagara tunnel. This is a three-compartment shaft, with outside dimensions of 6 ft. 4 in. by 15 ft. 6 in. and inside dimensions, for each compartment, of 4 ft. 2 in. by 4 ft. 8 in. The job was to extend this shaft 410 ft. deeper, to a point 492 ft. below the Niagara 1,600 level. It was accomplished in the interval between October 3, 1932, and April 16, 1933, using the equipment and methods of sinking described. The limestone through which the shaft was sunk was metamorphosed and very hard, containing many small tongues of porphyry; drilling, therefore, was a severe test of both men and machines.

The manway compartment of the main shaft, which was used as the hoisting compartment in sinking operations, was partially lined with 1 by 12-in. lagging and a bucket used without guides and crosshead. Preparatory work included the installation of a sinking hoist, a head sheave and a fleet sheave, a signal system, air and water lines, a sinker pump, a trap door and pocket for handling waste, racks for the steel used in shaft sinking, and lockers for drills, tools, and other equipment. A general plan for the layout is illustrated in Fig. 1.

For sinking a single 36-in. diameter drum, Denver Engineering Works hoist was set up on a concrete foundation on the 1,600 station opposite and 25 ft. back from the manway compartment of the main shart. Power was supplied by a 50-h.p. induction motor using 220 volts. Two sheaves were used, one for diverting the cable from the hoist up the shaft and the second in the manway compartment of the shaft 80 ft. above the station level.

One of the four pockets on the 1,600 level was used for the waste from the shaft. The trap door, 4½ by 10 ft., for diverting waste from the bucket to the pocket was fastened on hinges at the bottom to the sill of the station, so that the top would swing back over the shaft compartment. A cable and lever were arranged to enable the hoist engineer to raise and lower the door. A "V" notch cut in the top and centre of the door, together with a steel plate on the end of the chain hanging from the bottom of the bucket, supplied the dumping equipment for the waste. Two steel buckets were used in hoisting operations, each with a capacity of 17 cu. ft. The bails were fastened to a ⅝-in. non-rotating cable by a clevis that could be quickly removed.

A bulkhead, extending through three sets of shaft timber in the main hoisting compartments, was built beneath the spillage pocket to protect the men working in the shaft bottom. An 8 by 8-in. floor was laid on each set, over which were placed 10 by 10-in. fillers covered with blasting logs. Three posts were placed at each compartment corner. The design of the steel bulkhead is shown by Fig. 2. It was made of 30-lb. rails and ⅜-in. boiler plate,

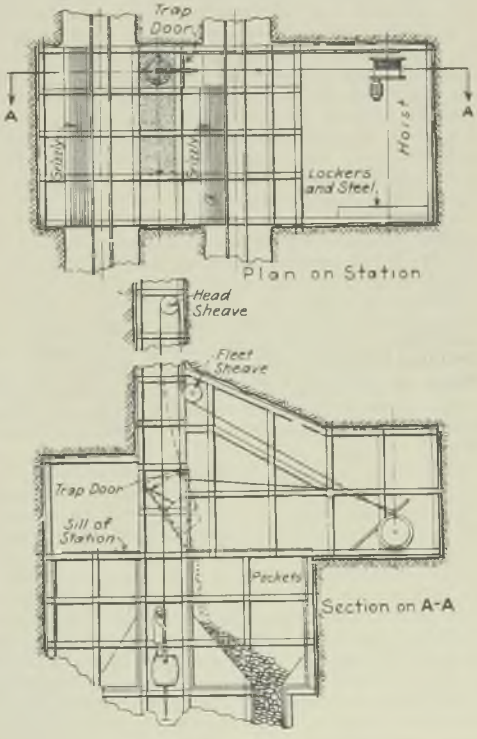


FIG. 1.—LAYOUT FOR SINKING.

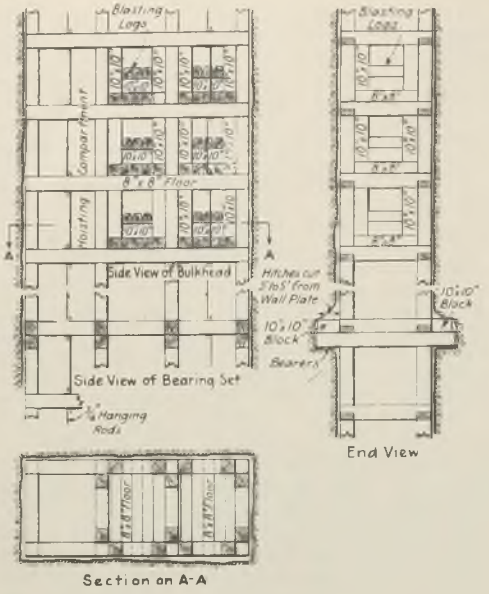


FIG. 2.—BEARING SET AND BULKHEAD.

constructed in the shops, bolted together in the bottom of the shaft, and hung by chain blocks below the bottom set of timber. That part of the bulkhead beneath the centre compartment of the shaft was doubly reinforced with rails; the boiler plate was bolted to the underside. The hoisting compartment was left open to enable the bucket to pass through and a small opening was made in the third compartment for lowering the sinking pump and suction hose. The object of the bulkhead was to protect the timber from blasting and also to form a platform for the men to work on when timbering. It could be raised or lowered, permitting both timbering and drilling or mucking operations to be carried on at the same time if necessary. Fig. 3 illustrates the design.

Work in the shaft was placed on the basis of two eight-hour shifts. The first shift worked from 8 a.m. to 4.30 p.m. and the second from 6 p.m. to 2.30 a.m. with half-an-hour for lunch. The men changed shifts on the first and sixteenth of each month. A shaft foreman, ten miners, and two hoist engineers composed the shaft crew. The miners were competent to perform any work in the shaft, whether timbering, drilling, or mucking. Each shift of five miners and a hoist engineer carried on the work of the preceding shift. The men supplied their own rubber boots and coats.

CYCLE OF SHAFT SINKING.—(*a*) *Drilling*.—A sumping or bench plan was used in sinking the shaft—only half the shaft was drilled and blasted with each round. This system enabled both drilling and mucking operations to proceed at the same time after about 15 buckets of muck had been joisted, which increased the rate of sinking compared with blasting an entire round at one time. A second advantage was in the physical effort of drilling on the miners: because of the hardness of the ground greater efficiency was obtained with less hardship by drilling one-half of the shaft bottom in three hours instead of the whole shaft bottom in one shift.

The most effective type of round was a simple "V" cut with 18 holes. The round drilled was placed as follows: Starting near the centre of the shaft the toe-holes were drilled at an angle of 50°, with the vertical end towards the opposite end of the shaft. Then four cut-holes were drilled parallel with the end of the shaft 1½ ft. back of the toe-holes and toward them at an angle of 45° with the vertical. Then four second cut-holes were drilled at an angle of 20° with the vertical. Then came the four breast-holes at 5° and lastly four back-holes were drilled vertically. The round drilled and the order of firing the holes are shown by Fig. 4. A set of 1¼-in. round steel consisted of:—

	Gauge of Bit, in.	*Length of Steel,* ft.
First Starter .	2½	1½
Second Starter .	2	3
Third Steel .	1⅞	4½
Fourth Steel .	1⅝	6

The first starter was used for collaring the hole. The hole was drilled 12 in. and was then cased by 12 in. of 2-in. pipe. After a hole was completed the pipe was covered with a wooden plug until the hole was blown out preparatory to loading. An average of sixty pieces of steel were used per round.

Three Gardner-Denver Model 207 drills were used in the shaft with one spare in case of a breakdown. For drilling a round, loading the holes, and lowering and hoisting equipment three hours was the average time required. The air pressure on the machines varied between 65 and 80 lb.

(*b*) *Blasting*.—A 40% gelatin dynamite in 8 by 1¼-in. red cartridges was used throughout the work, an average of 75 cartridges being required per round. As is the usual custom, holes were loaded two-thirds full of cartridges, the number varying from three to five cartridges per hole. No. 6 detonators, varying from 0 to 10 delay, were placed in primer cartridges, one cartridge up from the bottom of the hole. These detonators were connected in series with insulated wire and fired by a 220-volt a.c. line through a switch on the Niagara 1,600 level, an insulated rubber cable extending from the switch to the bottom of the shaft. The electric switch was locked with a padlock, the foreman being the only person permitted to carry a key.

(*c*) *Mucking*.—When first coming on shift after a round had been blasted, the miners cleaned off the loose muck that had accumulated on the timber from the blast and then lowered the sinking pump. Two buckets were used during mucking; the first was being hoisted while the second was being filled

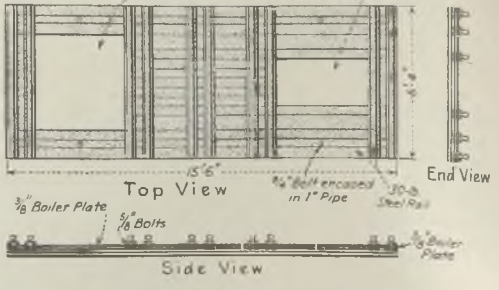


FIG. 3.—SWINGING STEEL BULKHEAD.

at the bottom. As soon as the first bucket was emptied and returned to the bottom of the shaft, the second bucket replaced the first bucket on the cable. After about fifteen buckets had been mucked from the bottom of the shaft enough rock surface was uncovered so that one machine could be started on drilling. As additional muck was removed the remaining machines began drilling. The average number of buckets per round was 37, requiring four hours for filling and hoisting. Each bucket held 17 cu. ft.

(*d*) *Timbering.*—In many places the ground was blocky, causing large slabs to work loose and requiring timbering of the shaft within one or two sets of the bottom. Timbers used in a set were 10 by 10 in. for wall plates, end plates, and posts, and 8 by 10 in. for the dividers. The wall plates were 15 ft. 6 in. long, the end plates 5 ft. 4 in. long, and the posts 4 ft. 4 in. in length. The timbers were framed to make the sets 5 ft. from centre to centre. All framing was done in the sawmill before the timber was taken into the mine. The type of framing and the size are illustrated in Fig. 5.

When the shaft was ready for a set of timber, the steel bulkhead, held by two chain blocks, was lowered far enough to make room for the set. The wall plates were then lowered one at a time by removing the bucket from the cable and fastening the cable clevis to a larger clevis on the wall plate. The clevis was secured by passing the 1-in. bolt in the clevis through the hole drilled for the hanging rods. Each wall plate was held in position by two $\frac{3}{4}$-in. hanging rods. Then the end plates, dividers, and posts were lowered down the shaft in the bucket and placed in position, after which they were alined, levelled, and blocked into place by

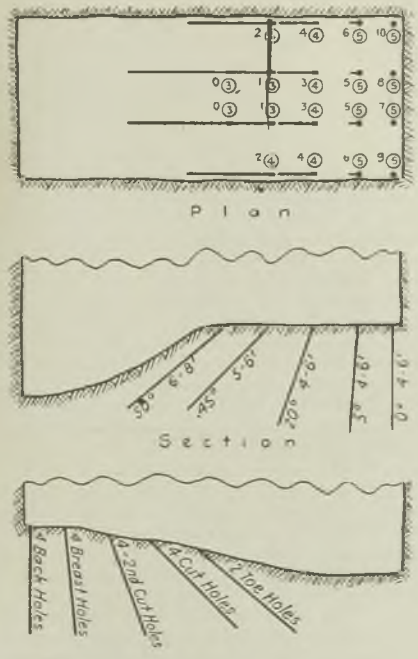


FIG. 4.—TYPE OF ROUND DRILLED, SHOWING ORDER OF FIRING AND STICKS OF DYNAMITE USED PER HOLE.

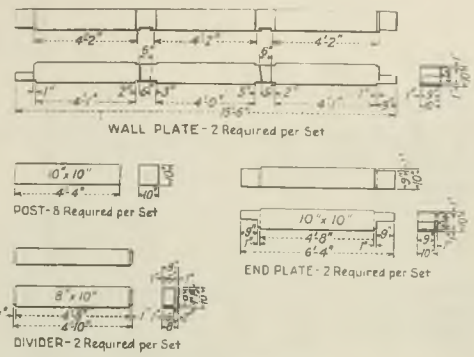


FIG. 5.—SHAFT SETS.

10 by 10-in. blocks and wedges placed at the corners and opposite the dividers and by tightening the hanging rods. The timbers were alined by three plumb lines hung over 2-in. blocks from above. Each set was checked for alinement and level by both the foreman and an engineer.

Bearing sets were placed 35 ft. above and 45 ft. below the sill sets of both the Niagara 1,800 and 2,000 level stations. In placing a bearing set, hitches were cut three or more feet from the wall plates, and the end plates and dividers doubled up and extended in the hitches and blocked. A bearing set is illustrated in Fig. 2.

Ladders in the centre compartment, with offsets every 10 ft., enabled the men to climb out of the shaft in the event of trouble with the hoisting equipment. Bulkheads, or floors of 8 by 8-in., were placed at intervals of 50 ft. in the shaft to protect the men working below. The entire shaft was partially lined on the outside with lagging placed horizontally. The end or hoisting compartment was partly lined vertically with 1 by 12-in. lagging on the inside to prevent the bucket from hanging up or upsetting when in motion through the shaft, since no cross-head was used with the bucket.

Very little water was made directly from the formation during sinking operations. Such water as accumulated in the shaft came from that used in the machines and from drainage from the levels above. The sinking pump was a Prescott "Cut 27" air-driven duplex with 7-in. cylinders, $3\frac{1}{2}$-in. pistons, and 10-in. stroke. It was operated most of the time during working hours in the shaft and pumped approximately 22 g.p.m. The length of suction lift was 14 ft. and a 3-in. pump column was used. Better pump operation was obtained by directly connecting the exhaust to the pump column. Before blasting, the sinking pump was hoisted about four sets from the bottom of the shaft on chain blocks and securely snubbed into place by chains. Water was pumped to the Niagara 1,600 level sump.

Every precautionary measure possible was taken to prevent accidents. All shaft men were required to wear "hard-boiled" hats. Only two minor accidents, with a total loss of $6\frac{5}{8}$ man-shifts, occurred during the entire period.

Cost data for the entire work have not as yet been completed, but the mine costs of an average month with an advance of 75 ft. sinking and 15 sets of timber may be given as shown in Table 1. These costs do not include power, drill sharpening, or overhead, but do include general maintenance and repairs.

TABLE I.—*Average Costs.*

Labour.	Total.	Per ft.
Machiners	$559·14	
Muckers	719·90	
Timberman	311·06	
Framing	91·53	
Hoist engineers	254·50	
Bosses	195·00	
Shop labour	24·34	
	$2,155·47	$28·74
Supplies.	Total.	Per ft.
Explosives	$266·46	$3·55
Timber	382·95	5·11
Miscellaneous	81·32	1·08
	$730·73	$9·74
Total labour and supplies	$2,886·20	$38·48

From October 3, 1932, to April 15, 1933, inclusive, preparatory and sinking operations showed an advance of 410 ft. in hard metamorphosed limestone and porphyry. These results under ordinary shaft-sinking conditions may seem far from speedy, but consideration must be given to the fact that the regular mine operations of hoisting 1,200 tons of ore and waste per operating day were not retarded or interfered with in any way.

Small Lode-Gold Mines of America.—A circular of the U.S. Bureau of Mines states that engineers of the Bureau have recently inspected 150 small lode-gold mines in California, Southern Oregon, Arizona, New Mexico, Colorado, Utah, Montana, and Idaho, for the purpose of gathering information on methods and costs of equipping and developing properties handling less than 100 tons per day. Data obtained will be compiled and published, but conclusions already reached are summarized as follows :—

(1) Few, if any, of the properties visited can be considered as potential large producers of gold ; the ores are mostly low-grade and occur in narrow veins. A number possess possibilities for profitable operation on a small scale if economically operated by experienced men. In some instances competent management is hampered by lack of capital. Most of the properties have little ore blocked out.

(2) Many of the operators are hopeful of an open market for gold. If they are allowed to sell their gold in the world market, thereby obtaining a premium of about 30% above the price paid by the U.S. Mint, the possibility of profitable operation will obviously be enhanced.

(3) Many of the operators of small properties have had little experience in mining and are in need of competent technical advice but in most instances they cannot afford to employ consultants. In some cases the erection of milling plants absorbed all available capital before ore had been developed. In other instances development expenditures were ill-advised and exploratory openings were poorly planned.

(4) Considerable ground which would warrant exploration is owned in fee or is held by location under the Federal mining and homestead laws by parties who have neither the intention nor the capital to investigate the mineral possibilities. A change in the law, which would required the holders of such property to either develop it or release it for legitimate exploration, would be beneficial.

(5) Much information has been gathered which, when carefully analyzed and correlated, will be of value, especially to the inexperienced small operator. It is planned to issue Information Circulars covering the best methods of development for different conditions, milling methods for different types of ores, unit costs of development in different districts, and actual installation costs of small milling plants. Separate circulars will be issued on a few individual operations where good practices in development, mining, and milling are being followed.

Telluride Treatment.—A discussion of the problem of the treatment of gold-bearing tellurides by W. E. Johnston appears in the *Engineering and Mining Journal* for August. A digest of earlier work on the identification and treatment of these minerals by the same author in collaboration with Professor H. E. T. Haultain appeared in the MAGAZINE for August, 1932. In the present article the author deals with the trouble that has been encountered in the treatment of telluride ores, going on to give the results of a series of concentration tests on such ores and of their treatment by cyanide. As a result of these tests he concludes that—

(1) Gold-bearing tellurides do yield up their gold to cyanide, if they are in a finely-divided state and excess lime is used.

(2) Sodium peroxide greatly reduces the time of treatment required for maximum extraction. It is not beneficial when used in quantities equivalent to commercial use.

(3) The tellurides are very brittle and, owing to their high gravity, will be retained in a mill circuit for a long time. They will thus be in a finely-disseminated state, approximately minus 1,600 mesh or the size required to yield a maximum extraction of their gold.

(4) Up to the present, gold-bearing tellurides have not been found in large quantities in mill tailings or in concentrates recoverable from them.

Golden Cycle Mill, Colorado.—Methods of milling gold ores used at the custom plant of the Golden Cycle Corporation at Colorado Springs are described by L. S. Harner in Information Circular 6739 of the United States Bureau of Mines. The plant treats Cripple Creek district sulpho-telluride gold ores by roasting and cyanide methods. It also treats other gold ores, received in small shipments from widely scattered districts, by direct cyanide methods and complex sulphide ores by selective flotation methods. The treatment of telluride ores consists in crushing to 4½ mesh size by jaw crushers, Symons cone crusher, and Schmidt comminuters. The crushed product is roasted in Edwards furnaces and the calcines, after being ground in cyanide solution by Chilean mills, are passed over blanket tables for the recovery of coarse gold. The concentrates from the latter operation are treated by amalgamation in a small grinding pan. The tailings are separated into sands and slimes ; the sands are cyanided by percolation and the slimes by agitation and filtration. The plant is provided with flotation equipment for the treatment of lead-zinc sulphide ores. It produces lead concentrates and zinc concentrates by selective flotation methods. The tailings of the flotation plant are further treated for the recovery of gold and silver by cyanide if conditions warrant such treatment. Low-grade telluride ores are first treated by flotation. The concentrates join the higher-grade telluride ores in the Edwards roasters and the tailings are cyanided

directly. During the year 1929 the plant treated an average of 818 tons of gold ore per day which contained 0·502 oz. of gold per ton. The recovery of gold amounted to 96·81%. Milling cost during this period was $2 21 per ton of ore treated.

SHORT NOTICES

Mine Haulage.—The combination-type electric locomotive for underground work is described by A. Neustaedter in the *Engineering and Mining Journal* for August.

Mine Openings.—Research into the correct design for mine openings involving the use of models is described by P. B. Buckey in the *Engineering and Mining Journal* for August.

Ventilation Surveys.—W. E. Cooke and I. C. F. Statham, in *Colliery Engineering* for July, discuss the use of the aneroid barometer for ventilation surveys and describe a method for its more accurate application.

Rock Temperatures in Northern Ontario.—In the *Canadian Mining and Metallurgical Bulletin* for August R. H. Cleland gives the results of determinations of rock temperatures in the mines of Northern Ontario and discusses some of the ventilating conditions.

Cyanide Process.—J. Gray and J. A. McLachlan give a short history of the introduction of the MacArthur-Forrest cyanide process to the Witwatersrand goldfields in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for June.

Sulphur Recovery.—In *Industrial and Engineering Chemistry* for August the recovery of sulphur dioxide as dilute sulphuric acid is described by R. L. Copson and J. W. Payne.

Chalcocite and Native Copper.—In *Economic Geology* for August E. S. Bastin discusses the chalcocite and native copper types of ore deposits.

Chrysotile Asbestos.—W. A. RuKeyser describes the occurrence of chrysotile asbestos in the Bajenova district, U.S.S.R., in the *Engineering and Mining Journal* for August.

Quicksilver in California.—C. N. Schuette gives an account of the Great Basin quicksilver deposits in the *Engineering and Mining Journal* for August.

Miami-Picher Zinc-Lead Deposits.—An account of the Miami-Picher zinc-lead district by W. A. Tarr is given in *Economic Geology* for August.

San Antonio Gold Mine.—J. A. Reid and D. J. Kennedy describe the San Antonio gold mine, Rice Lake, Manitoba, in the *Canadian Mining and Metallurgical Bulletin* for August.

Homestake Mine, South Dakota.—An account of the operations of the Homestake Mining Co., of Lead, Black Hills, South Dakota, is given by J. Simmons in the *Canadian Mining Journal* for August.

Great Bear Lake.—In *Economic Geology* for August C. Riley describes a chalcocite deposit at Great Bear Lake, Canadian North West Territories.

Cracow, Queensland.—Developments at Golden Plateau, Cracow, Queensland, are described in the *Chemical Engineering and Mining Review* of Melbourne for July 5.

Black Diamonds in Brazil.—D. M. Anderson describes black diamond mining in Brazil in the *Canadian Mining Journal* for August.

Bismuth in Bolivia.—T. L. Johnston describes the Bolivian bismuth industry in *Mining and Metallurgy* for August.

Venezuela.—In the *Mining World* for August 26 Noël G. Hackney gives an account of recent progress in Venezuela.

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.*

27,538 of 1931 (394,311). J. E. Lilienfeld, Winchester, Massachusetts. A welded joint between a metal and a silicious refractory is obtained by the use of a suitable flux.

28,214 of 1931 (395,367). Demag A.-G., Duisberg, Germany. Iron ores high in sulphur are smelted in such a way as to produce elemental sulphur as a by-product.

33,911 of 1931 (394,316). A. Amenabar, Santiago, Chile. A cyclic process for the extraction of copper from its ores in which the copper is precipitated from sulphuric acid solution as cuprous iodide, which is retreated to produce iodine for use in a new cycle.

34,770 of 1931 (394,650). K. W. Young and Imperial Chemical Industries, Ltd., London. Sulphide ores are roasted to produce sulphates that are subsequently recovered by solution or other means.

35,808 of 1931 (394,682). W. A. Ogg, Newton, Massachusetts. A mixture of zinc oxide and a carbonaceous material in an extended, mechanically-undisturbed layer is treated by radiated heat in a special furnace, the zinc vapours formed being recovered in the usual manner.

534 of 1932 (395,002). Anaconda Sales Co., New York. Improved process for the production of sheet metal electrolytically.

13,118 of 1932 (394,471). R. C. Forrer-Jaggi and Mines Domaniales de Potasse d'Alsace, Mulhouse, France. Apparatus for the electromagnetic separation of weakly magnetic materials.

19,349 of 1932 (395,159). American Smelting and Refining Co., New York. Cadmium-thallium solutions are treated with sodium bisulphite to reduce the thallium to the thallous state, the thallium being then precipitated from the solution as thallous chromate by the addition of sodium chromate or dichromate.

26,569 of 1932 (394,846). Meyer Mineral Separation Co., Pittsburg, U.S.A. Oxidized ores of metals such as iron, nickel or chromium are treated in such a way as to render them highly reactive towards acidic reagent gases.

36,503 of 1932 (395,602). New Jersey Zinc Co., New York. Impure zinc is cleaned of impurities by a process of fractional distillation.

2,153 of 1933 (395,619). J. E. Greenawalt, New York. In order to reduce the temperature of freshly sintered material it is introduced to a receiving chamber, the fines screened off and wetted, the generated steam being allowed to traverse the chamber.

8,191 of 1933 (395,305). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Process for the decomposition of monazite sand and similar ores bearing rare-earth metal compounds.

8,404 of 1933 (395,305). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Phosphoric acid and excess sulphuric acid obtained during the treatment of monazite sands are recovered by introducing the anhydrous sulphate into alcohols at a low temperature and separating the undissolved portion from the liquid.

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.

Handbuch der Geophysik. Edited by Dr. B. GUTENBERG, Vol. II, Part 3. Die Erdoberfläche. By Dr. E. KOSSINNA. Petrographischer Aufbau der Erdkruste. By Dr. S. ROSCH. Chemie der Meteoriten. By Dr. VON HEVESY. Paper covers, pp. 869–1119, illustrated. Subscription price RM. 28. Vol. VII, Part 1. Das Eis der Erde. By Dr. HESS. Seen. By Dr. HALBFASS. Das unterirdische Wasser. By Dr. KOEHNE. Paper covers, pp. 1–252, illustrated. Subscription price, RM. 28. Berlin: Gebrüder Borntraeger.

Cours de Géologie Appliquée. By L. DE LAUNAY. Cloth, octavo, 460 pages, illustrated. Price Fr. 90. Paris: Librairie Polytechnique Ch. Béranger.

A Textbook of Geology. By C. SCHUCHERT and C. O. DUNBAR. Part II.—Historical Geology. Cloth, octavo, 551 pages, illustrated. Price 25s. London: Chapman and Hall.

Petroleum Development and Technology: Transactions of the American Institute of Mining and Metallurgical Engineers, 1933. Cloth, octavo, 426 pages, illustrated. Price $5. New York: American Institute of Mining and Metallurgical Engineers.

The Analysis of Oil for the Production of Lubricants. By A. A. ASHWORTH. Cloth, octavo, 63 pages, illustrated. Price 9s. London: Ernest Benn.

Courbes Relatives aux Opérations du Classement et du Lavage des Charbons: Applications diverses et procédés de détermination. By O. DUPUIS and E. ÉVRARD. Paper covers, 43 pages, illustrated. Price Fr. 10. Paris: Librairie Polytechnique Ch. Béranger.

Mines Department: Report of the Secretary for Mines, 1932. Paper covers, 236 pages. Price 3s. 6d. London: H.M. Stationery Office.

Report of H.M. Electrical Inspector of Mines, 1932. Paper covers, 64 pages, illustrated. Price 1s. London: H.M. Stationery Office.

Mining Telephones: Report on an Investigation at the Mines Department Testing Station, Sheffield, of the Safety of Mining Telephones of the Magneto Ringing Type. By Capt. C. B. PLATT and Dr. J. T. BURDEKIN. Paper covers, 27 pages, illustrated. Price 6d. London: H.M. Stationery Office.

Safety in Mines Research Board: Report for 1932, including a report of the matters dealt with by the Health Advisory Committee. Paper covers, 112 pages, illustrated. Price 2s. London: H.M. Stationery Office.

British Columbia: Minister of Mines' Report, 1932. Cloth, large octavo, 301 pages, illustrated. Victoria: Bureau of Mines.

Summary and Review of the Mineral Industry of British Columbia for the six months to June 30, 1933. By John D. GALLOWAY. B.C. Dept. of Mines Bulletin No. 2. Paper covers, 31 pages. Victoria: Bureau of Mines.

Quebec: Bureau of Mines Report, 1931. Part E.—Commercial Granites of Quebec, Part I—South of the St. Lawrence River. By F. R. BURTON. Paper covers, 140 pages, illustrated. Quebec: Bureau of Mines.

Tanganyika Territory. Geological Survey Annual Report, 1932. Paper covers, 40 pages, with map. Price Shs. 2·50. Dodoma: Geological Survey Department.

Geology of British Somaliland. By Dr. W. A. MACFADYEN. Part I—Geology and Palæontology. Paper boards, 87 pages, illustrated, with map. Price 12s. 6d. London: Crown Agents for the Colonies.

New South Wales: Annual Report of the Department of Mines, 1932. Paper covers, folio size, 111 pages, with map. Sydney: Department of Mines.

California: Map of Northern California showing principal rivers and creeks. Scale: 18 miles to the inch. Price 25 cents. San Francisco: Division of Mines.

DIVIDENDS DECLARED

Amalgamated Zinc.—2½%, less tax, payable October 6.

Ashanti Goldfields.—1s., less tax, payable September 30.

Central Provinces Manganese.—4%, less tax, payable October 2.

Changkat Tin.—1s., less tax, payable Sept. 2.

Electrolytic Zinc.—Pref. 4%, less tax, payable November 2.

General Mining.—1s. 6d., less tax, payable November 23.

Globe and Phoenix.—1s. 6d., free of tax, payable October 18.

Kampong Lanjut.—6d., less tax, payable September 15.

Komata Reefs.—3d., free of tax, payable October 30.

Kramat Tin Dredging.—1s., less tax, payable August 26.

Malayan Tin.—1½d., less tax, payable September 21.

Mount Coolon.—1s., less tax, payable Oct. 26.

North Broken Hill.—1s. (Australian), less tax, payable September 29.

Nundydroog.—3s. 6d., less tax, payable Oct. 5.

Rawang Tin.—3d., less tax, payable October 21.

Waihi Gold.—1s., free of tax, payable Nov. 1.

West African Diamond.—1½d., less tax.

Witbank Colliery.—1s., less tax, payable October 10.

NEW COMPANIES REGISTERED

Auriferous Lands (Gold Coast).—Capital: £7,500 in 2s. shares. Objects: To acquire property in the Gold Coast Colony or in any other part of the world; to search for, prospect, mine, and prepare for market ore, metal, and mineral substances, etc. Office: 54, Old Broad Street, E.C. 2.

United Mining and Quarrying Company.—Capital: £10,000 in 8,000 6% cum. preference shares of £1 and 10,000 ordinary shares of 4s. Objects: To acquire and turn to account any mines, mining rights, and metalliferous land in Wales or elsewhere, etc. Office: 11, Queen Victoria Street, E.C.

Westralian Gold and Finance.—Capital: £1,000 in £1 shares. Objects: To acquire shares and financial interests in Westralian and other gold-mining companies, etc. Directors: Christopher J. Turle and Chas. Elderton. Office: Shortgate, Lewes, Sussex.