The Mining Magazine

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EDITORIAL

HELD every two years, the Public Works, Roads, and Transport Exhibition is taking place at the Agricultural Hall from November 16 to 21, when more manufacturers of mining machinery will be found assembled under one roof in London than at any other exhibition for some considerable time.

A GENEROUS offer made to the Council of the Institution of Mining Engineers by Messrs. Mavor and Coulson, Ltd., of Glasgow, of another travelling studentship has been accepted. The sum available, £300, must be used by the approved candidate in completing a tour which includes either the United States or Canada.

CLOSER union between Uganda, Kenya, and Tanganyika is not advocated by the Parliamentary Joint Committee—which has just issued its report—as was generally expected. Co-operation as far as possible is to be effected by periodical conferences of governors and as an aid the appointment of a supreme adviser on transport is recommended.

EFFICIENT tunnelling work in connexion with the Manchester Corporation Haweswater Scheme has been recorded in the last two issues of the MAGAZINE. Under the supervision of the contractors, the François Cementation Company, the rapid advance is being continued and all concerned in this work are to be congratulated on the manner in which it is being carried out.

WITH the appearance of Part III. of the "Summary of Progress" [1] for 1930 the report of the Geological Survey and Museum for that year is completed. Among the papers in this number are two relating to geophysical prospecting, the first, by W. F. P. McLintock and J. Phemister, relating to a magnetic survey over the Lornty dyke, Perthshire, and the second, by A. F. Hallimond, describing a similar survey over the Pentland fault, in Midlothian.

MUCH valuable information from the individual reports of the inspectors is given in the annual report [1] of the Mines Department. Although dealing primarily with questions relating to the health and safety of workers in metalliferous mines and quarries, it also contains figures relating to employment, output and value of minerals, and the use of explosives and electricity. During 1930 over 76,000 persons were employed in the quarrying industry and over 13,000 in metalliferous mines in this country, the value of mineral obtained from both sources amounting to approximately £18,500,000.

A COMMITTEE of experts appointed by the International Chamber of Commerce to advise on the silver question has now issued its report. The recommendations of the committee are four in number, the most important, perhaps, being one in which it is proposed that efforts be made to bring North American producers and refiners of silver into a sales agreement with India. The other proposals are: First, a plan for the use of silver as a backing for currency notes; secondly, a plea for the restoration of pre-war fineness to silver coinages, and thirdly, a recommendation to silver producers to institute research for devising new uses for the metal and for improving its properties. Further to this last point, it is stated that a method of avoiding the tarnishing of silver would alone increase its utility.

IN the August issue of the MAGAZINE reference was made to the postponement of the International Geological Congress until June, 1933, in view of the generally adverse economic conditions prevailing throughout the world. As a result of the responses to the preliminary list, the following revised programme of topics for discussion is now proposed: Measurement of geological time by any method, batholiths and related intrusives, zonal relations of metalliferous deposits, major divisions of the Palæozoic system, geomorphogenic processes in arid regions and their resulting forms and products, fossil man and contemporary faunas, and orogenesis. In the most recent circular a list of proposed excursions is given, all of which have been arranged to cover interesting features of American geology.

[1] "Summary of Progress," Part III. Geological Survey of Great Britain. Price 2s. London: H.M. Stationery Office.

[1] "Reports of H.M. Inspectors of Mines and Quarries, 1930." Price 1s. London: H.M. Stationery Office.

Smelting and Drainage Problems

The first meeting of the 1931–1932 session of the Institution of Mining and Metallurgy took place last month. This is the forty-first of these sessions and, although it is taking place in somewhat trying times for many members, those attending were privileged to hear two very interesting papers. The first of these, which appeared in the June *Bulletin* and extracts from which are given elsewhere in this issue, is by Mr. O. H. Woodward and is entitled "Some Features of Lead Blast-Furnace Operations at the Works of the Broken Hill Associated Smelters Proprietary, Limited, Port Pirie, South Australia." This paper has been presented simultaneously before the Australasian Institute and a comparison of the discussions before the two bodies should prove illuminating. The second paper, by Mr. L. C. Stuckey, had also appeared in an earlier *Bulletin*, that for August, and is called a "Note on the Use of Borehole Pumps for Mine Drainage." The two papers were presented at a well-attended meeting and each was followed by an interesting discussion, although all of it, perhaps, might not be considered relevant.

Mr. Woodward's paper was, perforce, presented in the absence of the author, its introduction having been left in the capable hands of Mr. Hugh Picard. The subject-matter covers certain features of operating practice at Port Pirie and deals particularly with the effect of zinc on lead blast-furnace operations, together with an account of the methods used to deal with the problem. In addition, the author examines the course of development of the tuyére position, particularly as regards its height above the bottom of the furnace jacket, and the extension of the tapping interval, showing the combined effect of these two factors on the lead content of blast-furnace slag. It is shown how costs at Port Pirie rendered it necessary to increase the lead content of the furnace charges and to reduce the quantity of barren flux added, which resulted in an automatic increase in the zinc content of the charge, with the troubles attendant thereon. The manner in which these troubles were overcome is fully explained and in the course of the argument it is shown how those in charge of operations at Port Pirie have evolved an empirical formula which permits of the control of ZnO, CaO, and FeO + MnO, a formula which, of course, may apply only to Port Pirie practice, where the variations in the slag constituents are within narrow limits, but the way in which it has been applied to varying conditions bears witness to efficient technical control. The author has shown that when careful attention is given to the quality of coke used in the blast furnaces and the empirical formula is applied the blast-furnace smelting of a charge carrying a relatively high concentration of zinc can be carried out successfully. As regards the second point dealt with in the paper, affecting tuyére position and the extension of the tapping interval, it is further shown how at one phase of the operations it became apparent that a good bed of coke had to be maintained below the tuyéres, with a minimum above them, and how it was decided to increase the height at which they were placed in the furnace. Further work showed the importance of the length of the tapping interval and it was decided to extend this. As a result of these modifications of practice the work at Port Pirie has proceeded more smoothly and the somewhat arbitrary way in which the tuyére height was altered has at any rate proved successful, the control of charge composition having been finally achieved. The discussion on this paper was opened by Mr. H. Lancaster, who, after commenting on several of the points outlined above, congratulated the author and his company, not only on the successful outcome of the work, but on the large-minded spirit which permitted the broadcasting of such important results, a tribute seconded by later speakers, who included Mr. A. H. Mundey, Dr. Sydney Smith, and Mr. R. Murray-Hughes.

Turning to Mr. Stuckey's paper, readers are reminded that a digest of this appeared in the MAGAZINE for September and they will recall that it described an installation using a pump suspended in a bore-hole to drain a mine in North Africa. Conditions in this instance favoured such a proposal, as the area consisted of porous schists intersected by five lead lodes, one of which is exploited over a length of one and a half mile. These lodes are themselves crossed by fissures and have a gentle dip, actually 30°, which means that lowering the water table by one foot uncovers 2 ft. of lode. These deposits have been worked extensively over the last 20 years, but prior to the introduction of the present scheme work had been confined to those parts accessible from adits, practically no work having been done below water level. Observation in various parts of the workings had shown the water table to rise

simultaneously in all lodes, a condition favourable for a central drainage scheme. The pump finally employed was of the mechanical transmission type, with vertical shafting, and this was installed in a bore-hole drilled 55 cm. in diameter at the top, with a casing leaving a clear 50 cm. from top to bottom. The hole was put down 131·4 metres from an old shaft and the cost of the total installation was £3,500. The water pumped is brackish, but over a period of two years the pump gave successful results and has since been replaced by a permanent installation of a similar character, which was described by Mr. Rundall, who opened the discussion, being followed by Messrs. Morgans, Chaplin, and De La Mare. The author, in introducing his paper, was able to show some slides of a modern submersible pump.

Placer Gold in British Columbia

With this and other countries forsaking the gold standard, there has been some speculation as to the future of the metal. General opinion seems to be agreed, however, that gold remains the most favourable medium for international exchange purposes and there appears to be no reason why the search for it should not continue—it is, indeed, being actively prosecuted, especially in the direction of the re-examination of old placer territories. The application of expert geological knowledge to the interpretation of the physiographical history of mineral-bearing regions was commented on in these columns last month, when attention was drawn to Professor Niggli's observation before the British Association that the extent and importance of sedimentary deposits could only be fully estimated by attempts to reconstruct the land and water distribution and the climatic factors which obtained at the time of their formation. At this juncture, therefore, it is possible to extend additional welcome to the recent bulletin of the Department of Mines of British Columbia, to which our Vancouver correspondent makes extended reference elsewhere in this issue, and to congratulate those collaborating in its preparation on the issue of an exceedingly useful document. This bulletin contains, in addition to the most recent reports of resident engineers on placer activities in their respective districts, a special report by the provincial mineralogist on the Rainbow Creek discoveries, in the Omineca Division, and a review of placer possibilities in the lands of the Pacific Great Eastern Railway, by Dr. R. A. Brock, who was appointed in 1929 to head the commission investigating the mineral resources of these reserved areas, in connexion with the general survey of resources, under the joint auspices of the Canadian Pacific and Canadian National Railways and the Provincial Government.

Turning to the bulletin itself, opportunities in the Atlin division are considered by Dr. J. T. Mandy, who says that, with the increased interest in prospecting and the sounder mining and exploration methods which are being introduced, the Atlin section promises a substantially increased placer-gold production. He points out that the operations of the "old-timers" were necessarily confined to the shallow and rich creek ground which was amenable to the crude mining methods then available and under the conditions then prevailing and which were easiest of access. Activity in recent years has covered drifting and hydraulicking operations in the bench and deeper grounds in known areas, together with the retreatment of old tailing, but no serious consideration has yet been given to likely new sections and the latent possibilities in ground already worked. In the Stikine and Liard divisions also there is virgin ground awaiting investigation, as, for example, the lava-buried gravels occurring along the banks of the Stikine River, in the region around Telegraph Creek, while some of the depression and trough areas on the east side of Dease Lake do not appear to have been examined. Dr. Brock's report covers much of the Cariboo division, where in the East block he considers that known or probable channels should contain much valuable gravel, although the ground requires intensive geological study, followed by geophysical testing to determine old channels, a task which he feels might well be undertaken by the Geological Survey and the Provincial Department of Mines. In the West Cariboo and West Lillooet blocks he reminds us that it was the gold-bearing bars and benches of the Fraser River which lured the early miners to the Cariboo, $1,700,000 being recovered during the years 1857 to 1859. Dr. Brock expresses the view that research work on the recovery of fine gold might well be of considerable importance, as the amount of such metal is very large in these areas. The report of Mr. P. B. Freeland on the Similkameen tells a similar story, as many old channels in this district which are overlain by glacial débris have never been thoroughly tested.

Finally, in a special report on the Rainbow Creek area, Nation River section, the provincial mineralogist, Mr. J. D. Galloway, expresses the belief . . . that there is an opportunity for the consolidation of leases along Rainbow Creek and the testing of the gravels by Keystone drilling.

All the work outlined in the bulletin emphasizes the improved conditions which exist for placer mining at the present day, bearing in mind the reduction of costs brought about by the building of railways and good motor roads. These improved transport facilities permit of the introduction of heavy modern machinery to the areas and the rapid import of necessities. In addition, the importance of methodical and sound methods of exploration are stressed in all the reports and, in the Atlin division at least, it is suggested that the co-operative introduction of drainage tunnel systems would make possible the mining of deep ground not otherwise workable. The moral seems to be, as Dr. Brock says, that "what was impossible to undertake in the old days may today be feasible and profitable"—if, of course, the gold is still wanted, as we hope and believe it is.

Fog and Fume

One of the main difficulties which have had to be faced by those in control of smelting operations is that created by the harmful effects of certain chimney effluents. The same is true, perhaps, with regard to the power station operator, although his troubles are probably not so serious. Nevertheless, the efficacious treatment of smelter fume will always be of importance and from time to time in the past attention has been directed in these columns to this and similar problems either in connexion with the erection of a new power house or the litigation, usually instigated by the agricultural community, against certain offenders. The matter again becomes a topical one in virtue of the findings of a committee appointed to inquire into the causes of the unhappy deaths which occurred in Belgium, in the valley of the Meuse, nearly a year ago.

It will be recalled that loss of life occurred over a comparatively wide area of the industrial outskirts of Liége during a period when a dense fog persisted in the valley for several days. All sorts of theories, many of them fantastic, were advanced to explain this rapid increase in mortality, although thinking people who were conversant with the nature of the industries in those parts had already made up their minds as to the probable cause. The commission of experts appointed to conduct the judicial inquiry into this matter and which for nearly a year has been examining the evidence has now issued a report which substantially confirms the opinions previously held. The death of 60 persons in the district of Engis is attributed to the presence of sulphurous acid gas in the fog. The gas was emitted from factory chimneys and owing to the low temperature and the absence of wind it had been converted into sulphuric acid. In this district, where most of the fatalities occurred, are collieries, iron and steel works, lead and zinc foundries, and many process industries, so that the charge of atmospheric pollution has not been laid against any particular industry, but is of a wider nature. The problem resolves itself, in fact, into preventing the emission of any sulphur-bearing gas from any chimney. In this particular case the works are in future to be equipped in such a manner that such emissions will be impossible, while, since the static air conditions associated with fog are the prime cause of the concentration of deleterious fumes, special precautions are to be taken to slow down work altogether when fog is prevalent. It is probable, however, that if steps are taken to prevent the evasion of the clause compelling the installation of modern apparatus for the recovery of noxious gases the second drastic step might not really be necessary. Legislation of this character only serves to emphasize the importance of the adequate control of furnace effluents, since it may mean under certain conditions discontinuity of operation for the metallurgist or process engineer in charge.

When this problem was dealt with on a previous occasion attention was directed to a number of remedies or means of cleaning flue gases in order to render them not only innocuous to human life but also to vegetation. The difficulty is by no means insuperable and has, indeed, been virtually overcome in many instances. It is doubtful whether the most modern practice can be proof against a combination of unusual circumstances, such as might arise during a dense fog in valleys densely populated and in which there are numerous smoke stacks. It is obvious, however, that there is ample scope for research in order to discover more efficient methods of cleaning chimney effluents, if health authorities are to be satisfied and the farmers' crops preserved from insidious attack. Indeed, it is self-preservation against the smoke farmer.

REVIEW OF MINING

Introduction.—As was expected, the appeal to the country gave the National Government the mandate it desired, although the size of its majority must have exceeded the hopes of even its most sanguine supporter. With political instability ruled out from the factors disturbing trade conditions in this country, there is a corresponding amount of additional confidence, but it seems to be recognized that the road back to prosperous conditions will not be a short one. Metal prices show an improvement, but it is reported that no agreement has been reached as to the regulation of copper production.

Transvaal.—The output of gold on the Rand for October was 900,353 oz. and in outside districts 44,760 oz., making a total of 945,113 oz., as compared with 916,024 oz. in September, constituting a new record. The number of natives employed on the gold mines at the end of the month totalled 208,987, as compared with 209,424 at the end of September.

The report of Glynn's Lydenburg, Ltd., for the year ended July 31 last shows a sound stoping position at the mines, the ore reserves at 316,330 tons, assaying 8·7 dwt. over 21·4 in., showing little change. The tonnage milled during the year was 74,500, yielding 26,301 oz. of gold, worth £111,529, the revenue from silver recovered increasing the total to £111,625. The working costs were £109,097 and the working profit £2,528. Although the revenue per ton milled at 30s. shows an increase of 1s. 11d. per ton, working costs have risen by 3s. 2d. to 29s. 4d., this being mainly due to reorganization underground and to the decline in the production of easily worked oxidized ore.

The report of Daggafontein Mines, Ltd., for the three months ended September 30 shows that the Rand Selection Corporation has exercised its right in respect of 8,801 of the 55,000 shares under option at 45s. per share. During the period No. 3 shaft was sunk 417 ft., carrying it down to 4,044 ft., the reef having been intersected at 3,878 ft. The main station has now been cut and the conveyor cross-cut started and it is expected that the shaft will be completed this month. The erection of the reduction plant is said to be proceeding steadily, every effort being made to commence production early in 1932.

During the three months to September 30 improvements have been made in the position of the mines of the Johannesburg Consolidated group. On the New State Areas the payable percentage of reef sampled rose from 36½ to 43 and the inch-dwt. to 516 from 450. At the Government Areas the pay percentage was better at 64, while the values at the Van Ryn Deep had increased to 302 inch-dwt.

The accounts of the Ferreira Estate for the year ended July 31 last show that after the repayment of 4s. per share made in January, when the capital was reduced from £192,765 to £154,212, the cash assets of the company are estimated at £47,667. The expenditure still to be incurred in connexion with the establishment of Selby Township is estimated at £35,000.

The report of the Transvaal Exploring Land and Minerals for the year ended June 30 shows that no sales of farm land have been made during the period. Work on the Kobolando prospect in Swaziland was continued during the year, but values proving too erratic it has been decided to try to lease the area on tribute, the prospecting expenses being written off.

The work of the Rooiberg Minerals Development Company during the year ended June 30 shows a loss of £5,891 and other expenditure totalled £5,569, reducing the available balance to £3,150. After the suspension of mining and milling operations in May last it was hoped that the new alluvial plant would produce sufficient revenue to maintain everything in good order and, although it was feared at one time that this might be impossible, recent results have shown considerable improvement and the alluvial plant is still running.

The output of coal from Witbank Colliery for the year ended August 31 was 760,670 tons, a decrease of 73,028 tons when compared with the previous twelvemonth, although decreases in working costs were such that the profit improved by £2,283 to £53,957. Approximately 75% of the output is now drawn from the southern section, development on both sections continuing to be satisfactory. Dividends paid during the year amounted to £34,455, equal to 10%.

The uncertainties of the general business situation have forced the Union Corporation to postpone the payment of a dividend until the end of the year, although it is stated that profits would permit of an interim distribution. The corporation has acquired an important interest in Grootvlei Proprietary Mines and accepted two seats on the board of that company, which has

now been granted a mining lease covering 2,553 claims. Prospecting of the property will, in the first instance, be carried out from the workings of the East Geduld mines. At a meeting of the Grootvlei company to be held at Johannesburg next month it will be proposed that the directors be given power to increase the capital to £2,500,000.

Diamonds. — Conferences of representatives of the diamond industry were held in Brussels last month to consider means of improving the present situation. It was confirmed that the Diamond Corporation will in future sell diamonds on a gold basis.

Southern Rhodesia.—The decision of the two Rhodesias to follow the example of this country in leaving the gold standard is bound to affect favourably the mining industry in those colonies. The output of gold from Southern Rhodesia during September was 42,846 oz., as compared with 43,292 oz. for the previous month and 46,151 oz. in September, 1930. Other outputs for September were : Silver, 6,423 oz. ; coal, 51,280 tons ; chrome ore, 6,854 tons ; asbestos, 1,283 tons ; mica, 2 tons.

The report of the Cam and Motor Gold Mining Company for the year ended June 30 last shows that the ore reserves have been well maintained at 878,000 tons, although the value has dropped from 50·8s. to 48·1s. per ton. The ore milled during the period was 292,000 tons, the total revenue being £540,219 and the gross working profit £218,612. Dividends paid during the year absorbed £131,250, equal to 17·5%, and, after making allowances for depreciation, reserve, and other items, there remained a sum of £4,461 to be carried forward.

During the year to June 30 last 182,651 tons of ore was crushed at the Wanderer mine, producing 45,283 oz. of gold, worth £191,113. Working costs amounted to £127,480 and the working profit to £63,633. Available ore reserves at the end of the year were estimated to be 225,000 tons, while a further 275,000 tons are considered to be indicated. Stoping has now been started at the Ashton mine on a small scale, the two mines being connected at the end of July.

The accounts of the Gold Fields Rhodesian Development Company for the year ended May 31 last show a profit of £7,181, which, added to the balance of £71,784 brought in, gives an available total of £78,965. After making various small allowances, the sum of £150,187 has been written off investments and loans, leaving a debit balance of £72,833 to be carried forward. The loss has been caused primarily by the closing down of the Mayfair mine.

Northern Rhodesia.—Shareholders of Roan Antelope Copper Mines were informed last month that the smelter had been successfully blown in, the first rail consignment of blister copper being loaded on October 22.

Nigeria.—The report of Naraguta Durumi Areas for the year ended March 31 last shows a loss of £2,423, although Nigerian expenses had been reduced to £71 9s. 7d. per ton, the fall in revenue amounting to £41 3s. 4d. per ton. The output for the year was 136¼ tons, as compared with 181¾ tons during the previous 14 months.

During the year ended March 31 last the accounts of the Yarde Kerri Group Tin Mines show a net loss of £70, increasing the debit balance brought in to £794. The output was 149 tons of concentrates, which realized £84 per ton, against £131 the previous year. Although reduced expenses enabled the mine to show a working profit this was insufficient to meet debenture interest. The tonnage of tin proved at the end of the year is given as 1,354.

Australia.—A circular to shareholders of the Wiluna Gold Corporation issued last month shows that 25,292 tons of ore was treated during September, the bullion yield being £32,487, or £41,988 including the exchange premium. The estimated working surplus for the month was £10,454.

Burma.—During the year to June 30 last the work of the Consolidated Tin Mines of Burma resulted in a loss of £15,737, there being a debit balance of £17,061 to carry forward. The output was 1,556 tons of concentrates, as compared with 1,366 tons in the previous year, but the price realized per ton fell from £103 to £64, while working costs fell from £100 to £75 per ton. Certain parts of the plant have been allowed to remain idle, but all is stated to be in a condition to resume work when required.

Malaya.—The report of Ayer Hitam Tin Dredging for the year ended June 30 shows the work of the dredge to have been suspended for two months in 1930, while since March 1 last the output has been restricted under the international quota scheme. The profit for the year was £28,942, from which dividends amounting to £13,500 have been paid. After writing £9,767 off property account there remains a balance of £5,960 to be carried forward. The output for the year was 970 tons of concentrates, which realized £73,330, working costs being £28,305.

During the year ended September 30, 1930, the output of Temengor Tin was 111 tons of concentrates, the year's operations being conducted at a loss of £12,725. Accompanying the report is a letter from Messrs. Osborne and Chappel in which they state that the sampling of the dumps does not in their opinion justify the erection of a mill. A letter from Mr. Frank Nicholls expresses an opposite opinion from that given in the original report of Messrs. Osborne and Chappel mentioned in the MAGAZINE in August, 1930, and states that recent operations have shown that the mine could be worked at a profit with tin metal at a price considerably below the figure of £260 mentioned at that time. At an extraordinary meeting held following the annual meeting last month, when it was proposed that the company should go into voluntary liquidation, shareholders negatived the resolution, and the board has tendered its resignation.

Kampar Malaya Tin Dredging for the year ended April 30 last made a net profit of £22,741. A dividend of 3¾% absorbed £6,761 and after placing £10,000 to reserve there was a balance of £4,353 to be carried forward. Ground dredged during the year was 32 acres, the yardage treated being 2,047,000 and the concentrates recovered 715 tons. The reduction of working costs from 3·78d. per cu. yd. to 2·83d. forms a satisfactory feature of the report.

The report of Temoh Tin Dredging for the year to June 30 last shows a net profit of £4,656, which, added to the amount brought in, gave an available total of £13,164. From this £3,937 has been distributed as dividend, equal to 9d. per share, the balance of £9,227 being carried forward. The dredge treated 669,950 cu. yd. in the 7½ months of running time, yielding 353 tons of concentrates. It was closed down at the end of the period under review, the directors considering it inadvisable to resume working under the present restriction scheme.

The accounts of Kinta Kellas Tin Dredging for the year ended March 31 show a profit of £7,683, increasing the amount brought in to £13,206. A dividend of 3¾% absorbed £3,937, while £8,626 was appropriated for depreciation, leaving £643 to be carried forward. Treating 1,525,100 cu. yd. of ground during the year, the company produced 440 tons of concentrates, equal to 0·646 lb. per cu. yd.

In May last attention was directed in the MAGAZINE to the claim of Pahang Consolidated for exemption from the tin restriction scheme, or, alternatively, for compensation from the State of Pahang. These claims have now been rejected in the local court. The company announces the passing of its final dividend on the ordinary shares.

Korea.—Shareholders of the Chosen Corporation have been informed that underground developments in No. 14 level east of the Great Nurupi mine continue to show improvement. Beyond the fault on this level an ore-body is being developed which shows an average grade of 5·5 dwt. over a width of 180 in.

Mexico.—It has been announced that an agreement has been made with the Mexican Federal Labour Department whereby the San Francisco Mines of Mexico will suspend production at the end of December. Arrangements are being made to maintain the mine and mill in good order.

Spain.—Shareholders of San Finx Tin Mines have been informed that efforts to raise further capital have been unsuccessful. It has, therefore, been decided to issue £10,000 of 10% debenture stock, which will also receive one-half of the net profits and will be repayable on December 31, 1941. Operations at the mine have been confined since April last to a one-shift programme.

Yugoslavia.—An initial payment of 5%, equal to 3d. per share, has been made by Trepca Mines. The report for the three months ended September 30 shows that 72,204 tons of ore was treated, the recovery being 10,503 tons of lead concentrates and 10,088 tons of zinc concentrates. The recovery of lead was estimated at 96·37% and of zinc at 85·49%. The surplus over working expenditure was £45,540.

Platinum.—Elsewhere in this issue we record the formation of a company which will regulate the supply and sale of platinum. It is hoped that this company, through its understanding of market conditions and its efforts to promote the use of the metal, will be able to effect stability within the industry.

Tin.—The total visible supplies of tin at the end of October were estimated at 57,777 tons, as compared with 56,528 tons at the end of the previous month. A communiqué issued by the International Committee last month showed the holdings of the Tin Pool to amount to 12,250 tons, all of this appearing in "visible supplies." It has been announced this month that the Government of Malaya intends to purchase 3,500 tons of tin, the excess production of that country to the end of September.

THE LUPA RIVER GOLDFIELD

By D. R. GRANTHAM, Ph.D., A.R.S.M., A.I.M.M.

In this article, which is a precis of a bulletin to be published by the Tanganyika Geological Survey Department, the author describes the geology of this goldfield in south-west Tanganyika Territory.

INTRODUCTION.—The Lupa River goldfield lies some 80 miles to the north-west of the head of Lake Nyasa, the river being tributary to Lake Rukwa, and not far from Mbeya, an administrative centre, with an aerodrome and wireless station on the England to Cape-town route. As at present known, the field is about 40 miles long, in a north-westerly direction, and 20 miles wide. It lies in an almost uninhabited area, although there is native population on every side, and labour for the field is drawn from the surrounding country, some from near by, some from a distance. Of the rivers only the Sira is permanent, the others being seasonal, although the Lupa and the Luika contain water in pools throughout the year. There are also many permanent water-holes.

Usually there are from 50 to 200 diggers on the field, the number varying with the season and the current rumours as to the richness of the strikes. A hard worker makes a good living; others who are not make enough to live on. All the alluvial gold so far found has been very patchy, the rivers being rocky and with no large alluvial flats along them. Sufficient volume of ground has not been found for company workings except along the lower Sira, although gravels or old river banks form attractive claims for single workers or small syndicates. The output for 1930 was £32,721.

So far no reefs have been mined, but very extensive trenching has been done on some (e.g. in the Saza area, trenches every 25 feet for over a mile) and a few prospecting shafts have been put down. It appears that some of the reefs will repay mining and it is hoped that the near future may see some activity in that direction.

The area was first examined by the Geological Survey Department in 1927 and a short paper was published the following year. Some preliminary observations were made in the MAGAZINE[1] in 1928. Further work was done in 1929 and 1930, and a bulletin is now in the press, topographical and geological maps being available on the 1 : 50,000 scale.

HISTORY OF THE AREA AND THE DISTRIBUTION OF THE GOLD.—In 1922 three traders at Ruiwa were not doing well and one of them, William Cummins, wandered off to look for gold on the Lupa, having heard that a German, Von Art, had reported gold from the Songwe River. At Manandengi's, having gone to the river to shoot a buffalo that had been worrying native women drawing water, he panned some sand in a dixie lid and found a yellow metallic grain. After satisfying himself that it was malleable by bending it with the rim of a cartridge, he decided that he must have found gold at last. Next day he started downstream and later found "fine" gold in fair amount in the river at "Golden Bend" just below the present Lupa market. Next year saw about eight diggers working there, practically without tools of any kind. The first working outfit was brought to the river by Esterman in 1924. "Rice" gold was found opposite the market and heavier gold higher up. By the end of 1924 workings had spread to the Sira River and thence to the Ngwaziba, and H. G. Jones had found the Kasanga. In 1925 the Lupa was supposed to be "worked out" and diggers explored the smaller streams. Gold was found in the Mawoga River in 1926, but was not worked there extensively till two years later. In 1926 Jones found the area round Itewe where, in the next two years, thousands of ounces of gold were taken from a few tiny streams, only one or two feet wide, and within a few hundred yards of their source. In the wet season 1929–30 a similar area, not so phenomenally rich but more consistent, was found on the headwaters of the Itete River. The record nuggets, as far as the writer is aware, were found one in 1927 near the old Kasanga police camp, weighing 125 oz. gold-quartz, which yielded 75 oz. of gold, and the other in 1930, near the top of the Ipogolo River, weighing 92 oz.

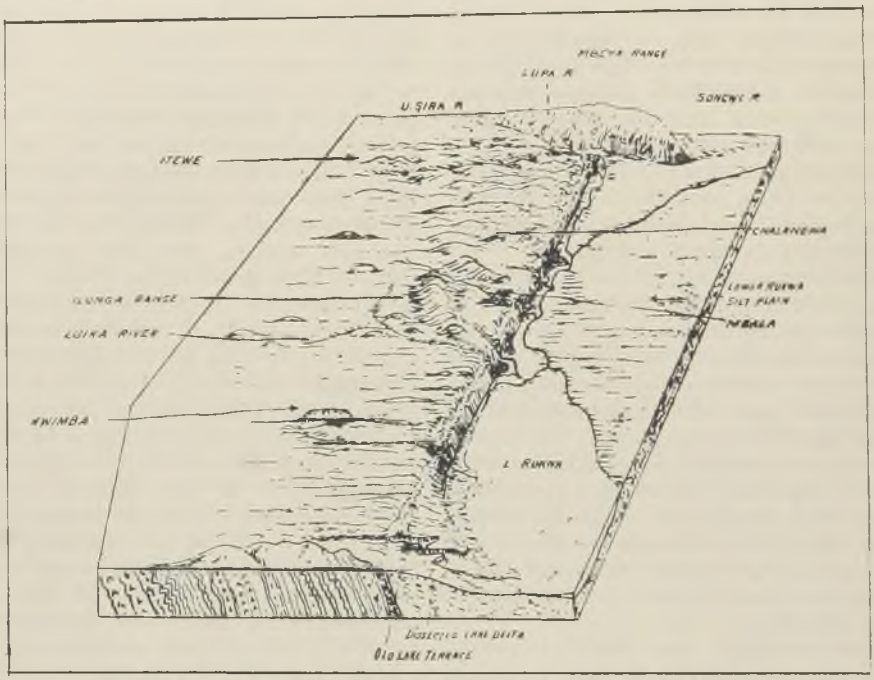
Up to the end of 1930 gold had been found in nearly every stream of the area, although in many the quantity is negligible. In fact so wide is the distribution that it is remarkable how the area was missed for so long; almost every pan, taken from a favourable spot, producing at least a "colour." The Sira has yielded good values over much of its length, as have also parts of its tributaries. The Lupa itself has seldom produced anything spectacular, although there is perhaps

[1] Tanganyika Territory, its Geology and Mineral Resources, E. O. Teale, THE MINING MAGAZINE, Aug., 1928.

hardly a quarter of a mile of it, from a little above the falls to the highest camp, nearly twenty miles in all, that has not furnished a good living for a hard worker (or would not have done so before it was picked over), and there still remain many places which will yield good profits, but require one or two months' hard work spent on the removal of overburden. Practically all the tributaries on the east have yielded heavy gold locally, and some have produced considerable amounts; from the tributaries on the west far less has been won.

angular pieces up to half-ounce (one 17 dwt.) was being scraped up and separated by dry blowing.

Topography and Tectonics.—The Lupa goldfield and its surroundings may be divided into three strikingly distinct areas: First, the vast peneplain to the north and west, dotted with island-like hills or mountains (inselbergs), among which the upper Lupa gently flows to the top edge of the second area, the belt of broken, exceedingly rough, complex, deeply dissected country through which the river leaps and roars over cataracts



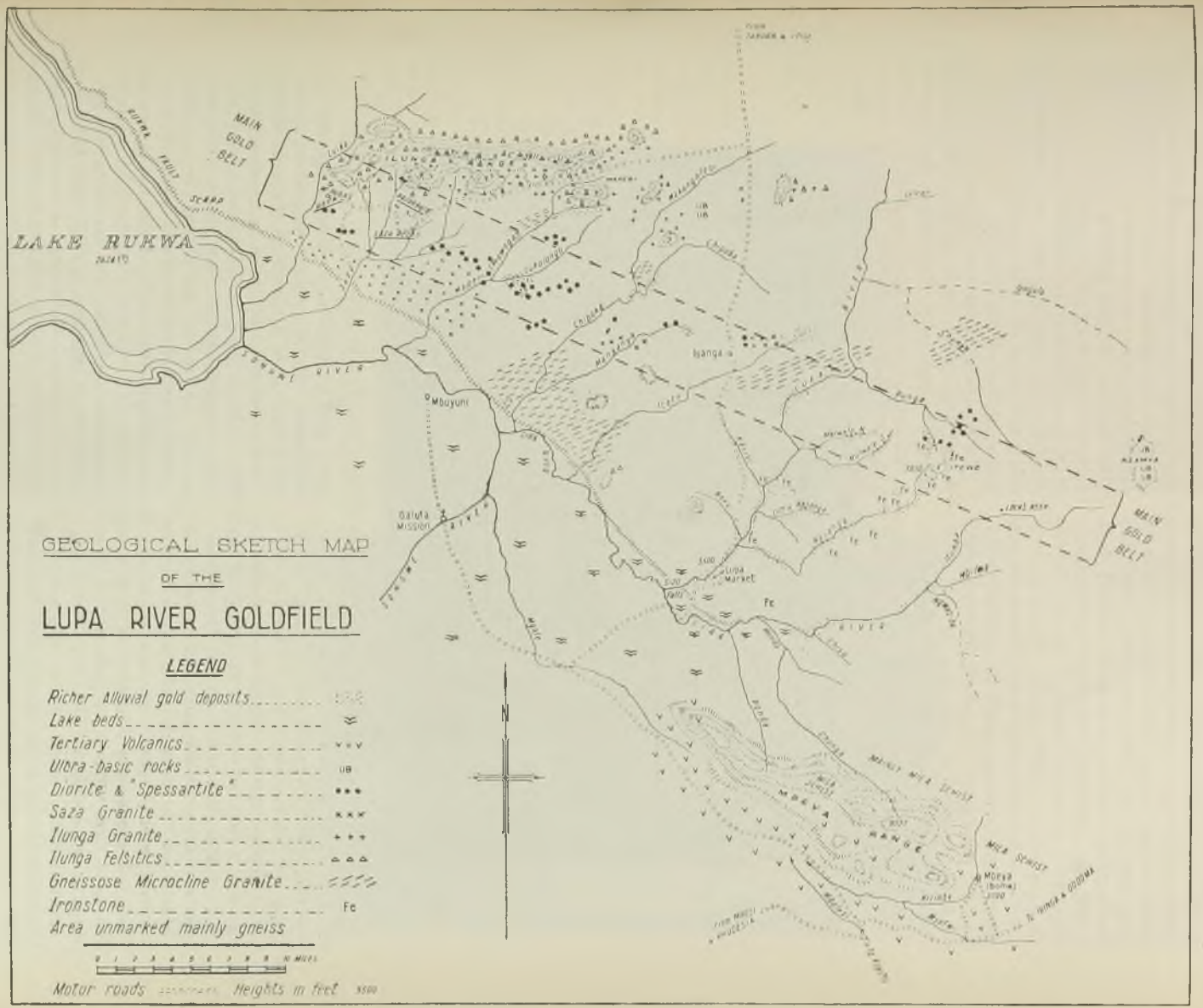
Block Diagram of Rukwa Trough and Fault Scarp.

The Manyanya River has yielded little except from its most easterly tributaries. The Chipoka River has been worked at intervals along its course, but the best areas were a little above and below its confluence with the Makongolosi, which was also good for two miles above this point. Gold has been found at intervals along the Mawoga; special reference must be made to the rich area all around the "spessartite" hill, and to its sources under the south side of Maperi Hill where it is eating into the old "mbuga" level.

Finally one small area, near the Luika path, 2½ miles west of the Mawoga, calls for mention, as there, in 1930, on the banks of a very tiny stream, actually at grass roots and lying on solid epidotized gneiss, gold in

finally plunging over falls on to the third area, the silted ancient bed of the once extensive Rukwa Lake, where, joined by the Sira and later the Songwe, it meanders on till it is lost in the brackish waters of the present diminished Rukwa.

This last area is separated from the middle one by the lowest visible step of the faults producing the Rukwa branch of the western great rift valley. This fault is seen as a nearly straight rock wall, 200 ft. or more in height, rising sheer from the old lake bed, over which every river makes a waterfall. It is the most remarkable feature, at once topographic and tectonic, of the region, and one of the most important in Africa. It differs from most of the rift walls in that the actual fault face is visible, almost


LAKE RUKWA
MAIN GOLD BELT
RUKWA FAULT SCARP
SONGWE RIVER
Mbuyuni
Galula Mission
Lupa Market
MAIN GOLD BELT
MBEYA RANGE
MBEYA SCHIST
GEOLOGICAL SKETCH MAP
OF THE
LUPA RIVER GOLDFIELD
LEGEND
Richer Alluvial gold deposits
Lake beds
Tertiary Volcanics
Ultra-basic rocks
Diorite & "Spessartite"
Saza Granite
Ilunga Granite
Ilunga Felsitics
Gneissose Microcline Granite
Ironstone
Area unmarked mainly gneiss
Motor roads
Heights in feet

continuously in parts and frequently elsewhere, for a hundred miles. This is due to its preservation from erosion under the waters of the ancient deep Lake Rukwa. For miles at a time the fault wall is perfectly straight ; its direction varying from 118° to 146° (true bearings), neglecting those short stretches where the scarp is abruptly bent. It dips to the south-west at 60° to 45°.

Although outside the scope of the present paper a fourth topographic division must perforce be mentioned, as no description could be complete without reference to that most magnificent feature flanking the goldfield to the south and south-east, the Mbeya range, towering alike above rift and plateau. In the centre its plateau-top is surmounted by still loftier peaks ; to the north-west its knife-edge nose pokes far out into the trough of the rift. Its structure is still an unsolved riddle.

Returning to the three main topographic divisions of the goldfield, this paper is concerned almost entirely with the middle one, because the known gold belt lies mainly in this zone and because only here are there plentiful exposures. The key words are "rejuvenation" and "tectonic control." The area abounds in examples which are alike the joy of the geomorphologist and the despair of the topographer. Almost every valley follows a line of strike or of shear or a fault, even the smallest tributaries, a fact which is strangely invisible in the field, only detailed mapping revealing it. The complexity of the topography and the depth of the rejuvenation dissection gradually diminishes from south-east to north-west. The Sira is incised 1,000 ft., whereas the Luika shows no incision except the usual short post-Pleistocene rejuvenation due to the desiccation of Lake Rukwa. The cause of this differential erosion appears to lie in a tilting of the ancient plateau.

Evidences of an ancient high level of Lake Rukwa are to be found in the terrace and numerous flats along the top edge of the scarp and in lake beds piled up against the fault face, mainly around the present rivers, which have now cut through their old deltas. The highest of these beds is approximately 600 ft. above the present surface of the lake.

The Lupa Falls : View of the Rukwa Rift Valley Fault Face.

The fact that the Sira River runs close against the foot of the scarp, except where pushed away from it by the banks of sediment dropped by each of the old rivers on meeting the still water of the lake when at its highest level, indicates one of two things : Either, that the floor of the lake has been tilted in towards the scarp, or, that the floor of the rift is tilted so that the lake beds are thicker on the one side and have therefore on consolidation sunk differentially. The rejuvenation of the rivers due to the final desiccation of Lake Rukwa, presumably

post-Pleistocene in age, has been remarkably slight. The bases of the Lupa and Sira show nothing definite, as there had been very considerable erosion there previously. All the other rivers show a very steep notch that does not extend more than a mile up their courses from the usual waterfall. In several cases the waterfalls are in part converted into narrow precipitous gorges by the more rapid differential erosion of a dolerite dyke.

GEOLOGY.—(*a*) *General Summary.*—To unravel completely the tangled skein of Lupa geology, from the unknown primeval, through cycles of deposition, intrusion and extrusion, metamorphism, and tectonic disturbances, infinite patience and almost unlimited time would be required. By three seasons' work a few salient features of the sequence of events have been extracted and may be summarized in the following stages :

1. Earliest stages unknown.
2. Igneous rocks, mainly dioritic, now represented by granulites, usually pyroxene bearing, often with hypersthene. Associated with these are the banded ironstones. Trend, perhaps, N.E.
3. Intrusions of dolerite and outflows of basalt.
4. Foliation and *lit-par-lit* intrusion of the main granitic gneiss. Trend E.S.E.
5. Shearing, S.E.
6. Probable intrusion of some of the older dolerites.
7. Extrusion of the Malwelo rhyolitic and trachytic series, intrusion of their hypabyssal associates, and perhaps the extrusion of basic lavas and ashes now represented by chlorite schist. Carbonation of all of these and other rocks then at surface.
8. Either as a facies of the above, or later, the Ilunga felsitic series. Trend E.S.E.
9. Intrusion and foliation of the gneissose microcline granite. Trend N.E.
10. Intrusion of the older dolerites.
11. Intrusion of the Ilunga granite into a steep anticline of the Ilunga felsitics and elsewhere. Trend E.
12. Intrusion of the Saza granite with its peripheral diorites and "spessartites." Trend S.E.
13. Intrusion of the younger dolerites including (13a) Quartz-dolerites. Trend S. and S.E.
14. Intrusion of olivine-dolerites. Trend (chiefly) N.E. and S.E.
15. Long stage of peneplanation.
16. Rift valley tectonic disturbances with extrusion of the Tertiary alkaline lavas and deposition of the lake beds.

Evidence required for assigning ages to the various stages is almost entirely lacking. Nos. 1–9 are probably pre-Cambrian. Somewhere between Nos. 9 and 14, probably between 12 and 13a comes a period of erosion and deposition starting with the Kwimba conglomerate (which is chiefly composed of pebbles of metamorphosed Ilunga felsitics) and continuing up through the Mwendo sandstones which form high hills and cover an extensive area to the north of the goldfield. These are very probably Waterberg in age.

KWIMBA : 1,000 FT. FACE OF CONGLOMERATE, PROBABLY OF WATERBERG AGE.

No. 13a may be Karoo ; 16 is Tertiary and recent.

The compressions may be summarized as having produced first a N.E. strike (poorly preserved), then the most prevalent E.S.E. foliation, followed by the S.E. sheer, then by a strong N.E. foliation, followed by a milder one E.S.E. or S.E.

(*b*) *Notes on Individual Formations.*—(1) *Granulites and Associated Rocks.*—Scattered irregularly throughout the area are outcrops of granulitic rocks of medium grain, frequently of speckled, dark green and white, dioritic aspect, usually well foliated. In the field they appear to contain mainly hornblende but, although this is usually

present, the predominent ferro-magnesian mineral is (or was) pyroxene. Other specimens, brown or grey in colour, sometimes exhibiting bronzitic schiller in some grains, are hypersthene-bearing, ranging to hypersthenites. Associated with the granulites are found picrites and peridotes, now almost completely changed to serpentine and talc. These may be hard dark rocks showing bastite and only soapy after bruising, or may be pale grey, soft rocks passing into talc schist. No large areas of these have been found.

The tendency of the granulites to be found on the tops of the highest hills is noticeable. Some are phenomenally tough. These rocks must have been of considerable extent originally, not only because of their wide distribution, but because of the considerable portion incorporated in the mixed gneisses, in particular around the lower Lupa.

(2) *Ironstones.*—Under this convenient term come a series of rocks of unusual character, which should properly be called quartz-magnetite-, or quartz-magnetite-amphibole-schists, granulites, or gneisses according to structure. They tend to merge by variation in the relative amounts of the different constituents into quartzite, magnetite rock, or pyroxene granulite, but always retain a characteristic appearance. Formerly imagined to be of sedimentary origin, by analogy with banded ironstones, itabirites, etc., they are similar in general appearance to the banded ironstones of Rhodesia, which are considered to be of sedimentary origin, but they differ in various ways. An open mind must be preserved at present as to the origin of these Lupa ironstones. Their field occurrence is erratic in the extreme, small patches of rubble being the most common, while thick beds, forming hundreds of feet of a hill, are capped by small areas of granulite or mixed granulite and gneiss. This latter type is well seen in many of the higher hills near the lower Lupa. There is a remarkably constant association of small amounts of pale grey talc rocks with the ironstones. The ironstones may be a hydrothermally altered form of granulite. On the other hand, they may be granulitized sediments that were associated with the igneous rocks now represented by the granulites. This question is all the more important as ironstones, itabirites, etc., from West Africa, Brazil, and Rhodesia are auriferous.

(3) *Basic Gneiss.*—This was largely doleritic in origin, perhaps in part basaltic. No large body of this rock has been found unmixed with later intrusions, but large amounts are incorporated in the composite gneiss, especially in the Mawoga–Luika area.

(4) *Granitic Gneiss.*—Excluding the outcrops of the three later granites, the granitic gneiss covers more than three-quarters of the remaining area. Whether it may be considered a single type, or, if not, what are the characteristics of its components, has not been determined; it cannot have been intruded as a mass for it is typically a *lit-par-lit* injection and incorporation of the basic gneiss, the granulites and whatever else may have been there. Foliation (excluding shearing) was probably more of an injection-incorporation effect than of a later impressed characteristic. Few areas are even relatively free from contamination. When clean the granitic gneiss is a white rock of medium, granular, uniform grain, showing very pronounced foliation, and appearing to be a very acid type.

(5) *Malwelo Rhyolitic and Trachytic Series, and the Carbonate Rocks.*—For convenience various rocks found in small, widely-scattered exposures have been grouped together. The main types include: Rhyolitic rocks, very pale grey or white in colour, stony to finely granular in texture, with occasional small idiomorphic quartz and felspar; trachyitic rocks, some with good flow structure and phenocrysts; microsyenites and quartz-porphyries. Very many of these, clearly volcanic or hypabyssal in origin, contain carbonates, usually siderite. Others, clearly basic volcanic or dyke rocks, are a mass of carbonate and chlorite, and their weathering to a soft mass of limonite suggests original siderite. Some of these rocks bear a strong resemblance to some in the Gold Coast associated with manganese deposits.

(6) *Ilunga Felsitic Series.*—In the centre of the Ilunga range occur rocks not too highly altered to be recognized as rhyolitic lava flows, felsitic rocks, and coarse felspathic ashes. The prevailing colour is pink, although some of the lavas are grey or pinkish grey. Most of this series are altered almost beyond recognition; many are gneissose.

(7) *Gneissose Microcline Granite.*—This is a handsome rock varying from foliated porphyritic granite to augen gneiss. The microcline phenocrysts are pink in colour, often with a grey core and are set in a coarse matrix of milky quartz, greenish-white felspar, and dark green ferro-magnesian material. In

many cases the foliation can only be seen by examination of variously orientated faces in order to find the disposition of the tabular phenocrysts. In other cases the phenocrysts have become augen set in a fine-grained, streaky, pink and grey base. The rock is usually contaminated having a grano-dioritic aspect.

(8) *Ilunga Granite.*—This is a coarse rock, pink or greyish pink in colour, composed of equigranular perthitic microcline, quartz, and altered biotite. It appears as if this granite filled in the centre of a steep anticline of which the northern limb is relatively intact (the main Ilinga range) whereas only relics of the southern limb remain (the southern sides of the outlying hills).

(9) *Saza Granite.*—This is the youngest granite of the area. It is normally a coarse hornblende granite, but is conspicuously variable in grain and composition. In the centre of the area it is very coarse, pink and white, has less hornblende, but has biotite, and occasionally pink phenocrysts. Near the margins it is finer, white and green, and is packed with dark inclusions which must form an appreciable proportion of its total volume. It is not foliated (except where sheared near the edge of the scarp), but lines of inclusions and their elongations show a south-east trend. Under the microscope oligoclase is seen slightly more in amount than microcline, with chlorite after biotite, hornblende, and a little epidote, magnetite, and apatite; sphene is often conspicuous. The inclusions approximate in composition to quartz-oligoclase-hornblende-syenite and resemble marginal rocks which are presumed to be hybridized basic gneiss, presumably doleritic in origin.

(10) *Diorites and "Spessartites."*—These two rocks must be considered together, along with various hornblendic hybrids, for although the two types are in themselves quite distinct the gradation of one into the other is so complete that there is no dividing line. The diorites are medium-grained rocks, apparently fresh, with typical dioritic (two-colour) aspect. Some are paler with abundant felspar and occasionally a little visible quartz, while some are dark with abundant hornblende. Both types may have darker fine-grained inclusions. Under the microscope considerable variations in proportions of hornblende and felspar may be seen; the felspar is usually altered but where fresh enough for determination is oligoclase; quartz is invariably present; chlorite after biotite, brown sphene, pyrite and apatite are common minor constituents. It will be seen therefore that there is a very close similarity to the inclusions in the granite and its marginal hybrids.

The "Spessartite" is of striking appearance characterized by porphyritic dark green hornblende set in a pale greenish grey, medium- or fine-grained matrix. There is considerable variation in the size of the

Near Mawoga River: Grubbing for Gold at Grass Roots.

phenocrysts, though there is uniformity in any one specimen ; they range from 0·2 to 1·0 in. In thin section the matrix is seen to be composed of equidimensional idiomorphic aluminous diopside (often margined by, or having internal zones of, green hornblende) with some green hornblende, plagioclase and quartz, sometimes also microcline ; the last two minerals are the last to crystallize and ophitically surround or poikilitically enclose other minerals. Pyrite is a constant minor constituent.[1]

Particular attention must be called to the location and distribution of these rocks. The peripheral arrangement with regard to the Saza granite is most striking, as for nearly a quarter of the elipse made by its outcrop it is margined by them, either in direct contact or slightly removed into the country rock. Close by, a whole hill is composed of a mixture of the two. Elsewhere there are many dykes near the contact. Other occurrences are scattered between the main granite and those bodies presumed to be its offshoots.

An extensive area of diorite to the north of Itewe has not yet been mapped, although the specimens obtained from there appear identical with those from the Mawoga area. No hornblende granite has as yet been located there.

(11) *Schists and Mylonites.*—A few true schists may exist, but the majority of rocks previously considered schists are certainly mylonites, sheared members of the gneiss. One curious type of rock appears in hand specimen almost exactly like sheared sandstone with a fine-grained base. Bruised under the hammer it becomes soapy and it appears that this strange rock is an alteration of granitic gneiss, presumably by some form of mylonitization with hydrothermal action. This type builds small hills in the Saza area and elsewhere. It is of special interest as it is intruded upon by " spessartite," dolerite, and gold-quartz reefs.

(12) *Ultra-Basic Rocks.*—There are two large occurrences of these and some dykes. Their associations are not known ; they may or may not be related to the picrites found with the granulites. The Nsamya hills appear to be composed entirely of peridotite or picrite and allied rocks. A prevalent type is now mainly serpentine after medium-grained, granular, olivine with a fair amount of residual olivine cores, larger crystals of schillerized augite, some relics of felspar, rare grains of amphibole and green spinel. Apart from platinum and chromium, of which no trace has as yet been seen, there is the possibility of asbestos. The serpentinized peridotite is crossed by hydrothermal veins along which little stringers of asbestos are formed. These are chrysotile, but none have yet been found wider than a quarter of an inch, although search has been made and a few pits sunk by prospectors.

Another area which the writer has not yet examined lies to the east of Ilunga ; the only outcrops visited were of fresh troctolite and norite.

(13) *Dolerites.*—No attempt has yet been made to classify the very numerous highly altered, uralized or metamorphosed dolerites throughout the region. In one small area near the lower Chipoka 95 dolerite dykes have been mapped in an area of 45 squ. miles and at least double that number must exist. An attempt is being made to classify the relatively fresh varieties ; half a dozen types can be distinguished.

(14) *Other dyke rocks.*—(a) Hypersthene bearing : Some of these are hypersthene diorites, others are norites. The largest of these is a beautiful olivine-norite forming a dyke about one and a half miles long to the east of Punga. In the absence of any evidence it might be mentioned that this rock and those above noted of the second ultra-basic area are not dissimilar to rocks from the Great Dyke and the Bushveld. (b) Perknites : Near the Mawoga occur a number of dykes of coarsely-crystalline, dark, heavy rocks composed of hornblende, either green or brown, secondary amphibole, schillerized augite, talc, chlorite, apatite. (c) Minettes : several of these have been found in the area surrounding the geissose microcline granite.

(15) *Lake Beds.*—These have not been studied in detail. Some 600 ft. of them must be exposed between the Lupa and Lake Rukwa, though not much more than 200 ft. are exposed in any one face. At least another 600 ft. of them must lie under the present surface of Lake Rukwa. These beds are very pale in colour and fine in texture, some being loose and soft, some firm, and some hard enough to break under the hammer. Some of them are exceptionally light in weight.

[1] This rock falls in the class of lamprophyres, being a dyke rock (also small bosses) with predominant ferro-magnesian minerals, associated with a granite mass. Being composed of hornblende, pyroxene and plagioclase it falls in the category of "spessartite" though differing from the type rock. The name is retained in parenthesis in the absence of a better.

With only one exception all have been found to be diatomaceous, over a dozen forms having been recognized. The beds contain a very high proportion of volcanic ash and some, particularly bands very near the top of the series, are composed almost entirely of fine angular sheds of volcanic glass. Occasional pebble beds alternate with the fine layers.

Reef Gold Occurrences.—There is a fairly well defined belt in which most of the reefs and much of the richer alluvial gold has been found. This lies along, and to the north of, a W.N.W. line drawn from Lock's Reef to McHugh's Reef on the Luika. The reef occurrences are characterized by a system of quartz lenses "en echelon," though in some cases single lenses may be 1,000 ft. or more in length. In some, payable values run for several hundred feet and are followed by barren areas. When one lens "cuts out" it is usual that another "makes" a little to one side, but in the same fracture zone. There is every reason to believe that the state of affairs found on the surface will be repeated in depth. This view is based mainly on two facts: First, that the quartz reefs are not confined to any one level of the present surface, they are found on hills and in valleys differing in level by 1,500 ft. or more; secondly, that the present surface is but an accident of time and erosion; had man lived an age earlier or later he would have found a higher or lower surface. The probability, therefore, that the present accidental surface happens to be the only, or the richest, auriferous one, is remote.

The most prevalent type of reef is of quartz, white, blue, or ivory in colour, with sulphide mineralization, laminated structure being favourable. The quantity of pyrite is usually low, and of other sulphides (principally chalcopyrite and galena) still less, although a reef near the Nsamya hills, one near the Kasisi river, and one above Njila contain considerable amounts of them. One reef being opened up near the Chipoka River is a type of ironstone, being composed of magnetite, quartz and amphibole (? cummingtonite). Some parts of a long reef two miles north of Isanga are highly ferruginous and may represent an intermediate type. As weathering is shallow and most of the lodes are not heavily charged with sulphides or manganese it is not considered that secondary enrichment has played any important role.

Trench on Saza Reefs, showing Turnover and Rubble.

Notes on Individual Reefs.—No useful purpose will be served by descriptions of the very numerous reefs that have been pegged. The big majority are in granitic or basic gneiss, usually parts in each, with a tendency to increase in value in the basic rock. Many are definitely in shear lines or zones, the walls being mylonitized gneiss, of which the basic variety, probably partly leached by lode solutions, produces a rock having the appearance of a phyllite or an argillaceous schist. Where shearing has been less intense

a "greenstone schist" results, composed of chlorite, altered felspars, etc. The easterly striking reefs are generally considered to have better values.

Lock's reef, one of the earliest discoveries, is in an area of mixed rocks having partly an easterly or east-south-east foliation and partly a southerly shear-foliation. These rocks consist of granitic and aplitic gneisses with some basic gneiss and old dolerite. The reef strikes east-north-east and has a total exposed length (not necessarily

McHugh's Reef on the Luika River.

absolutely continuous) of 900 ft. Alongside and parallel to the lode is often a narrow band of highly sheared rock; in some trenches the country rock can be seen having the southerly foliation but considerably silicified and pyritized. Cut by the reef is at least one old dolerite and here occurred the "bonanza" known locally as the "jeweller's shop," which ran about 8% gold. The writer has not systematically sampled any reefs and is not therefore in a position to express any opinion on their value. Chalcopyrite, galena, pyrite, siderite, covellite and calcite were noted in addition to gold and quartz. There are several other auriferous reefs in the vicinity.

The Saza reefs (Nutting's) are the best exposed set of reefs in the goldfield, owing to the extensive prospecting work done by the Central Mining and Investment Corporation Ltd. The country here also is granitic and basic gneiss, the average strike being east-south-east, but this is seldom seen in the trenches as the reefs all lie in one broad sheer zone running east-and-west. The granitic rocks in this zone vary, some are completely mylonitized, others only slightly so. Similarly with the basic gneiss which predominates, some is recognizable under the microscope as being of doleritic origin, other has reached the phyllitic condition. The longest continuous reef lies to the west of Need's camp and is over 1,000 ft. long, but never wide, certain shoots appearing to be payable. Those to the east of that camp are somewhat shorter, sometimes 6 ft. wide, sometimes overlapping, sometimes two parallel reefs up to 100 ft. apart, sometimes a series of leaders, sometimes completely absent, but all in the same shear zone which seems to persist. There is quartz, more or less continuously, for 1·9 miles in this zone. A good deal of reef runs 10 to 20 dwt. to the ton, much is richer. The mineralization is mainly pyrite, small quantities of all the above reef minerals have been found, and barytes and tourmaline in addition. Some of the dark quartz of the reefs is full of minute tourmaline, with magnetite and free gold visible under the microscope. It should be noted that in these as in many other reefs the assay values are higher than would have been estimated from the pannings as much gold is locked up in the pyrite.

For size there is nothing yet known to equal the "Razorback," a reef-hill with 1·4 miles continuous quartz, 200 to 300 ft. high, and of considerable width. Unfortunately most of this, though not all, is unpayable.

The "Black Tree" reef (to the west of Black Tree Hill) has a nearly continuous length of half a mile. It is intruded mainly into granitic gneiss, but some basic gneiss and some diorite are also seen in the trenches.

McHugh's on the Luika is another reef-hill with different strike and values in parts.

Origin.—The gold belt has been mentioned. From the mapping, it has been found that with the exception of the ubiquitous granitic gneiss, only one rock and its associates pervades the length of that belt, that is, the Saza granite with its differentiates the diorite and "spessartite." Earlier on Mr. Oates (Chemist and Petrologist to the Geological Survey) did many assays of different rocks

in the hope of finding some helpful indicator. Various diorites carried traces of gold. Latterly he has concentrated on the "spessartite" as being a pyritiferous differentiate of the granite. Clean fresh material, free from any sign of quartz veining, was chosen; elaborate precautions were taken to prevent accidental "salting." His conclusion is that various samples are definitely auriferous. (Actually 4 grains to the ton of 2,000 lb. in one case, slightly higher in another, and distinct gold in another; these results being obtained from the combination of the products of many "assay tons.") Therefore, as one differentiate of the Saza granite has been proved to be auriferous, and as this granite and its associates pervade the gold belt, the author puts forward the suggestion that the Saza granite is the parent of at least some of the gold reefs, regarding these as acid differentiates, just as the diorite and "spessartite" are basic derivatives of the granite.

Alluvial Gold Occurrences.—The characteristic which seems to distinguish this goldfield is the finding of very rich (unfortunately often very local) patches in tiny streams, really very small storm drains as they never flow for more than a few hours, within a very short distance of the watershed. There seems no area but the immediate vicinity from which the gold can possibly have come. A very common feature is that most of these stream valleys have been eroded at some remote period, then aggraded, perhaps nearly filled up and covered over with surface "cement," and are now being re-eroded along the old valley. In some cases gold lies on the "cement," a false bottom, but often in better quantity on the true bottom and hidden, till eroded or excavated, by the false bottom. Even in the Lupa itself one claim in 1929 went down over 20 ft. below the apparent bottom of the river in a steep rocky gorge; enormous boulders had to be blasted away to do this. The bottom yielded heavy gold that justified the outlay of time and money.

A very great deal of the gold in the smaller streams and, in fact, much in the rivers, is angular. It seems that erosion and drainage in the present direction has been in progress for a very long period and the idea that there may have been a previous, totally different drainage system seems too remote to be useful. It appears therefore that the origin must be sought in the vicinity of the deposits. Throughout the area are many auriferous quartz stringers and veins of no persistence. Occasionally one is found full of visible gold. Such occurrences must contribute largely to the alluvial gold. Some of the ironstones have been found to be auriferous, notably around Itewe and the Kasisi, and they are sometimes seen full of auriferous quartz stringers. Near the headwaters of the Maperi, a rich area, one hill is almost entirely composed of epidotized gneiss. This was again noted in the workings west of the Mawoga. These are all evidences of hydrothermal activity. Whether they are in any

View along McHugh's Reef.

way connected with the Saza granite or whether they are very much older is not known, but it is suggested that to such activity, part of which is the production of quartz reefs and veins, the origin of the gold must be attributed.

The prospector is advised to examine the areas round all non-foliated hornblende-granite and diorite or "spessartite" areas, to prospect streams that are eroding into watershed or "mbuga" areas and perhaps re-eroding along old channels, and to look under the "cement."

A further word is required as to the

possibility of locating gold in the lake beds and in the overlying alluvial beds of the Rukwa depression. Without doubt hundreds of thousands of ounces of alluvial gold lie there, but, as postulated above, the beds cannot be less than 600 ft. thick, perhaps double that. The grade is low, infinitesimally so, in most of the beds, as a small amount of river sediment is diluted with a large proportion of ash. On general theoretical grounds it would be imagined that where a river flowed into the deep lake the gold would fall immediately and be banked against the scarp. Big banks of sediment thus formed occur at the mouth of every river, but pannings are poor. Perhaps in the Sira-Lupa delta there may be beds of undiluted alluvium. On paper the proposition is very attractive—in the field very disappointing.

THE GENERATION OF POWER FROM PYRITES

By ARTHUR J. CADDICK, M.I.M.M.

In this article the author discusses the economics of the generation of power from pyrites, in relation to the cost of copper production.

The possibility of harnessing, for steam-raising purposes, the heat generated by the combustion of pyrites is a subject of financial importance as affording, for many districts short of carbonaceous fuel or water power, a local supply of fuel. When considered in conjunction with the production of copper from cupreous pyrites, by the roasting of the pyrites and subsequent wet extraction of the copper from the calcines, and the utilization of the surplus heat generated by the roasting operations for power generation, an efficient and cheap process for copper production is obtained. Where smelting operations are conducted, the utilization of the heat generated by the combustion of the pyrites also offers scope for considerable economies in fuel costs. From a large amount of research work, conducted over a number of years, the results given in the present communication will indicate the financial possibilities.

In the following article theoretical considerations are given in the first instance and these are followed by experimental results obtained on a small boiler and a U-tube. Continuing, there are working particulars as to size of boilers and evaporations of water per hour from three firms of boilermakers and, finally, the value of the heat harnessed in terms of saving in coal bill and the economy in cost per ton of copper produced with coal at different prices are shown.

HEAT UNITS GENERATED BY THE CALCINATION OF PYRITES.—In the following notes the total amount of heat contained in the gas produced from the roasting of 300 tons pyrites per day is shown, also the amount of heat available for the raising of steam.

Pyrites roasted per day, Tons	300
Sulphur Content of Pyrites, %	45
,, ,, ,, ,, , Tons	135
Calcined Residues produced, % as on Pyrites	80
,, ,, ,, per day, Tons	240
Sulphur Content of Residues, %	8·0
,, ,, ,, , Tons per day	19·2
Sulphur burned to SO_2 per day, Tons	115·8

1 ton of Sulphur produces 2 tons pure SO_2.
Pure SO_2 gas produced per 24 hours, 231·6 Tons.

Average Composition of Gas Produced (% by Volume).—

SO_2	8·0%
Oxygen	10·0%
Nitrogen	82·0%

64 grammes SO_2 occupy 22·4 litres at 0° Cent. and 760 mm. pressure.
64 kilos SO_2 occupy 22·4 cubic metre at 0° Cent. and 760 mm. pressure.
1 kilo SO_2 occupies 0·35 cubic metres at 0° Cent. and 760 mm. pressure.
231·6 tons pure SO_2 occupy 81·060 cubic metres at 0° Cent. and 760 mm. pressure.
Gas contains 8% SO_2 by Volume.

From this data the heat units in the gas produced can now be estimated.

Gas produced from 300 tons Pyrites per 24 hours.—The gas produced will measure 1,013,250 cubic metres at 0° Cent. and 760 mm. pressure. This gas will contain the following amounts of component gases measured under the same conditions of temperature and pressure.

	c. metres
SO_2	81060
Oxygen	101325
Nitrogen	830865

Weight of Gas produced per 24 hours from 300 tons Pyrites.—In the following table is shown the weight, in kilogrammes, of 1 cubic metre of the component gases at 0° C. and 760 mm. pressure.

SO_2	. .	2·88 kg.
Oxygen	. .	1·44 ,,
Nitrogen	. .	1·26 ,,

From these figures the weight of the total gases produced can be calculated for the same conditions of temperature and pressure.

SO_2 .	81060 c. metres	weigh	233452·8 kg.
Oxygen .	101325 ,,	,,	145908·0 kg.
Nitrogen .	830865 ,,	,,	1046889·9 kg.
Total .	1013250 ,,	,,	1426250 kg.

Temperature of Gas Produced.—450° C.

Specific Heat of Gas Produced.—

SO_2.—1 kilo = 0·125 + 0·001t = 0·125 + 0·001 × 450 = 0·125 + 0·45 — at 450° Cent. = 0·170.

Oxygen.—1 kilo = 0·2104 + 0·0000187t = 0·2104 + 0·0000187 × 450 = 0·2104 + 0·0084 — at 450° Cent. = 0·2188.

Nitrogen.—1 kilo = 0·2405 + 0·0000214t = 0·2405 + 0·00963 — at 450° Cent. = 0·25013.

Average composition of Gas by Weight.—

SO_2 . .	16·37%
Oxygen . .	10·23%
Nitrogen . .	73·40%

Mean Specific Heat of Gas at 450° Cent.—

SO_2 . .	16·37% at 0·17000 =	2·7829
Oxygen .	10·23% at 0·21880 =	2·2383
Nitrogen .	73·40% at 0·25013 =	18·3595
		23·3807

Mean Specific Heat 0·2338.

Total Heat Units Contained in Gas Produced per 24 Hours from the Roasting of 300 tons Pyrites.—

Weight of Gas = 1426250 kg.
Temperature = 450° Cent.
s.p. heat of Gas = 0·2338

1426250 × 450 × 0·2338 = 150,055,762 kg. Calories.

As the whole of the heat units contained in the gas are not available for power generation, it is necessary to determine the amount of heat carried away by the gas after the absorption of heat for steam raising.

Available Heat for Steam Raising in Gas Produced per 24 hours.—

Temperature of Gas Produced . 450° Cent.
Temperature of Gas after Heat absorbed for Steam Raising . 150° C.

Heat contained in Gas at 150° Centigrade after absorption of Heat for Steam Raising.—

Weight of Gas per 24 hours = 1426250 kg.

Specific Heat of Gas at 150° Centigrade.—

SO_2.—1 kilo = 0125 + ·001t
1 kilo at 150° Cent. = 0·140

Oxygen.—1 kilo = 0·2104 + 0·0000187t
1 kilo at 150° Cent. = 0·2132

Nitrogen.—1 kilo = 0·2405 + 0·0000214t
1 kilo at 150° Cent. = 0·2437

SO_2 . .	16·37% at 0·1400 =	2·2918
Oxygen .	10·23% at 0·2132 =	2·1810
Nitrogen .	73·40% at 0·2437 =	17·8876
		22·3604

Fig. 1.—Furnace Shells and Basements for Driving Gear.

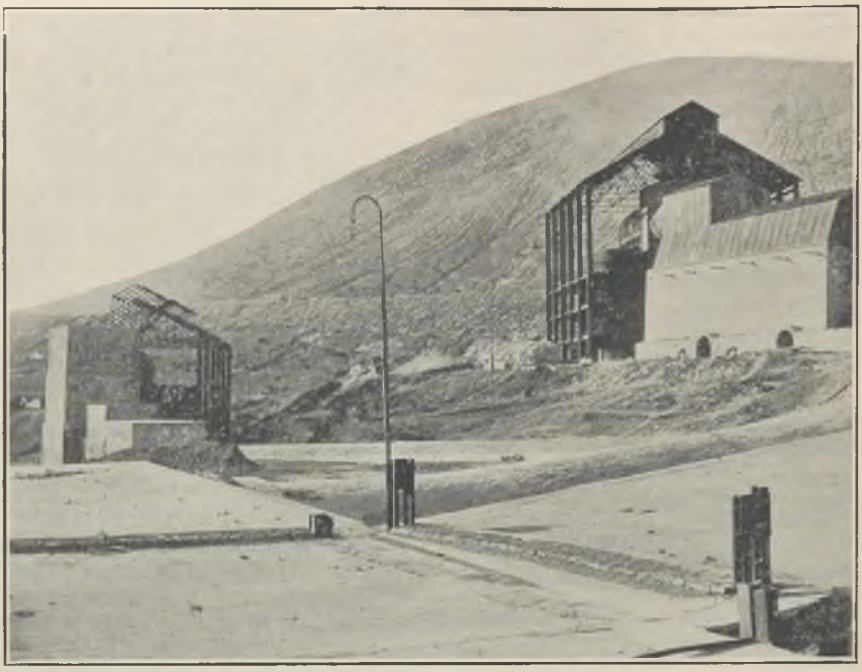


FIG. 2.—DUST CHAMBER.

Mean Specific Heat at 150° *Cent.* 0·2236.

Heat Units contained in Gas at 150° Cent.—1426250 × 150 × 0·2236 = 47,836,425 kg. Calories.

The amount of heat units in the gas as produced, and in the gas after heat absorption for steam raising having been ascertained, by difference the amount of available heat for power generation is obtained.

Heat Units in gas as produced	150,055,762 Kg. Calories.
Heat Units after Heat Absorption	47,836,425 ,, ,,
Available for Steam Raising	102,219,337 ,, ,,
Available for Steam Raising	405,606,329 B.Th.U's
Available B.Th.U's produced from 1 ton Pyrites	1,352,021

Owing to the lower temperature of the final gas there is a substantial reduction in the volume as compared with that of the gas originally produced, the difference in volume being—

Volume of Gas Produced per 24 *hours from* 300 *tons Pyrites.*—1,013,250 cubic metres at 0° Cent. and 760 mm. pressure = 2,683,442 cubic metres at 450° Cent.

Volume of Gas after cooling by abstraction of heat for steam raising, temperature of Gas 150° *Cent.*—1,569,980 cubic metres at 150° Cent.

Reduction in Volume by heat abstraction for steam raising.—58·5% as on volume at 450° Cent.

Turning next from these theoretical considerations, the following are experimental results obtained on a small boiler in which pyrites was used as the fuel, and an experimental U-tube immersed in a blast-furnace flue, the tube being heated by waste blast furnace gases.

EXPERIMENTAL VERTICAL TUBULAR BOILER.—For these trials a small boiler was used without economizer or feed-water heater. No alterations were made to the firebox from that used when burning coal. Under these conditions the combustion of the pyrites was only partial, the final calcines containing as much as 27% sulphur. The working results obtained, however, were :—

Duration of trial	12 hours
Pyrites burned	825 lb.
Sulphur in Pyrites burned	48·8%
,, ,, ,, ,,	403·0 lb.
,, ,, Calcined product	27·65%
Water Evaporated	768 lb.
,, ,, per lb. pyrites	·93 lb.
,, ,, from and at 212° Fahr. per lb. pyrites	1·115 lb.
Temperature of Feed Water	53° Fahr.
Boiler Pressure, lb. per sq. inch	71
Total B.Th.U's in steam and Feed Water	905,165
B.Th.U's in Feed Water	16·128

B.Th.U's in steam from Pyrites	889,037
B.Th.U's per lb. steam from Pyrites.	1157·6
B.Th.U's obtained from 1 lb. Pyrites	1078

Experimental Tube Immersed in Blast-Furnace Flue.—In this experiment a steel U-tube was placed in the flue of a blast-furnace engaged on pyrite smelting. The dimensions of the tube were :—

External diameter	2½ in.
External circumference	7·85 in.
Length in contact with gas	33 ft. 3 in.
Total external heating surface	21·7 sq. ft.
Internal diam.	2 in.
Internal circumference	6·28 in.
Total internal surface	17·4 sq. ft.

	Test 1.	*Test* 2.
Duration of trial	1 hr. 23 min.	1 hr. 25 min.
Water passed through tube	390 kg.	390 kg.
Water—ingoing Temperature	35° C.	35° C.
Water — outgoing Temperature.	85° C.	84·3° C.
Rise in Water Temperature	50° C.	49·3° C.
Water passed per hour	281·93 kg.	275·29 kg.
B.Th.U's per hour	55935	53853
Average B.Th.U's per hour	54894	
B.Th.U's per sq. ft. heating surface of 2½ in. U-pipe	2522·7	

Boilers for Steam Generation from the Heat of the Gases Produced by the Calcination of Pyrites.—Following the foregoing experimental results, quotations were made by three firms of boilermakers of repute, for boilers to raise steam from the gases produced by the calcination of pyrites, the working particulars as given by them being :—

A. Waste Heat Boilers for gases from 300 *tons Pyrites per day.*—

Evaporation from and at 212° Fahr. 100 lb. pressure 13,500 lb. per hour.

Evaporation from and at 212° Fahr. 150 lb. pressure 12,750 lb. per hour.

With increase of 25% by addition of economizer.

Size of boilers, 3 at 7 ft. 3 in. diam. by 22 ft. long or 2 at 9 ft. 0 in. by 22 ft. long.

B. Water Tube Boiler for Gases from 300 *tons Pyrites per day.*—

Heating surface 8,800 sq. ft.

Evaporation 9,000 lb. per hour at 120 lb. per sq. in.

2/300 lb. per hour less for 150 lb. pressure per sq. in.

Temperature of exit gases 450° Fahr.

Exclusive of Economizer.

C. Water Tube Boiler for Gases from 100 *tons Pyrites per day.*—

Heating surface of boiler 3,500 sq. ft.

Evaporation 3,300 lb. of water per hour.

Exit temperature of gases could probably be reduced to 350° Fahr. without serious harm occurring, but considered it advisable to keep above this temperature, say 400° Fahr.

Value of the Heat of the Gases Obtained by the Calcination of Pyrites in Terms of Coal.—Taking the amount of steam produced, according to the boiler-makers' quotations, as 9,000 lb. per hour from 300 tons pyrites per day, and considering this in relation to an average

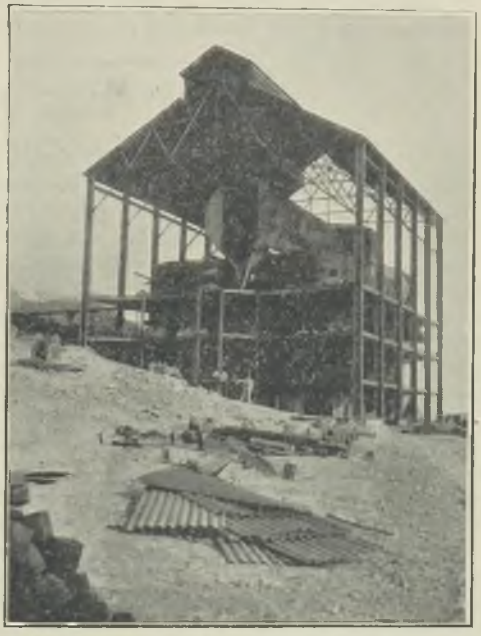


Fig. 3.—Gas-Collecting Flue.

evaporation of 7 lb. steam per lb. of coal, the 9,000 lb. steam per hour correspond to an equivalent of 30,857 lb. coal per day, which at 360 days per annum mean 4,959 tons coal.

	per day	*per annum*
With Coal at 15s. per ton	£10·32	£3718
,, ,, 20s. ,,	£13·77	4959
,, ,, 30s. ,,	£20·65	£7438
,, ,, 40s. ,,	£27·54	£9918

Considering these sums in relation to the amount of copper from different grades of pyrites the importance of the economies possible are emphasized.

At 0·5% Copper produced from Ore = 1·5 tons Copper per day.

At 1·0% Copper produced from Ore = 3·0 tons Copper per day.

At 2·0% Copper produced from Ore = 6·0 tons Copper per day.

	Economy per ton Copper produced		
Copper produced from Ore	*0·5%*	*1·0%*	*2·0%*
With Coal at 15s. per ton	£6·88	£3·44	£1·72
,, ,, 20s. ,,	£9·18	£4·59	£2·29
,, ,, 30s. ,,	£13·76	£6·88	£3·44
,, ,, 40s. ,,	£18·36	£9·18	£4·59

Value of Available Power from the Calcination of Pyrites in Relation to Electrical Power Generation.—For an electric power station with a normal load of 42000 to 44000 k.w.h. per 24 hours the B.Th.U's used when burning a very low-grade of fuel were 18430 per k.w.h. The avilable heat units, per calculation, for 300 tons pyrites per day (405,606,329 B.Th.U's) are therefore equivalent to 22008 k.w.h. With the price of fuel at one farthing per k.w.h. the value of the 22008 k.w.h. would amount to over £8000 per annum and with fuel cost of one halfpenny per k.w.h. to over £16000 per annum.

The photographs illustrating this article show four multiple-hearth roasting furnaces in course of construction for the contemplated generation of steam by the surplus heat of the gases produced by the roasting of pyritic ores. The first shows the furnace shells and basements for driving gear ; the second shows the dust chamber at top battery of furnaces ; and the third the gas collecting flue. This installation was designed and constructed under the supervision of the author.

DUMPING MINE REFUSE

By GUIDO BRILLO

In the present article the author deals solely with the dumping of mine refuse, but hopes in a subsequent communication to cover the reclamation of dumped material.

When planning the exploitation of a mine, a problem to which careful consideration should always be given is the disposal of the mine refuse—where and how the waste material should be dumped. It is the author's intention in the following article to outline the aspects of this problem which are most frequently met by mining engineers and to suggest some useful methods on how to deal with them. At the commencement, at least an approximate idea should be formed of the amount of refuse to be dumped over a period of years, if possible up to the exhaustion of the mine. Obviously this knowledge will assist in the choice of the dumping site, as well as in indicating the size of the conveying and dumping plant required.

Under the following headings three typical instances are arranged in order of increasing difficulty, the cases being subsequently examined in turn :

(1) When the waste material has to be dumped on the slope of a hill ;

(2) when the waste material can fill up a valley, and

(3) when the waste material has to be dumped on flat ground.

To these considerations the following points should be added :—

(*a*) The distance of the chosen available dumping ground from the source of the waste material ;

(*b*) the accessibility of the route between the source of the waste material and the dumping ground ; and

(*c*) the hourly or daily maximum tonnage of material to be dealt with.

Only from an analysis of any of the above three cases is it possible to arrive at the most efficient method of dumping. It can almost be said that in the vast majority of cases one of the three following plants will be

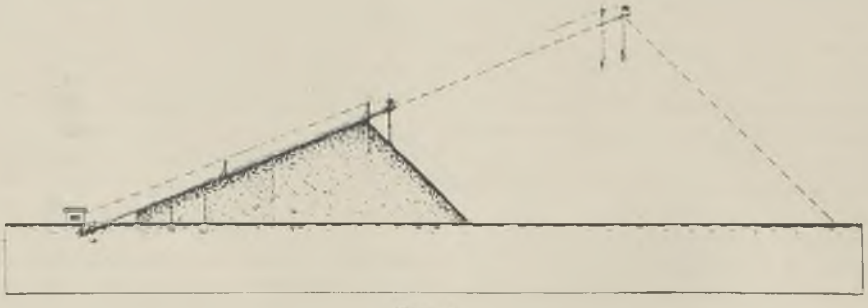


Fig. 1.

found to cover most satisfactorily the mine's requirements :

(*a*) A light railway.
(*b*) An extendible cable incline railway.
(*c*) An aerial ropeway.

These three methods are dealt with on their individual merits and the decision to use them at the mine is naturally dependent to a wide degree on the local requirements.

Light Railway.—The light railway can occasionally be adopted in the first two cases previously mentioned and either animal or mechanical traction can be used. If the latter, this can be obtained by means of either steam or petrol engine, or by rope or chain haulage. Animal traction is usually adopted when the daily output is not very great, and when the distance between the dumping area and the point whence the waste material comes, is not only reasonably short, but easily accessible. For this case the track has usually a small gradient in favour of the load, so that the loaded waggons reach the dumping point almost by gravity, and are conveyed back to the loading point by mules, either separately or in train formation.

Mechanical traction is used when the daily output is fairly large or when the source of the waste material is rather far from the dumping point. Once the traffic is of such a nature that heavy earth work is necessary to support it, or if the line deviates considerably so as to counter the uneven nature of the ground, it is necessary for the engineer to turn his mind to some of the more effective and modern methods of transport which are examined in detail below. According to the requirements of the installation, the track can be single or double—this applying both to animal and mechanical traction. The double track allows one section to be used for the conveyance of the loaded waggons, and the other for the return of the empty ones. The waggons can discharge their contents on the dumping ground by tilting either sideways or forwards, or even by opening the sides. The light railway only allows the dump to proceed horizontally as the discharges are made, and is formed by bringing forward the dumping point, or section, by adding to the track when the material already dumped does not permit of any additional discharge.

Extendible Cable Railway Incline.—This installation is usually adopted when the waste material has to be dumped on flat ground, and Fig. 1 illustrates a plant of this kind. The refuse that comes from the mine by, say, a light railway, is tipped either directly or through hoppers into a skip (A).

The formation of the dump is commenced with about 100 ft. of track, which is placed where it starts, the track having a gradient of about 1 in $2\frac{1}{2}$, and is supported by wooden trestles and longitudinal and transverse wooden sleepers. The steel wire rope, which has one end attached to the skip, turns around the return pulley at the top of the incline, and winds itself on to the drum of the motor-controlled driving-gear, placed at the lower terminal. This rope hauls the skip to and from the two terminals. The two sides of the skip can be automatically opened by a special device

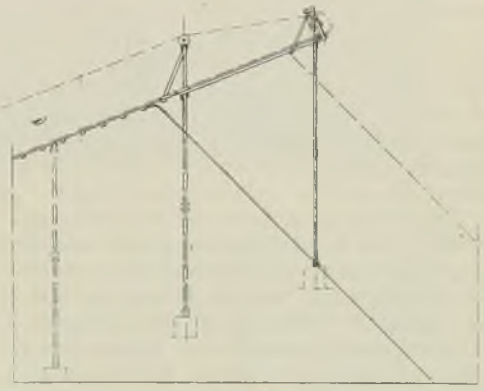


Fig. 1a.

which can be placed along any portion of the track. The skip can therefore discharge its contents on both sides of the track at any desired intermediate point. When at any given point, the full quota of material has been unloaded and there is no room for additional quantities to be dumped, the incline is extended by adding another length of track about 20 ft. in length, complete with wooden longitudinal and transverse sleepers previously referred to. One end obviously is joined to the old track and the other end is supported by a wooden trestle placed on a foundation previously prepared on the existing portion of the dump. The return pulley is also removed to the far end of the new section of track and the skip will then be able to unload on both sides of this new portion. The extension of the track has naturally to be repeated each time the material has completely filled up the space between the ground and the track.

Rollers for the support and guide of the hauling rope are placed at equal intervals along the track, at track level for the hauling section, and on wooden trestles for the

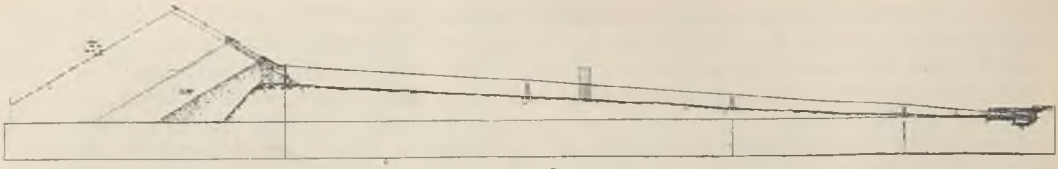


FIG. 2.

return section. When the plant is first installed it is also customary to supply a hauling rope sufficiently long to last for all the necessary extensions—if not for the completion of the dump, at least for the life of the hauling rope itself, which in normal circumstances is about five or six years. The spare length is generally stored on the drum of the winding gear, and uncoiled according to the needs of the installation. It is obvious that with this kind of plant the carrying capacity per hour gradually diminishes with the increase of the length of track, and, therefore, it is necessary to plan a plant designed to cope with the required capacity per hour or per day, when the track reaches its maximum length.

The carrying capacity of the skip varies greatly, but in any case it is not advisable to go above four or five tons. The speed of the hauling rope may be as high as 500 ft. per minute. It is up to the designer to proportion satisfactorily the capacity of the skip and the speed of the hauling rope so that he has the maximum output with the minimum expenditure. In certain cases, when a great capacity per hour is required two skips attached together can take the place of one, thus doubling the capacity of the incline. If this is done the rope, driving gear and motive power, etc., have to be proportioned to it. Occasionally, instead of discharging by automatically opening its sides, the skip empties its contents by tilting at the top end of the track. With this type of skip, however, the capacity of the plant has to be kept rather low, and it is not possible to have two skips coupled together. With the adoption of a cable railway incline, the dump usually progresses in the shape of an ever-increasing cone, but when a certain height is reached, the track, and therefore the dump, can develop horizontally.

Aerial Ropeway.—By far the most modern and most efficient means to cope with any of the above mentioned cases of dumping is the installation of an aerial ropeway. This applies to all conditions of work and all types of material to be dumped. The aerial ropeway is especially suitable when a regular hourly output of material has to be disposed of; when the route between the source of the waste material and the dumping area is difficult; and when a great hourly capacity is required. Another important feature of this type of plant is that very little running labour indeed is necessary, and thus it contrasts favourably with the previous types of plants mentioned, where labour is no insignificant feature.

For the formation of dumps, two types of aerial ropeways are constructed which need particular mention—one with extendible overhead discharging rail, which is extended according to the progress of the dump, and the other on which a particular span or spans are provided to cover the whole of the dumping area, both in height and extension. Both these plants are of the bi-cable system, but whereas the first is always of the continuous movement type, the second in certain unusual instances may be of the jig-back type. Figs. 2, 3, and 4, illustrate ropeways with extendible overhead discharging rail. With this type of plant, as can be clearly seen from Fig. 2, the driving station is usually placed at the loading terminal and an automatic return station is situated at the unloading terminal. Thus the carriers arriving at the latter terminal do not leave the hauling rope, but continue to grip it and are hauled through the inlet section of the overhead rail up to the large diameter sheave. Turning around this sheave, they continue through the outlet side of the rail and back again on the return side of the ropeway to the loading station. At the loading stations the ropeway carriers are

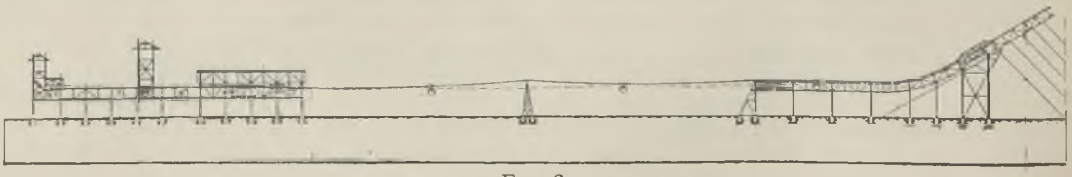


FIG. 3.

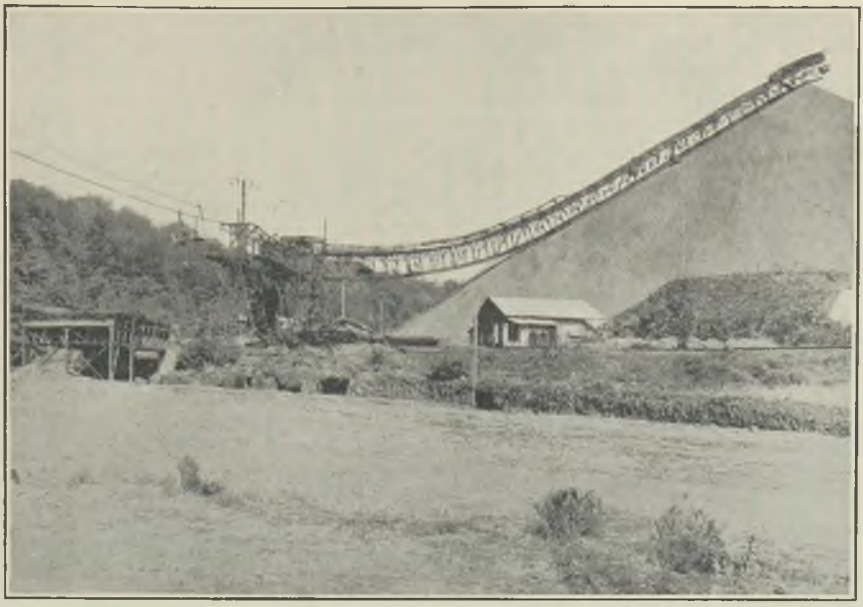


FIG. 4.

loaded by means of hoppers, and at equal intervals proceed towards the unloading station, where, whilst on the rail, they automatically tilt at any desired point, through suitably placed automatic tippers.

When the dump has reached such a height that no further addition of material is practicable, the overhead discharging rail is extended by moving forward the structure carrying the large diameter sheave, and inserting between it and the entrance of the unloading station, some additional steelwork, which carries the extension of the overhead rail as well as the rollers for the

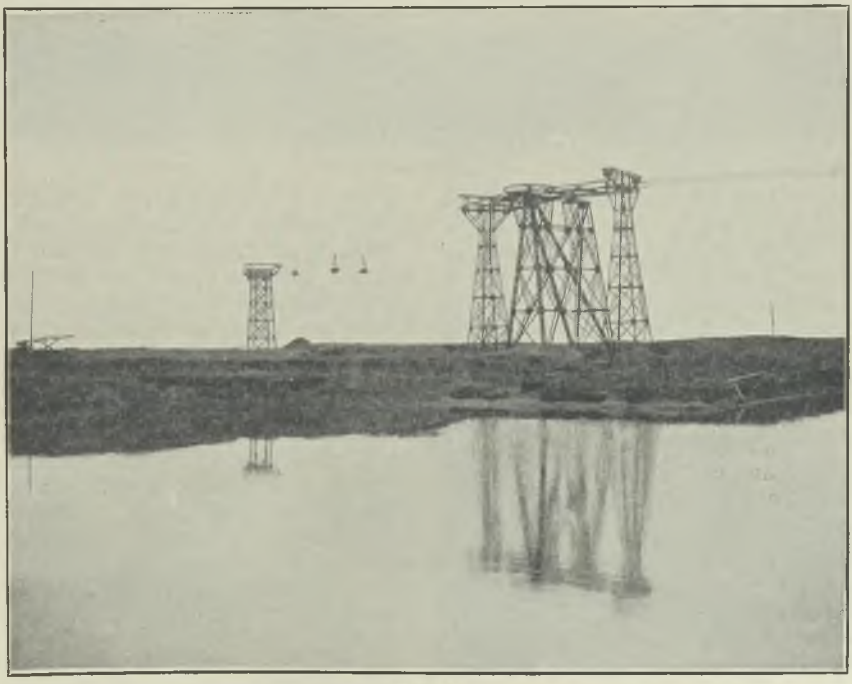


FIG. 5.

guide and support of the hauling rope. This operation has to be performed every time it is necessary to extend the overhead rail, and is very simple. Obviously, in theory, there can be endless extensions of this plant and, contrary to the extendible cable railway incline, the hourly capacity of the plant does not diminish with the increased length of the rail, owing to the fact that it can be maintained at certain fixed quantities by keeping constant the spacing of the carriers and suitably increasing their total number. When designing an installation of this kind the motor supplied must be able to cope with the maximum extensions which will be required by the plant. The overhead discharging rail usually goes upwards as illustrated in figure No. 4, thus forming a conical shaped dump. This kind of plant is specially suitable when the material has to be discharged on flat ground, and when dumps of great height have to be formed. By having the discharging rail horizontal or only slightly inclined, this arrangement is suitable for forming dumps on the slope of a hill and it is obvious that the extension of the rail is not bound to proceed in a straight line, but can turn to suit the varying requirements of the dumping ground.

The hauling rope is generally long enough to allow such extensions as may be needed during its life. With a plant of this kind it is possible to deal with a capacity up to 250 tons of material per hour. Figs. 5, 6, 7, and 8 show examples of the other type of aerial ropeway—where one, or more, spans of the installation at whatever height required, cover the whole of the dumping area. The loading station is, practically speaking, the same as that used for the ropeway already described and is almost invariably also the driving station. The return terminal, placed at the end of the dumping ground, is a high tower on which a short circuit of rails and a large diameter sheave are placed for the automatic return of the carriers. These spans above the dumping area are usually horizontal and on both the carrying ropes, movable automatic dischargers are fixed, so that the carriers can automatically tilt at any desired point, whilst travelling either towards or from the return terminal.

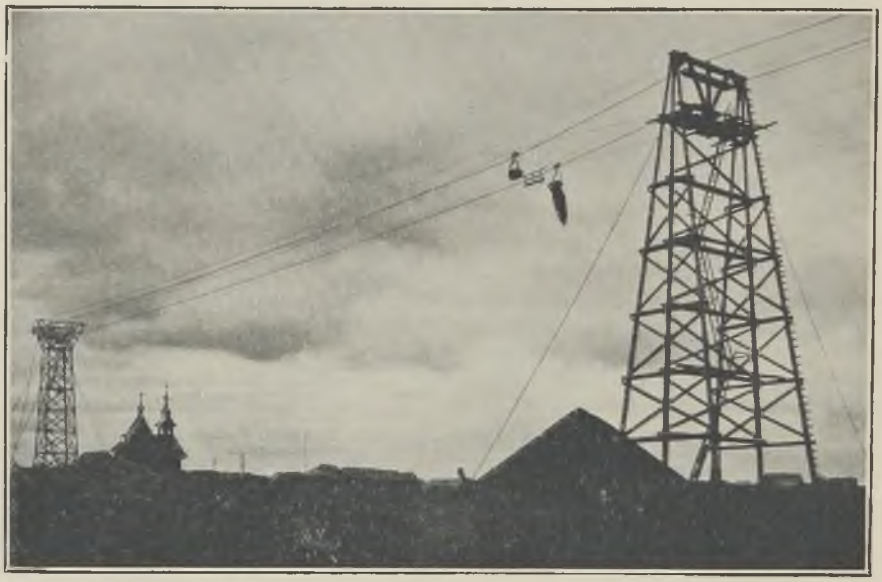


Fig. 6.

This type of ropeway is also especially suitable when a valley has to be filled up. As has already been explained this plant is of the continuous movement type and it is possible for it to dispose of about 250 tons of material per hour—this with a single installation. Should the quantity of material to be dealt with be more than 250 tons an hour, all that need be done is to install two or more parallel ropeways. An interesting variation is that when required in very high dumps, the towers all over the dumping area can be increased as desired, to whatever height necessary within, of course, reasonable limits, taking a maximum as say 400 ft.

Perhaps some mention should be made of the aerial cableway, a variation of the aerial

FIG. 7.

ropeway. Under certain conditions the aerial cableway can be most satisfactorily used for dumping and this particularly applies when the dumping takes place in a narrow, but long and regular, valley, or when dumping on flat ground, where the height of the dump must not rise above a certain level, but may proceed forward at almost any length. The cableway may be defined as a gantry bridge, on which steel girders supporting the carriers are substituted by one or more steel wire ropes—see Fig. 9. The towers of the cableway can travel on previously erected rails so that when the ground between the two towers of the cableway is filled up, and no more material can be added to it, the whole cableway is moved along the rail to another free section of the dumping area. The material is brought to the tower usually by a light railway, its track running by the side of the rails of one of the cableway towers. The load is picked up at one tower and automatically tilted at any point above the section covered by the cableway. The mechanics and a general description of aerial ropeways were covered in two articles which appeared in the issues of the MAGAZINE for February and March last.

Obviously the important item to be considered in installing one of these plants is its cost. Most mining engineers have had experience in erecting at least a small light railway, and will be prepared to estimate the price of such a plant, should it be decided to install one for dumping purposes. It is more difficult, however, to estimate the cost of the other types of plant which have been

FIG. 8.

dealt with, as this depends on many factors which may greatly vary. The following two examples which came under the notice of the writer will prove of some guidance.

The approximate cost of an extendible cable railway incline, similar to that illustrated in Fig. 1, with a permanent gradient of 1 in 2½, a track with a total developed length of about 500 ft., and a carrying capacity of approximately 15 tons an hour, in complete working order, including the cost of extensions, was just over £900. The incline was operated by a 20 h.p. motor,

FIG. 9.

and in a period of five years, working 10 hours a day and 300 days in a year, it was able to form a conical dump of about 225,000 tons. The cost was spread over a period of five years for repayment, and including interest, driving power, labour and maintenance, it was found that the cost of dumping the material was about 4d. per ton. This calculation did not allow for the transport of material from its source to the loading point of the incline.

An aerial ropeway similar to that illustrated in Fig. 2, with a length of about 2,000 ft. from the loading station to the return sheave of the unloading station at the beginning of the dump, with a gradient of the extendible overhead rail at 30°, and with a capacity of 40 tons an hour, costs, in complete working order, and including all extensions over a period to which reference will be made, about £3,400. Over a period of 10 years, working 10 hours a day and 300 days a year, it was possible to dump 1,200,000 tons of waste material. This means that, including repayment of the plant within a period of 10 years, interest on capital, cost of driving power (25 to 30 h.p. motor), labour, maintenance, etc., the cost is just under 2½d. per ton for dumping the material. Furthermore—and this is an important point—this figure of 2½d. includes the cost of transport from the pit of waste material. With a ropeway of the other type under similar conditions, and with similar specification, the ton cost would be approximately the same figure.

In this comparatively short article it has only been possible to outline in general the typical methods adopted for dumping waste material, but it is hoped that the various points mentioned earlier on may help in the wise choice of the plant most suitable for any particular case. Great attention should, of course, be paid to the economical features, not considering only the first expenditure, but rather how this initial expense will ultimately affect the cost per ton of transporting and dumping the waste material. Viewing the problem on general lines, the writer, as a result of his experience, is convinced that, where the material to be transported is more than 150 tons a day, and where the dumping operations will extend over a longer period than five years, the installation of an aerial ropeway is generally desirable. At a first glance the initial cost may seem comparatively high, but in the long run it will certainly be found the cheapest possible solution, and, after all, in any engineering undertaking it is the ultimate cost that should always be carefully borne in mind.

In conclusion the author wishes to acknowledge his indebtedness to Mr. Eugene Beglan for help in compiling this article.

BOOK REVIEWS

Simple Determinative Mineralogy. By H. R. BERINGER. Cloth, octavo, 227 pages, illustrated. Price 10s. 6d. London: Mining Publications Ltd.

The use of the word "simple" as part of the title of this book is fully justified, for the author, who has had great experience in this subject, deals with the determination of minerals only by methods which are readily applicable in the field with apparatus that is easily portable; and the methods themselves can, with some practice, be applied by prospectors who may not possess the scientific knowledge essential for the

investigation of ore minerals by more refined means. The book is not intended to supplant systematic training in determinative mineralogy ; that is made quite clear by the author, whose object is to facilitate the recognition of certain ore minerals that may be deceptively similar to others in their outward appearance.

Although it is stated in the preface that " the present work is a considerably revised and much enlarged edition of a book by the same author, entitled " Mineral Determination," published in Cornwall some years ago," this new edition contains so much more information than its predecessors, and differs so radically from the usual book on this subject, that it merits special attention. Its main feature is the diagnostic use made of two outstanding physical properties of minerals, namely specific gravity and hardness. These two properties, although not constant even for the same mineral species (and hardness, being a vectoral property, varies to some extent according to crystallographic directions) frequently suffice, when determined carefully by the methods described in great detail in this volume, to limit the possible species to a small group. The number of possible minerals is then further reduced by applying other tests, also described by the author, until eventually the particular mineral, in most cases, is determined.

Most books on determinative mineralogy give insufficient attention to the great diagnostic value of these two properties and too meagre descriptions of the technique for their investigation. The author is to be congratulated on the careful and detailed descriptions of the procedure, supplemented by useful advice of how to avoid errors of determination. He realizes fully that the specific gravity and hardness of a specimen are not sufficient data, in many cases, to determine the mineral species, but that the two properties, taken together, do provide the investigator with a ready means of allocating the specimen to one of the many groups arranged in this book. If the precautions emphasized by the author are then followed, the investigator will succeed in running down the specimen to an individual mineral, or to a very limited number of possible species. Proof of the usefulness of this method is supplied by the author's statement that it has been used with good results for over ten years at the School of Metalliferous Mining, Camborne.

The first 13 pages give detailed descriptions of how to determine the specific gravity of minerals occurring as grains, or as larger specimens, and the kinds of apparatus necessary. Three clearly drawn figures illustrate the methods and the apparatus. In the 27 pages that follow, the minerals are grouped in order of their specific gravity, and arranged in each group in order of hardness ; 172 pages of useful information relating to the chief physical characters of minerals in order of their specific gravity form a notable part of the volume ; and pages 212 to 223 contain an alphabetic list of elements found in minerals, with the methods by which the elements can be identified. The index to subject matter is supplemented by a full index of the mineral species described in the context, and the quality of paper, printing, and binding reaches the high standard we have learnt to expect from the publishers.

The book will be found particularly useful in the field, not only by prospectors of limited scientific training, but also by trained engineers who appreciate the importance of determining carefully the chief physical properties of minerals before studying the more obscure, and sometimes misleading, properties due to impurities and superficial alteration.

William R. Jones.

Prospecting for Gold. By Ion L. Idriess. Second edition. Cloth, octavo, 204 pages, illustrated. Price 5s. Sydney : Angus and Robertson. London : Australian Book Co.

This work is different from most of the other somewhat academic books on the same subject, in that it is based entirely on field experience. In the cheery, colloquial style of the prospector, it tells the new chum setting out for the first time on the adventure of gold discovery how to conduct his search and how to work a deposit when found. From an experience extending over twenty years, the author gives practical information on dishing, cradling, boxing, sluicing, gold saving, river work, hydraulicking, dry-blowing, reefing, and other allied matters. He points to his construction of a good hydraulic plant for £100 to show that the cost of working ground on a fair scale need not be prohibitive ; and instances the finding of the richest claim on the Edie goldfield of the Mandated Territory of New Guinea by an inexperienced digger, who happened to put his camp on it, and the recent picking up of a £6,000 nugget in Westralia by a lad

of seventeen, as proof that fortune sometimes smiles on beginners. The illustrations of apparatus are mostly dimensioned or to scale, making construction easy for anyone possessing a knowledge of bush carpentry. The rapid issue of a second edition of the book should encourage other experienced practical mining men to record the information they have accumulated, instead of allowing it to die with them.

ALEX. RICHARDSON.

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

NEWS LETTERS

JOHANNESBURG

September 30.

Far East Rand.—Government ground containing over 6,000 claims has been thrown open for mining purposes. Applications have been invited for the exclusive rights to work a portion of the farm Daggafontein No. 9, in extent about 3,426 claims, and a portion of the farm Grootfontein No. 152, in extent about 2,907 claims, in the mining districts of Johannesburg and Heidelberg, respectively. The first-mentioned area is situated to the south of the property of the Daggafontein Mines, Ltd. This company already holds two lease areas in addition to its original mynpachts. The Grootfontein area now offered lies between the Sub Nigel's lease area and ground belonging to the New Consolidated Gold Fields, and is bounded on the east by the Marievale Nigel Company's claims. Lying between the new areas is the farm Vogelstruisbult, which belongs to the Rand Mines, Ltd., and the New Consolidated Gold Fields.

Western Rand Developments.—Thanks to the remarkably favourable developments that have taken place in the Randfontein Estates mine—notably the flattening of the Main Reef Series at depth—the prospects of obtaining capital for the purpose of establishing new large gold mines on the Far West Rand have considerably improved and it is reported that the New Consolidated Gold Fields group is making arrangements to extend its interests in that hitherto neglected portion of the Witwatersrand. The group is said to have acquired an option to purchase the mineral rights of the Western Areas, Ltd., with a view to forming a company to work this extensive gold-bearing property. The mineral rights cover 18,662 morgen (over 37,000 acres) including the farm Gemsbokfontein No. 1, which formerly belonged to the Western Rand Estates, Ltd., Western Areas, Ltd., is controlled by Messrs. Donaldson and Carlis, who also own the mineral rights of the farm Luipaards Vlei No. 10, which is situated to the south of the Randfontein Estates property. The mineral rights of Luipaards Vlei No. 10 were formerly held by the Coronation Syndicate, which put down bore-holes and sunk a shaft on the farm. Gemsbokfontein No. 1 lies to the south-west of Luipaards Vlei No. 10. Its former owners, the Western Rand Estates, put down a number of bore-holes, three of which extend over a distance of some five miles along the strike of the reef. The average of the values struck in these three holes was 52·75 dwt. over a width of 9·24 inches. A large shaft was started, but so much water was encountered in the dolomite which overlies the Main Reef Series that the work had to be abandoned and the company subsequently went into liquidation. It may be that no further steps will be taken to develop the Gemsbokfontein property until the recommendations of the Low Grade Ore Commission are known, or until the Government's intention regarding much-needed alterations in the Gold Law have been made perfectly clear. The directors of the Western Areas, Ltd., have submitted evidence to the Commission showing that when the Gold Law was enacted and its later amendments were framed, conditions such as prevail in the company's properties and the difficulties set forth had not been considered. The directors stated that, in order to interest capital, the extent of the mynpachts that may be selected requires to be greatly increased, or alternatively, the right should be given to acquire areas on lease adjoining the mynpachts selected, and the rentals should be no greater than the usual mynpacht dues. In any event, however, it is desirable that machinery be created whereby it will be possible to ascertain in advance the size of the additional area contemplated in Section 2 of Act 30 of 1918 and the terms under which the lease can be obtained. On Luipaards Vlei No. 10 the same arguments apply. There the enormous difficulties encountered by the Coronation Syndicate led to the abandonment of the mineral rights after the syndicate had expended large sums of money.

Orange Free State.—The operations of the Oranjeville Goldfields, Ltd., successors to the New Rand, Ltd., in the Orange Free State, have been suspended. The New Rand, Ltd., was formed about 30 years ago by Mr. A. R. Sawyer, a Rand geologist, to drill for the Main Reef Series in the Orange Free State. Encouraging geological results were obtained, but payable gold values were not encountered in any of the reefs intersected by the drill. It is estimated that drilling on the company's property has involved an expenditure of nearly a quarter of a million sterling.

Rhodesian Gold Discovery.—Mr. George Hickey, discoverer of the Auric gold mine, in the Gwanda district, Southern Rhodesia, who is said to have declined offers for the property amounting to a substantial fortune during the last five months, has now granted an option to a South African mining group on a six-figure basis. The formation is schist, Mr. Hickey's first pannings indicating a yield of about 10 dwt. to the ton. He then sank a shaft to a depth of 75 ft., and struck solid reef. Further prospecting showed that the reef runs east and west for a distance of some 2,000 ft., and that it has an average width of no less than 80 ft. Two further shafts were sunk on the line of strike, and these showed that the reef continues at depth, with almost uniform values averaging 10 dwt. The reef lies between two diorite bars some 120 ft. apart, running more or less parallel. Expert opinion is said to confirm the general belief held in Bulawayo that Mr. Hickey's discovery is altogether to be distinguished from the " pocket " finds with which the colony is periodically thrilled.

Government Laboratory in Rhodesia.—A fully equipped metallurgical laboratory, specially designed for the carrying out of practical tests on all types of gold ores, free of costs, has been established by the Southern Rhodesian Government. Although the plant has only been running a few weeks, successful analyses have already been made of parcels of ore and sands, which have proved of great benefit to several small workers faced with extraction troubles. A Mineral Separation experimental outfit is also to be added for more refractory and complex ores. This innovation, it is stated, is likely to be of great service to the mining industry, since a half-pennyweight better extraction is as good as 2s. per ton bonus.

South African Process for Australia.—An offer from Australia, backed by certain financial interests in Melbourne, has been made to the proprietary company, the Ferro Alloy Company of South Africa (Pty) Ltd., for its process for separating gold and antimony contained in sulphide of antimony ores. It is the intention to use the process in Australia for the treatment of these and other highly complex ores, some of which contain from two to five ounces of gold to the ton.

South Africa's Mineral Output.—Statistics issued with the Government Mining Engineer's annual report show that for the year 1930 the value of the Union's output of minerals from the earliest date of the existing records to December 31 last is £1,530,609,796, of which the Transvaal contributed £1,219,226,911, the Cape £242,451,035, the Orange Free State £33,097,921, and Natal £35,833,929. Some of the details are :—

Gold	£1,095,436,526
Diamonds	303,121,469
Coal	87,557,244
Copper	27,328,638
Tin	6,688,716
Silver	3,828,500
Asbestos	3,016,137
Platinum	1,028,137

City Deep.—A gold-bearing erosion fissure cutting through the formation has been found in one of the lower levels of the City Deep mine. Several of these localized fissures have been struck in the Rand mines from time to time, but it is rare to find gold in them. These vugs are usually lined with quartz or calcite crystals, sometimes of great beauty. They were formed by secondary deposition from hot mineralized solutions and it is quite evident that in the case of the City Deep, gold found its way into the fissure also through the medium of a hot " mineralizer," and the circumstance might be used as another proof of a partial truth of the infiltration theory. The cost of recovery of this gold is almost too great to make it of any significance to mining operations. In fact, the occurrence only has a sentimental value for the specimen hunter.

Gold Mining in Northern Rhodesia.—For July the Northern Rhodesian mineral output was £106,650, as compared with £85,900 in June. The bulk of the output is accounted for by copper and vanadium, but the gold yield also shows a considerable increase and indicates that gold-mining activities are becoming a striking feature of mining enterprise north of the Zambesi.

For the first time in the history of the territory the production of gold has exceeded 1,000 oz. a month and, having regard to the discoveries recently made in the neighbourhood of the capital-designate, Lusaka, a correspondent says that it is certain that much more attention will be given in the future to the quest for precious minerals, which hitherto has been regarded as a small side line, and has been pursued only in a random way. Vanadium from Broken Hill is also taking a much more conspicuous place in the outputs.

BRISBANE

September 22.

Mount Isa Reports.—Official reports for August from Mount Isa, North Queensland, show that the bullion railed to the coast during the month contained 2,242 tons of lead, worth £26,773, and 158,550 oz. of silver, valued at £9,249. The quantity of ore treated at the mill was 26,955 tons, the concentrates from which totalled 5,608 tons. On account of the excess of material on hand for smelting, the total production of ore for the month was somewhat less than the tonnage mined during July. Operations, the local mining warden says, will presumably return to normal as soon as this excess material is used up. Alterations have been in progress at the sintering plant and when these are finished the rate of smelting by the blast furnaces will be materially increased. The grade of ore produced on the Black Star lode, where operations in August were normal, was practically the same as in the preceding month. The high-grade carbonates were got from the Rio Grande lode, so that there was no stoping in the Black Rock section. By means of diamond drilling and driving, development and exploration work in the sulphide zone on the main haulage level was continued. Owing to the variations in the requirements of mill concentrates for smelting work, stoping in the sulphide zone of the Rio Grande section was discontinued during about one-half of the month, necessitating the laying off of some of the men for a time. In the south end of the lode on the main haulage level the ore veins were encountered for which search had been made after the information projected from diamond drilling had been checked.

Metallurgical Problems and Gas.—The Government Inspector of Mines makes some reference to the metallurgical problems which have presented themselves at the Mount Isa smelters, but which, it has been explained, are such as are incidental to the development of all plants. Mr. Young reports that these problems had recently to be grappled with, chiefly in connexion with the Dwight-Lloyd sintering process, but says that latest advice is that the difficulties met with have been practically overcome. He also states that some inconvenience has been caused through the appearance in the main haulage level of carbonic acid gas, which issued from the rock on the eastern side of the drive. The installation of a fan and air-jet not proving sufficiently effective, although doing some good, the erection of a larger fan, as an effective means, was started, and is probably in commission ere this.

Claim for Longer Working Hours.—A claim, on behalf of the Mount Isa Mines, Ltd., for an award extending the hours of underground workers from 44 to 48 a week has been before the Queensland Industrial Court. Hitherto surface workers only have been employed 48 hours and the request was for a consolidation of the different awards under which the company's employees work, so that the longer time should apply to all. The court, however, refused the application, declining to depart from the general Australian standard hours for employees working underground. The court at the same time refused an application by the unions concerned to reduce the time worked by all employees to 44 hours. It was held that the longer hours for surface men had not been shown to be detrimental to the health of surface workers and that the time was not opportune to increase in any way the company's costs of production. It was affirmed on behalf of the Mount Isa Company that, with the present low prices of lead, zinc, and silver, Mount Isa could not treat its average-grade ore profitably, and was compelled for the moment to extract ores having a higher value ; also that the company was not making any profits. It was likewise stated that, with the 48-hour week asked for, a saving of £50,400 a year could be made.

Refining Mount Isa Lead.—When Mr. Leslie Urquhart first announced the intention of the Mining Trust, Ltd., with regard to Mount Isa, he said it was hoped that the whole of the treatment work, including the lead refining would be done in Queensland, and enquiries were made as to the feasibility of erecting a hydro-electric refinery on the Northern coast of this State. It has now,

however, been definitely stated by Mr. J. M. Callow, the company's designing and constructing engineer, when passing through Brisbane on his return from the mine to London, that this has not been found to be practicable, because the saving in freight rates by the erection of a local plant would not be enough to warrant the expense ; also because there would be no market in Queensland for the by-products from the refinery.

Murdoch Copper Process.—The operations of the company (Cloncurry Copper, Ltd.) which has in hand the trying out of the Murdoch copper treatment process at the Vulcan mine, 30 miles south of Cloncurry, North Queensland, are being watched with considerable interest by those concerned in copper mining. The distinctive feature of this process, as compared with other leaching methods, is the precipitation of the copper with lime, instead of with scrap iron or electrolysis. The plant at the Vulcan mine now has been completed, and a trial run was given to the engine and crushing machinery in August. The crushing section was found to be in good running order and capable of handling the estimated daily quantities of ore, but much trouble was experienced owing to the dusty nature of the ore being dealt with. After a quantity of 100 tons had been crushed, the plant at the end of last month was closed down for a week or two in order that a change might be made from dry to wet crushing. There has since been a satisfactory trial of a portion of the leaching and precipitation sections, and the whole of the plant is expected to be in full operation as soon as the dust nuisance, caused by the dry nature of the ore, has been overcome.

British Interests in Queensland.—The British company, Gold Mines of Australia Ltd., has closed on the last of the options which they have held on gold mines at Mount Coolon, North Queensland. The lease of one of these mines, owned by the Mount Coolon Gold Mining Company, was bought right out in July of last year for £26,000. Now the British company has exercised its option over the Native Bear mine, known as Barclay's, which it has bought for £75,000. During the term of the option over £80,000 has been spent in active exploration work, with the result that the large tonnage already opened up and in sight will be such as to very much swell the gold production of Queensland. Since Gold Mines of Australia started mining development work in May, 1930, the Mount Coolon goldfield has produced over £200,000 worth of gold from within 100 ft. of the surface. The company itself, however, has not yet begun production, but has done everything possible to prove for big-scale operations the mines which it now owns. Besides the Mount Coolon and Native Bear. the company holds in its own right two other leases, the total area possessed being about 80 acres. On the authority of the Queensland Minister for Mines (Mr. A. E. Atherton) it is stated that many enquiries are still coming to hand from mining people overseas who want concessions in this State on which they are prepared to spend from £5,000 to £10,000 a year in prospecting. By an Act passed last year obstacles previously existing to the expenditure of outside capital were removed, and the attention of these would-be investors thus was attracted to promising mining ventures in this country.

Shale Oil Mining.—Work has been resumed by the Shale Oil Development Committee, Ltd., at Wolgan, in the Newnes Valley, New South Wales, after the field had been closed for nearly eight years. This committee, which has been registered as a company, has undertaken to spend £93,000, the New South Wales portion of a grant of £100,000 provided by the Federal Government for the repatriation of surplus men in the coal-mining industry. The Federal Minister for Development lately stated, in connexion with the unemployment problem, that careful investigations into the possibilities of shale oil had led to the conclusion that direct employment in this industry would be available for 40,000 men and indirect work for 60,000.

Broken Hill Proprietary Company.—At the annual meeting of the Broken Hill Proprietary Company, Ltd., held in Melbourne the other day, the chairman made special reference to the decision of the directors to turn attention to gold mining. The lead-zinc mine of the company at Broken Hill has been closed, and its principal activities are at Newcastle, where the steel works are evidence of its enterprise, and at other places in Australia where the raw materials for steel manufacture are obtained. A large number of likely gold properties have during the past year been brought under the notice of the directors and a thorough inspection and prospecting campaign is at present in progress. The principal object in view is to secure a large low-grade gold-bearing formation, capable of being

thoroughly tested, and in the operation of which profits will depend more upon efficient management than the vagaries of values that are usually associated with richer deposits. A short time ago this company took an option over some mineral leases (called the Silver Casket) about seven miles from Mount Isa, but subsequent to the annual meeting dropped the proposition, the reason given being an adverse report made by a Queensland Government geologist.

Broken Hill Central Power.—It was on July 18 last that the new central power station of the western New South Wales Electric Power Proprietary Company, Ltd., took over the continuous electric load of the North Broken Hill, Broken Hill South, and Zinc Corporation mines. Since then the new plant has run without untoward incident—an achievement that is regarded as remarkable for so large a plant and one so unique in type. The station is also to supply the three mines named with compressed air, but its equipment for this purpose is not yet fully complete.

IPOH

October 9.

Metal Prices.—In the last ten days of September the price of tin showed a material improvement in terms both of Sterling and of local currency, and though there have been quick declines from peak quotations the net result of movements is locally favourable. It is fully realized that the fluctuations of rates of exchange have been a large factor in these movements, and that it may be premature to count upon much continued appreciation.

Statistics.—The position as at the end of September is stated to be as follows :—

Visible supplies . .	50,408	tons.
Consumption . .	8,600	,,
Supplies . . .	8,100	,,
Shipments from Straits .	6,285	,,

September shipments of 6,285 tons from Straits are nearly as estimated, and the statistics for that month are generally satisfactory. The bad conditions in China, United States and parts of Europe are unfavourable to consumption, and tend to offset improvements in the position which would otherwise result from restriction.

Grouping.—The permissions for grouping have given very valuable assistance and, with the additional facilities recently authorized for transfer of quotas by producers, have contributed greatly towards continuation of regular work, especially by selected small mines, and to the avoidance of unemployment and destitution.

Repatriation.—Returns were required in August from mines employing Chinese to show how many employees would be discharged as the result of the 60% cut in output and of conditions generally and the Government was thus enabled to make efficient arrangements for repatriation. From Perak all were put on board ship at Penang and not landed until at their port of destination. Between August 15 and the end of September nearly 8,200 unemployed Chinese and about 1,000 decrepits were repatriated. Since the end of September the numbers leaving are much less and it seems unlikely that there will be any very large additional repatriation if conditions remain as at present. In the same period the numbers of Chinese repatriated from Selangor, Pahang, and Negri Sembilan together amount to about half the total from Perak.

TORONTO

October 19.

Porcupine.—The output of the gold mines of the Porcupine area during September showed a substantial increase over that of the previous month, amounting in value to $1,981,572, as compared with $1,692,709, although the tonnage milled was slightly lower. The mill of the Hollinger Consolidated is treating about 5,000 tons per day, with millheads averaging about $6·50 a ton. Large tonnages of ore for milling are being drawn from the open-cut surface deposits, but with the setting in of cold weather the supply will come from the mine proper, which should considerably increase the recovery. Mine development is proceeding satisfactorily, some new ore sections having been opened up, which show improvements in value. Preparations are being made for sinking towards the 6,000 ft. level and diamond drilling has indicated that ore deposits below the present workings show greater enrichment than those now being worked. Throughout the greater part of this year the mill of the Dome Mines Ltd. has been treating ore at the rate of about 1,500 tons per day. Up to the end of September production totalled $2,644,674 from the treatment of 405,577 tons of ore, of an average grade of $6·52 per ton. Opera-

tions are being pushed in the new high-grade section located on the 16th level, with values stated to average better than $15 to the ton. Good showings have also been opened up on the 18th level. The new mill of the McIntyre is working at full capacity treating 2,000 tons of ore per day, the ore ranging between $7 and $8 per ton. It is recovering about 50 cents more gold per ton than did the old plant. The company has entered upon an extensive development plan, involving the sinking of a winze from the present 3,875 ft. level to the 6,000 ft. horizon. It will enable the exploration of an important new vein, that is marked by a width of 64 ft. of quartz, which is believed to have good possibilities at depth. At the Coniaurum between 350 and 360 tons of ore are being treated per day, with millheads averaging about $6 to the ton. Development is being actively carried on on No. 2 vein, which has been opened up on the 850 ft. level with good values and a cross-cut is being run towards it on the 1,000 ft. level. Operations at the Canusa have been somewhat restricted owing to the shortage of power. Ore for the small pilot mill is being drawn from the 100 and 55 ft. levels, where much high grade ore is said to be available. It is proposed to increase the capacity of the mill to 100 tons. The shaft is being sunk to a depth of 600 ft. the ultimate objective being 1,000 ft. The Ankerite is being dewatered, preparatory to the resumption of operations, an extensive development programme having been planned. During the quarter ending September the Vipond recovered $115,656 in bullion from the treatment of 23,715 tons of ore. New ore has been encountered on the 500 and 600 ft. levels and cross-cutting at the 1,450 level has reached the extension of the Porcupine Crown vein system.

Kirkland Lake.—Bullion to the value of $1,781,573 was produced by six mines of the Kirkland Lake camp during September, as compared with $1,758,015 for August. The Lake Shore has opened up a rich ore deposit on the 2,200 ft. level. This is stated to be 66 ft. wide carrying $20 to the ton in gold, and other important additions to the ore reserves are being made. The mill is now treating 2,500 tons a day and in view of the large tonnages of ore now available the management is now preparing to instal a new unit, bringing the milling capacity up to 4,000 tons of ore a day. For the year ending August the gross earnings of Teck-Hughes are estimated at $6,049,879, as compared with $5,318,033 for the previous year. Operating cost totalled $2,113,548, as against $2,185,719, which leaves a net profit after taxes and depreciation of $3,311,639, as compared with $3,051,886. Recent operations on the 25th to the 30th levels are opening up values well above the average mine run. Millheads from the ore now going to the mill range between $14 and $15 in gold to the ton. The Wright Hargreaves has started work on the new central shaft, which will be carried down to a depth of 4,000 ft. and on completion the present two shafts will be carried down to a similar depth. New ore sections carrying high values in gold are being rapidly opened up, the ore at the 3,000 ft. horizon being wider and richer than on the levels above. The mill is treating from 750 to 800 tons daily. At the Sylvanite steady progress is being made with the sinking of the No. 2 shaft, which is now down some 2,600 ft. No. 4 shaft is also being deepened to 1,750 ft. An ore zone showing values of from $15 to $20 has been cut on the 200 ft. level and a cross-cut on the 1,600 ft. level has cut ore stated to run $45 to the ton over drive widths. The Bidgood has obtained good results from driving on the 325, and 500 ft. levels, and two new levels will be opened up. The Kirkland Lake gold mine is increasing its output, with millheads running $17 to the ton. New discoveries of high-grade ore sections have been made in the lower working. Work is being pushed on the 4,100 ft. level, where the vein shows a width of 15 ft. and yields high assays. The drive into the Macassa from the adjoining Kirkland Lake property has encountered a vein showing good values which has been opened up for 50 ft. The Barry-Hollinger is opening up the 1,875 ft. level with good showings of high-grade ore. A winze will be sunk to the 2,000 ft. level to follow up the continuation of the vein.

Sudbury.—Mining activities in this field will be aided by the completion of the transmission line of the Ontario Hydro Electric Power Commission, which has arranged for a supply of electric energy from the Ontario Power Service Company. The contract of the Commission calls for a present supply of not more than 24,000 h.p., which will be sufficient to meet the requirements of the district. The International Nickel Company, in view of the restricted demand for nickel recently decided to curtail

mining and smelting operations. Coniston smelter operations have been confined to one furnace instead of two, the work at the Garson mine has been restricted to one shift per day, and the output at the Creighton mine has been reduced by 50%. Normal shipments of matte to Port Colbourne are continuing. Contrary to the policy adopted by many other leading industrial concerns, in the United States and Canada, the wages and salaries have not been reduced during the present crisis. Mine and smelting operations at the Falconbridge continue on an unrestricted scale. Production for September averaged 357 tons of ore per day, the highest since the commencement of operations, and matte production continues at the rate of nearly 400 tons per month. Sinking on the new subsidiary shaft, for back filling and ventilation purposes, has reached a depth of about 75 ft. where further progress was halted by quicksand. Ore for smelter is being drawn from the 350 and 1,000 ft. levels. Owing to the fact that the company had big ore reserves blocked out, no attempt has been made to carry out an extensive development campaign this year. A new gold strike, regarded as important, is stated to have been made on a property owned by Dominion Explorers Ltd. near Stoney Portage, west of Sudbury. The Consolidated Mining and Smelting Company also owns property in this neighbourhood on which a wide vein showing high-grade ore has been opened up.

New Goldfields.—Prospecting for gold has been actively carried on during the season in various directions, resulting in the opening up of several new goldfields. The Mining Corporation of Canada Ltd., through its subsidiary Ashley Gold Mining Corporation Ltd., has taken the lead in opening up the Matachewan district in Northern Ontario, where it has secured 18 claims on which active development is being carried on. A shaft is being put down and has reached a depth of 250 ft. and a diamond drilling campaign has disclosed good commercial ore at depth. The Davidson property to the northwest of the Ashley holdings is opening up well. The Hilltop Gold Mines has optioned a number of claims and is carrying on exploration. Another area which is attracting much attention among prospectors is situated near Stoney Portage south of Missanabie in the Algoma district of Ontario. The Consolidated Mining and Smelting Company has taken up some 40 claims on which promising veins have been found, a large force of men are engaged in exploring the property. Important gold discoveries are reported to have been made at Big Timber Creek, 65 miles northwest of Morley, Alberta, followed by a rush of several hundred prospectors.

Rouyn.—The Noranda is operating its concentrator and smelter at full capacity with a production of approximately $100,000 in gold per week and copper to the value of about $400,000 per month. In an official statement by President James J. Murdock, it is pointed out that the precious metal production is being maintained at an approximate rate of $5,000,000 a year, while the sinking of Nos. 3 and 4 shafts an additional 500 ft., to a depth of 2,500 ft., and the consequent lateral work, is with the object of placing the company in a position to continue its present rate of production for some time. Exploration by diamond drilling and rising on the westerly end of the H. orebody, between the 100 and 400 ft. levels has indicated approximately 60,000 tons of ore, averaging something over $35 per ton in gold, and 2·4% copper. Siscoe Gold Mines Ltd. for September made a new high record with a gold production valued at $83,623, the average value of the ore treated being $16·26. Development work has been followed by discoveries which have added to the ore reserves. The Granada Gold Mines is carrying the workings to greater depth, the winze going down on the number 2 vein has reached a depth of 800 ft., with a level established at 775 ft., on which driving is being done east and west on good grade ore.

Manitoba.—During the first six months of the year Manitoba moved up from ninth to sixth position among the Provinces in point of value of its mineral production. The output for the first six months of 1931 was valued at $1,236,417, as compared with $378,950 for the corresponding period of 1930. The increase was mainly due to the operation of the smelter of the Hudson Bay Mining and Smelting Company at Flin Flon.

Radium.—Development is being actively pushed by the International Radium and Resources, Ltd., on its property near Wilberforce, Ont. A small concentrator will be installed close to the mouth of the tunnel, where development is taking place, the work continuing to indicate a deposit of uraninite ore from which radium can be recovered in commercial quantities.

VANCOUVER

October 6.

Placer Mining Opportunities in B.C.—In view of the revival of interest in placers in British Columbia, a special report that has just been issued by the Provincial Department of Mines reviewing conditions and indicating the opportunities that still exist for this form of gold mining, is particularly timely. Prospecting this year has been more than usually active consequent on the general lack of employment, and while no new discoveries of major importance have been made, a considerable amount of gold in the aggregate has been won by prospectors working with pan and rocker in many parts of the Province, and especially along the Fraser, Thompson, Similkameen and other rivers, where bars which have been unworked for years have again been attacked. Placer mining in British Columbia, as is well known, dates from 1858, following the discovery of gold on the Thompson River in the preceding year, which led to the great influx of gold seekers from California and elsewhere who, following up the Fraser River, succeeded in discovering the rich Cariboo diggings. To date the production of placer gold amounts to a total value of $87,588,949, but in recent years the output has been quite inconsiderable, declining in 1929 to the minimum level of $118,711. Last year it increased to $152,235 and it is expected that there will be a further increase in yield this year. As a matter of fact a great deal of work of a preliminary character, such as testing, has been in progress in various sections of the Province during recent seasons, and in some cases productive results from these operations should ere long eventuate. That opportunities still exist for the discovery of important new fields is indicated in the reports of Mr. Douglas Lay, Resident Engineer of the North Eastern Mineral Survey District; the special report by Mr. C. W. Moore on Cariboo, Quesnel, and Ominica Divisions, the appraisal of the placer resources of the Pacific Great Eastern Railway Lands by Dr. R. W. Brock, and the report by Dr. J. T. Mandy, Resident Engineer of the North Western Mineral Survey District with special reference to the Atlin and Dease Lake areas.

Pacific Great Eastern Railway Lands.—The report by Dr. Brock was made in connexion with a special survey of the natural resources of large blocks of land reserved for the purposes of the Pacific Great Eastern Railway, and was undertaken jointly by the Government of the Province, the Canadian Pacific Railway and the Canadian National Railway. These blocks consist of what is known as the East Cariboo Block lying west of the Fraser River in the vicinity of Quesnel; the West Cariboo and West Lillooet Block lying west of the Fraser and south of the Chilcotin River, and the Peace River Block covering a large area on the Upper Peace and Parsnip Rivers. The East Cariboo Block, at least as far South as the Moffatt Creek basin is part of the Cariboo placer field, and Dr. Brock states that conditions in this northern portion for large accumulations of placer gold are perfect, namely, large areas of mineralized rock and long-continued weathering and erosion to separate and concentrate the gold from vast masses of such rock. He adds, the mineralization here seems to be at least as heavy as in the Barkerville area, and the old maturity of the topography is a witness to the great amount of erosion. Dr. Brock points out that the bulk of production from the Cariboo to date has been from the creeks within a few miles of Barkerville; but this must not be taken to prove that these creeks contain more gold than all others, but only that the gold was easier to discover and extract. Indeed, that rich concentrations were not confined to Barkerville was demonstrated when in 1921 what was perhaps the richest small patch of ground ever found in the Cariboo was discovered near the head of Cedar Creek, just outside the northern boundary of but in the same placer area as the East Cariboo Block. In brief, the chief reason for the Barkerville production was that conditions there were simpler; pay-dirt was not deeply buried and could be reached and handled by crude methods or light machinery. The creeks were worked down-stream until the overburden became too heavy for such methods and work was discontinued. To-day conditions are improved, for the railway and good motor-roads have reduced costs and permit heavy modern machinery to be brought in, so that what was impossible to undertake in pioneer days may now be feasible and profitable. However, except in the Cariboo mountains, where local glaciers have probably removed the old gold-bearing Tertiary gravels, natural conditions in the East Cariboo Block are much more complex than in the Barkerville area. A further complication lies in the alteration in the drainage line. Some

changes were produced as the result of glacial damming, either temporarily by ice itself or by its deposits. This switching of drainage, Dr. Brock states, is the most striking physiographic phenomenon of the area and it signifies that there are a great many old channels to be located. Since the conditions described are different from those in any other known placer field, in order to discover and trace many of these old channels, highly detailed, refined geological study is necessary. Dr. Brock nevertheless considers that the placer potentialities of the area are very considerable and, after making due allowances for all adverse factors, remarks that there must be a great deal of ground that could be profitably handled and might support large enterprises over a long period of time. For these to be successful, however, work must be undertaken in a scientific and business-like manner. What is first required is intensive geological study, followed by geophysical testing to determine the old channels, followed by a determination of the distribution of gold in them by drilling, and other methods of testing, together with a determination of the quantity and distribution of available water. The precise engineering problem to be solved would thereby be outlined. It is believed that efficient exploration of this kind, despite its cost, could easily be justified by the expectation of subsequent mining operations on a large scale, provided it were undertaken by an organization that owned or controlled the rights to a sufficiently large area of productive ground. In brief, the maximum chance of success and the maximum recovery would appear to depend on large-scale operations. There also appear to be interesting possibilities in the West Cariboo and West Lillooet Blocks. Between 1857 and 1859 the gold-bearing bars and benches of the Fraser yielded, it is estimated, $1,700,000, and subsequent mining brought the total up to at least $4,000,000. These bars have been worked by skimming, for water and other difficulties have discouraged bedrock mining from which the greatest values might be expected. Dr. G. M. Dawson pointed out that throughout its long history the Fraser has acted as a great ground sluice, separating the precious metal from the gold-bearing rock débris that it has carried seaward. Dr. Brock remarks that bedrock can be seen at many points, so that by a careful study of the problem of engineering, a successful method might be devised of exploiting the bedrock gravels. He considers that the gold possibilities fully warrant such a study. Moreover, many of the bench deposits have never been touched and afford opportunity therefore for hydraulicking enterprises.

Atlin District.—Concerning possibilities for increased gold production from the Atlin district, Dr. J. T. Mandy, Resident Engineer for the North Western Mineral Survey District, is most sanguine. There was indeed an increase of output in 1930 as compared with the 1929 years and this year a further increase will be recorded. Dr. Mandy however, considers that the section has not yet received the attention it warrants. Even from the present known gold-bearing area a substantially increased production is not only possible, but latent potentialities remain unexploited, and " these possibilities may produce a greater quantity of gold in the future than has been won from this area in the Bonanza days of the past." Thus it is suggested that west and east of the divide between the Surprise Lake and Gladys Lake drainage basins, over a length of about 60 miles, numerous creek-troughs would seem to warrant intensive investigation for virgin deposits of both shallow rich ground tractable to the individual operator and deeper ground suitable for drifting or hydraulic operations. In this respect the drainage area of Consolation Creek, Lincoln (Chehalis) Creek, Zenazie Creek, and the numerous creeks draining easterly into Sucker River are worthy of particular mention. All these drain from the easterly side of a divide on the westerly side of which are the numerous creeks known to be gold bearing. As geological and erosional conditions on both sides of this divide are similar, it is logical to assume that the gold-bearing potentialities of the creeks on the west of the divide may possibly be duplicated in those on the east side. The same reasoning would apply to the creeks, and those of the upper reaches of the O'Donnel River. Some of this area has received cursory prospecting only, and its systematic investigation, particularly with regard to possible hydraulic operations, would seem to be warranted. In the known gold-bearing creeks, operations subsequent to those of the old-timers have been continued in drifting and hydraulicking in the bench and deeper ground with some shovelling from remaining virgin patches in the creeks, and in some cases the re-working of old

tailings. This practically embraces the activity of recent years, with its confinement to the originally prospected area. Considering that the greatly improved transport facilities into this area have made the outlying territory easily accessible, it is unfortunate that no serious consideration or effort has been given to the possibilities for important placer-gold discoveries in likely new sections.

Premium on Gold.—The fall in Canadian exchange in New York has had the effect of benefitting those of our mining industries which are marketing their product in part or entirely in the United States. In particular the gold mines have derived advantage. No embargo has been placed on the export of gold at the time of writing,[1] but in the East, the Ottawa Mint is purchasing Canadian gold in terms of the American dollar, less a small deduction to cover express charges from Ottawa to New York. For the present, however, the premium is not payable on gold deposited with the Dominion Assay Office in Vancouver and consequently the gold now being produced in British Columbia and the Yukon has been diverted to Seattle. The gold normally consigned to the Vancouver Assay Office is as a rule in small parcels with the exception of the periodical shipment of the Consolidated and the Pioneer, but these consignments in the aggregate amount to a considerable quantity in the course of the year.

Coast District.—On Phillips Arm development work is proceeding with very encouraging results on a small gold property known as the Alexandria. The ore is pyrite in a gangue of quartz and carries fair values —from $8 to $12 in gold. The two-compartment shaft has now been sunk to a depth of 275 ft. and driving in progress on the 100-ft. level has already demonstrated that the vein here is considerably longer than on the upper horizon. The ore shoot which is being followed is about 6 ft. wide and averages $12 in gold. It is understood that negotiations are in progress for the acquisition of the property by one of the larger operating companies. Production on a curtailed schedule is being maintained from the Britannia at Howe Sound. The company is conserving so far as possible its higher-grade ore-reserves and is drawing mainly broken ore of a lower grade. As a result of some improvements in milling practice as well as of well-co-ordinated effort to reduce costs to the minimum the Britannia now ranks among the low-cost copper-producing mines of the Continent. Although an American-controlled company the policy that has been persistently followed has aimed at insuring that a maximum benefit from the operation shall be derived by Canadians. Thus so far as possible not only are all materials and supplies used by the company purchased in this country, but most of the members of the technical staff are Canadians. The Mine Superintendent is Mr. C. V. Brennan, a graduate of McGill and practically all his engineering subordinates are graduates of the University of British Columbia.

Portland Canal.—There has been some revival of mining activity in this district of late. Two new promising prospects are now under development, one having been optioned to the Premier Gold Mining Co. This is known as the Salmon Gold Group and is situated on the west side of Summit Lake at the divide between the Salmon River and Nass River drainage basins. Here there are three siliceous replacement-zones in augite-porphyrite, heavily mineralized with massive pyrrhotite, associated with some pyrite, chalcopyrite, zinc-blende, and galena, and carrying fair values in gold. Some assays have given as high as 2·68 oz. to the ton. While milling has been suspended at the Big Missouri, mine development is being continued. The mill was installed essentially for the purpose of bulk sampling, and the cessation of work may merely imply that this object has now been achieved. The last report of the Consolidated Mining and Smelting Co. stated that commercial ore over mineable widths had been indicated by diamond drilling, and it is quite possible that the property may develop into a profitable low-grade large tonnage operation. It is meanwhile to be noted that arrangements have been made for the resumption of development operations on the Georgia River Gold Mines. The work was suspended on account of lack of funds last year although the results up to that time had proved encouraging. If the next stage of development realizes the expectations of the company, the erection of a mill may be justified.

Bridge River.—Activity in this district is particularly marked. The Bralorne Mines, Ltd., operating the Lorne mine, decided this month to proceed with the installation of

[1] The embargo became effective on October 19, after this letter was written.

a 100-ton mill, the machinery for which has been purchased from the Dunwell Co., whose mill at Stewart, after being in operation for only a short time, has been idle since 1928. The Bridge River Exploration, Ltd., has acquired the Shepherd-Wihksne Group of claims, which are said to be promising, and a placer operation of some magnitude is being undertaken by Lower Bridge River Placers, Ltd., which has acquired five bench leases and several creek leases on the Bridge River, about five miles below Horseshoe bend. Reporting on this operation the District Resident Engineer states that on the north or inner side of the wide sweep taken by the river there is a large accumulation of tailings from old-time operations along a lower bench reaching to a height of about 40 ft. above the stream.

Trail.—With the exception of gold the production of the Consolidated Mining and Smelting Co. during the third quarter of the present year showed a considerable decline as compared with the returns for the corresponding period of 1930. Production for this quarter amounted to: Gold, 6,065 oz.; lead, 30,962 tons; zinc, 24,059 tons; copper, 143 tons; and silver, 1,721,504 oz.

PERSONAL

H. Foster Bain has resigned his position as secretary of the American Institute of Mining and Metallurgical Engineers and will be succeeded by A. B. Parsons.

B. S. W. Buffam has left Ontario for Buffalo.

E. W. Byrde is returning from Nigeria.

J. M. Callow and M. J. Callow have returned from Queensland.

G. W. Campion has left for West Africa.

Oscar S. Dawbarn is home from the Straits Settlements.

B. C. W. Gullachsen is home from Norway.

J. A. L. Henderson is home from Canada.

A. N. Lucie-Smith has left for Venezuela.

G. R. Matthews has returned from Nigeria.

James Park has resigned his post as Dean of the Mining Faculty and Professor of Mining Geology in the University of Otago.

F. W. Payne has left for Australia.

T. Penhale is returning from Nigeria.

Thomas Pryor has left for India.

W. E. Sinclair is leaving for South Africa.

J. H. Southwood having returned from Nigeria is proceeding to Sierra Leone.

W. E. Thorne has returned from Central America.

W. R. Tretheway is leaving for Brazil.

A. H. E. Turner is home from West Africa.

K. S. Twitchell is on a visit to Arabia.

Louis A. Wright is visiting South and Central Africa.

TRADE PARAGRAPHS

Austin Hoy and Co., Ltd., of Bush House, London, W.C. 2, draw attention to their coal cutter gibs and chains, concerning which they issue two leaflets which are fully descriptive.

Bureau of Information on Nickel of the Mond Nickel Co., Ltd., Imperial Chemical House, Millbank, London, S.W. 1, publish a further bulletin devoted to nickel-copper alloy condenser tubes, which contains examples of their applications.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E. 7, issue a pocket edition of the catalogue of their products. This covers 140 pages, and includes reference to sheet-metal manufacture and woven-wire work of all descriptions.

Westinghouse Electric International Co., of 2, Norfolk Street, London, W.C. 2 (Head Office: New York), publish a catalogue describing carbon circuit breakers which is fully informative as to their use. They also issue a leaflet giving particulars of a new type of contactor.

Hopkinsons, Ltd., of Huddersfield, send us a new catalogue of their parallel slide valve which is suitable for use in pipe systems whether for steam, boiler-feed water or cold water, air, or oil. They are made in either cast iron or steel depending on the pressures to be withstood.

Adam Hilger, Ltd., of 24, Rochester Place, London, N.W.1, publish Bulletin No. 3 dated June, 1931, on the subject of spectrum analysis. This deals with applications of these methods to mineralogy, chemistry, and metallurgy and cites references to the work of various authorities.

British Jeffrey-Diamond, Ltd., of Stennard Works, Wakefield, send out a leaflet giving particulars of their products, mainly of interest to coal miners, which include conveyors, gate-end loaders, storage battery and trolley locomotives, switchgear and compressed-air and electric mining motors.

Edgar Allen and Co., Ltd., of Sheffield, announce that they have received a contract for the supply and erection of a complete Portland cement plant, which will be situated in Sussex. The factory is designed for an ultimate capacity of 180,000 tons per annum, and will comprise three units of 60,000 tons, the first of which is now being installed. The equipment is to include recuperator type rotary kiln, Rexman balanced rod-mills and the Fuller-Kinyon cement conveying equipment.

Leeds and Northrup Co., of Philadelphia, Pa. (agents for the British Isles The Intergra Co., Ltd., 183, Broad Street, Birmingham), publish a catalogue covering 45 pages, which is fully illustrated and descriptive of their Micromax improved potentiometer pyrometer. This is made in a number of ranges and types and includes those for automatic recording and automatic temperature control. Details are given of the working of the different instruments and of the necessary auxiliaries such as thermo-couples.

Atlas Diesel Co., Ltd., of New Oxford House, Hart Street, London, W.C. 1, announce that their works at Stockholm have granted a manufacturing licence for the "Polar" two-cycle airless injection Diesel engine to **British Auxiliaries, Ltd.,** of Helen Street, Govan, Glasgow. The latter company, which

was formerly known as the Fiat British Auxiliaries, Ltd., has been reconstructed and will manufacture British " Polar " engines of the various types and sizes which will, however, continue to be sold through the existing selling organization.

Holman Bros., Ltd., of Camborne, draw attention to the fact that the statistics issued with the annual report of the Government Mining Engineer in the Union of South Africa disclose that at the end of December, 1930, the firm had the largest number of rock-drills employed on the gold mines—2,999. In other words, for the first time in the history of the Rand a British firm was in the position to claim that it headed the list of suppliers of rock-drills to the greatest goldfield in the world. This is an achievement upon which all concerned are to be heartily congratulated, and it is the more noteworthy at a time when British manufacturers are admittedly having a hard fight to maintain their position in the world's markets.

Mine and Smelter Supply Co. (Marcy Mill Division) of Denver, Colorado, publish new catalogues devoted to Marcy ball-mills and rod-mills. Both these products are too widely known to need any special description. The catalogue recalls the early tests carried out in 1917 to prove the efficiency of this type of mill, which was done at the Inspiration Consolidated Copper Company's property. The mill was first introduced, however, at the Utah Copper Co. and later at the Magma Copper Co., where was installed the largest tonnage ball-milling plant in the world. There followed the installation at Braden, Kennecott, Arizona-Hercules, Ray-Hercules, The United States Smelting and Refining Co., and a number of others. While the Marcy mill is perhaps not so well known outside the United States and Canada it is finding its way to other parts of the world and is included in the mill of the Roan Antelope mine, as was indicated in the article published in the MAGAZINE for November, 1930. Marcy rod-mills it is stated have their principal application in the paper industry, where they are used for reducing pulp.

METAL MARKETS

COPPER.—The tendency of the Standard Copper market in London was rather firmer during October, values recording a moderate advance, but this was possibly partly due to the movement of sterling exchange, the £ weakening from 3·92–3·95 at the beginning of the month to 3·84–3·86 at the close. The American quotation for electro was steady at 7·25 cents per lb. f.a.s. Industrial demand everywhere was rather subdued and the market was inclined to await the outcome of the New York copper conference which commenced, at least unofficially, in the closing days of October. Some producers were in favour of a further heavy output " cut."

Average price of Standard Cash Copper : October, 1931, £35 0s. 1d. ; September, 1931, £31 11s. 1d. ; October, 1930, £43 1s. 5d. ; September, 1930, £46 6s.

TIN.—Standard Cash Tin values in London hardened from the neighbourhood of £120 at the beginning of October to about £131 on October 15, but subsequently reacted to £127. In America the quotation advanced from 22·25 cents to 23·37½ cents, subsequently receding to 22·87½ cents. Consumption remained subdued, but hopes are held that at last the measures taken by producers will soon make themselves evident in the statistical position. Surplus stocks are of course heavy and some considerable time will have to elapse in any circumstances before these can be drastically reduced.

Average price of Cash Standard Tin : October, 1931, £127 0s. 9d. ; September, 1931, £117 17s. 10d. ; October, 1930, £117 11s. 1d. ; September, 1930, £132 14s.

LEAD.—The market opened weak on October 1, but this was mainly owing to " jumpy " sentiment, connected with uncertain exchange movements, and prices subsequently improved somewhat. Business, however, was not too good, apart from certain outlets in this country, and both Continental and American advices were gloomy. The American quotation receded from 4·40 cents to 4·00 cents per lb. during the month and conditions in the lead consuming trades on the other side of the Atlantic are reported to have taken a further turn for the worse. The outlook is very uncertain, dependent as it is on exchange considerations and further developments in the international political situation, but there is an encouraging undercurrent of optimism in the market.

Average mean price of soft foreign lead : October, 1931, £13 4s. 11d. ; September, 1931, £11 19s. 6d. ; October, 1930, £15 14s. 2d. ; September, 1930, £17 17s.

SPELTER.—This market manifested a moderately firm tone throughout October, despite only a moderately active demand, and was surprised towards the close by an announcement that the Zinc Cartel had decided to curtail output by a further 5% as from December 1 as stocks during September had increased by 1,000 tons. The stocks held by the Cartel's members now amount to about 197,000 tons—a pretty formidable total and despite the drastic output-reduction measures which have been taken it would be rash to look for any early statistical improvement.

Average mean price of spelter : October, 1931, £12 19s. 5d. ; September, 1931, £11 16s. 4d. ; October, 1930, £14 13s. 9d. ; September, 1930, £15 18s. 5d.

IRON & STEEL.—The British pig-iron market benefited during October from the depreciation in sterling, which resulted in a revival of trading confidence and industrial demand so that makers were able to encroach heavily on their substantial surplus stocks. Cleveland minimum prices, however, were maintained with No. 3 G.M.B. quoted at 58s. 6d. Hematite firmed up, East Coast Mixed Numbers being dealt in towards the close of October around 65s. Output is still on a restricted scale, but should the business improvement continue more furnaces will probably be blown in. As regards iron and steel, British mills do not appear to have secured very much benefit so far, but the situation may be changed in their favour if the National Government decides to give the industry protective tariffs. The Continental steel market has remained dull and sluggish on the whole, the world trade position having undergone no improvement at all.

IRON ORE.—Although the pig-iron position in this country has improved somewhat since the suspension of the gold standard there has been no corresponding expansion in the demand for iron ore, most ironmasters having plenty of ore on contract. Prices are somewhat nominal on the basis of about 17s. per ton c.i.f. for best Bilbao rubio.

ANTIMONY.—At the close of October English regulus was realizing between £40 and £42 10s. per ton whilst Chinese metal was dull around £25 10s.

LONDON DAILY METAL PRICES.

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

	COPPER.								TIN.				ZINC (Spelter).			LEAD.				SILVER.		GOLD.	
	STANDARD.				ELECTRO-LYTIC.			BEST SELECTED.								SOFT FOREIGN.			ENGLISH.				
	Cash.			3 Months.					Cash.			3 Months.								Cash.	Forward.		
Oct.	£	s.	d.	£	s.	d.	£	s. d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	d.	d.	s.	d.
12	34	16	3	35	16	3	41	7 6	129	5	0	131	7	6	12	17	6	13	5	0	14	15	0	17½	17 11/16	106	9
13	35	16	3	36	15	7½	42	0 0	130	6	3	132	7	6	13	0	0	13	10	0	15	0	0	17 7/16	17 9/16	106	6
14	35	11	3	36	6	10½	42	0 0	130	17	6	132	16	3	12	16	3	13	7	6	15	0	0	17 9/16	17 11/16	106	6
15	34	18	9	35	13	9	42	0 0	131	2	6	133	6	3	12	10	0	13	5	0	14	15	0	17	17 1/16	106	6
16	34	16	10½	35	13	1½	41	0 0	37	10	0	131	0	0	133	2	6	12	8	9	13	3	9	14	15	0	17 5/8	17 7/8	106	11
19	35	11	10½	36	7	6	41	0 0	—			128	8	9	130	17	6	13	0	0	13	5	0	14	15	0	17 9/16	17 11/16	106	8
20	35	15	0	36	6	10½	41	0 0	37	10	0	127	3	9	129	11	3	13	0	0	13	6	3	14	15	0	17 1/16	17 1/8	105	9
21	35	13	9	36	8	9	41	0 0	—			127	13	9	130	3	9	13	2	6	13	7	6	14	15	0	16 9/16	17	104	8
22	35	16	10½	36	11	10½	42	0 0	—			127	3	9	129	15	0	13	0	0	13	7	6	14	15	0	16 11/16	16 13/16	104	6
23	36	8	9	37	4	4½	42	0 0	38	5	0	126	11	3	129	3	9	13	0	0	13	8	9	14	15	0	17 1/16	17 1/8	105	8
26	36	13	1½	37	8	1½	42	0 0	—			126	15	0	129	8	9	13	1	3	13	7	6	14	15	0	17 1/16	17 1/8	105	3
27	35	19	4½	36	15	0	42	0 0	38	0	0	127	3	9	129	16	3	13	0	0	13	7	6	14	15	0	17 1/16	17 1/16	105	9
28	36	0	7½	36	15	7½	42	0 0	—			127	5	0	129	13	9	13	8	9	13	10	0	15	0	0	17 1/16	17 1/16	105	9
29	35	15	7½	36	11	3	42	5 0	—			126	15	0	129	3	9	13	6	3	13	8	9	15	0	0	17 1/8	17 1/8	106	8
30	35	0	7½	35	11	3	41	10 0	37	5	0	127	3	9	129	11	3	13	2	6	13	8	9	15	0	0	17 3/16	17 13/16	107	3
Nov.																													
2	35	8	9	36	2	6	42	5 0	—			127	10	0	129	13	9	13	7	6	13	10	0	15	0	0	18¼	18 7/16	108	2
3	36	3	9	36	18	9	43	0 0	37	10	0	129	7	6	131	7	6	13	8	9	13	15	0	15	5	0	19 1/16	19 3/16	111	5
4	35	15	0	36	6	10½	42	0 0	—			128	2	6	130	3	9	13	3	9	13	11	3	15	0	0	18¾	18 15/16	110	3
5	36	15	7½	37	8	1½	43	0 0	—			128	13	9	130	16	3	13	7	6	13	17	6	15	5	0	19 3/16	19 5/16	110	3
6	37	8	9	37	19	4½	43	0 0	38	5	0	130	2	6	132	3	9	13	15	0	14	10	0	16	0	0	20 1/16	20 3/16	109	4
9	38	11	3	39	3	9	44	0 0	—			132	16	3	134	16	3	14	2	6	15	0	0	16	10	0	21 1/16	20 7/16	109	3
10	39	3	1½	39	15	7½	44	0 0	40	0	0	134	11	3	136	11	3	14	3	9	15	1	3	16	10	0	21 1/16	20 5/8	108	9

to £26 ex warehouse for spot and £25 5s. c.i.f. for shipment from China.

ARSENIC.—Cornish white continues in very short supply, with prices nominally about £23 per ton f.o.r. mines. Mexican remains nominal.

BISMUTH.—The official price has been advanced to 6s. 4d. per lb. for 5 cwt. lots and over, a fair demand being witnessed at the higher figure.

CADMIUM.—Current quotations are about 2s. 2d. to 2s. 3d. per lb., according to quantity.

COBALT METAL.—Leading interests continue to quote 3·75 dollars per kilo, business being only moderate.

COBALT OXIDES.—Quotations remain on a gold basis at about 4s. per lb. for black and 4s. 9d. for grey.

CHROMIUM METAL.—A fair demand is maintained by the plating trade at about 3s. 1d. per lb.

TANTALUM.—Prices are nominal owing to the scarcity of business, somewhere about £30 to £35 per lb. being the present value.

PLATINUM.—During October a new company—Consolidated Platinums Ltd.—was formed by the leading platinum producers for the allocation of sales on a quota basis. Prices stand at £9 14s. to £10 per oz. for refined metal, but business has not improved.

PALLADIUM.—Current quotations are about £4 10s. to £5 per oz.

IRIDIUM.—Demand has been small, but prices are fairly steady at about £22 to £24 per oz. for sponge and powder.

OSMIUM.—About £15 10s. to £16 per oz. is named for this metal.

TELLURIUM.—There is no business passing and prices are quite nominal.

SELENIUM.—Since the abandonment of the gold standard quotations are only made against enquiries, but values are fairly steady at about 7s. 8d. to 7s. 9d. (gold) per lb.

MANGANESE ORE.—Indian producers have been a little more willing to sell recently and some small parcels have changed hands. Prices are steady at about 10½d. to 10¼d. per unit c.i.f. for best Indian ore and 9d. to 9½d. c.i.f. for washed Caucasian.

ALUMINIUM.—During October the European aluminium consortium was renewed and extended to embrace Canadian producers. The control of the body has now been vested in a new company styled Alliance Aluminium Compagnie A.G., incorporated in Switzerland. Prices have undergone no change, being £95 (sterling) delivered in this country and £85 (gold) or 2144 Swiss francs on the international market.

SULPHATE OF COPPER.—Current quotations for English material are about £18 to £18 10s. per ton, less 5%.

NICKEL.—Demand is not brisk and makers hold large stocks. Prices stand at £215 to £220 per ton, according to quantity.

CHROME ORE.—Quotations are nominally 80s. per ton c.i.f. for good 48% Rhodesian and 95s. to 100s. c.i.f. for 55 to 57% New Caledonian, but these figures are subject to additions occasioned by exchange differences.

QUICKSILVER.—The official price of Mercurio Europeo, the Italo-Spanish cartel, is now 80 dollars per flask f.o.b. Spanish or Italian port or frontier, the spot price in this country being about £20 5s. to £20 10s. net.

TUNGSTEN ORE.—Demand has remained very slow and prices on balance are somewhat easier, about 14s. 6d. per unit representing the current value of Chinese ore.

MOLYBDENUM ORE.—Prices are rather nominal between 37s. 6d. and 42s. 6d. per unit c.i.f. for 80 to 85% concentrates.

GRAPHITE.—Demand continues quiet with prices around £15 to £16 per ton c.i.f. for 85 to 90% raw Madagascar flake and £16 to £17 c.i.f. for 90% Ceylon lumps.

SILVER.—Quotations have fluctuated in a somewhat erratic manner during the past month, but on balance are firmer. On October 1 spot bars stood at 15 1/16d. and despite some fairly free offerings from China rose to 17⅝d. on October 19 on Indian bear covering. Towards the end of the month India again featured as a good buyer and on October 31 spot bars closed at 18 3/16d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
October, 1930	884,632	41,929	926,561
November	844,038	40,715	884,753
December	867,202	41,290	908,492
January, 1931	873,872	40,704	914,576
February	800,991	38,946	839,937
March	869,331	41,667	910,998
April	840,259	42,078	882,337
May	867,949	42,330	910,279
June	855,073	42,677	897,750
July	872,198	44,645	916,843
August	870,822	45,603	916,425
September	872,053	43,971	916,024
October	900,358	44,760	945,113

TRANSVAAL GOLD OUTPUTS.

	September.		October.	
	Treated Tons.	Yield Oz.*	Treated Tons.	Yield Oz.
Brakpan	96,500	£148,560	104,000	£156,075
City Deep	77,000	20,013	81,000	20,696
Cons. Main Reef	66,800	22,503	67,000	22,828
Crown Mines	264,000	83,436	271,000	84,087
D'rb'n Roodepoort Deep	46,800	15,109	49,000	15,628
East Geduld	42,000	£44,626	45,000	12,608
East Rand P.M.	156,000	41,743	160,500	42,746
Geduld	84,200	26,881	86,500	27,674
Geldenhuis Deep	72,500	16,941	74,500	17,524
Glynn's Lydenburg	6,100	2,594	6,400	2,665
Government G.M. Areas	203,000	£403,979	210,000	£415,823
Kleinfontein	49,200	9,955	52,100	9,925
Langlaagte Estate	82,000	£112,656	84,000	£114,804
Luipaard's Vlei	30,500	£32,833	32,000	7,998
Meyer and Charlton	17,600	£17,767	18,300	£19,569
Modderfontein New	164,000	65,014	170,000	67,738
Modderfontein B	74,000	22,103	76,000	22,938
Modderfontein Deep	44,200	21,976	46,000	22,788
Modderfontein East	72,500	21,518	75,000	21,731
New State Areas	83,000	£171,364	87,000	£183,277
Nourse	70,000	21,107	70,000	20,985
Randfontein	230,000	£262,721	250,000	£286,180
Robinson Deep	97,500	28,140	100,000	28,625
Rose Deep	61,000	12,634	64,000	13,009
Simmer and Jack	76,800	22,183	77,300	22,695
Springs	73,000	£150,279	76,000	£152,478
Sub Nigel	36,000	30,198	36,500	30,567
Transvaal G.M. Estates	16,000	5,085	16,600	5,112
Van Ryn	45,000	£42,750	46,000	£44,521
Van Ryn Deep	66,000	£97,889	67,000	£97,420
West Rand Consolidated	91,500	£103,601	94,500	£106,502
West Springs	72,400	£74,450	76,500	£78,078
Witw'tersr'nd (Knights)	62,000	£52,895	64,000	£54,706
Witwatersrand Deep	36,800	11,694	37,100	11,594

* Values in S.A. currency.

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
July, 1930	2,706,900	28 5	19 8	8 9	1,184,107
August	2,693,100	28 3	19 6	8 9	1,174,828
September	2,653,250	28 5	19 8	8 9	1,160,430
October	2,741,080	28 5	19 7	8 10	1,212,822
November	2,628,800	28 4	19 7	8 9	1,145,097
December	2,661,200	28 6	19 9	8 9	1,160,548
January, 1931	2,721,316	28 3	19 8	8 7	1,171,456
February	2,481,600	28 6	20 1	8 5	1,045,980
March	2,718,400	28 2	19 9	8 5	1,151,017
April	2,592,800	28 7	20 1	8 6	1,105,711
May	2,751,400	27 10	19 6	8 4	1,149,105
June	2,698,100	28 0	19 7	8 5	1,140,399
July	2,771,400	27 10	19 6	8 4	1,155,466
August	2,799,800	27 10	19 5	8 5	1,159,382
September	—	—	—	—	1,162,355

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
October 31, 1930	206,778	14,482	5,032	226,292
November 30	205,030	13,973	4,748	223,751
December 31	203,473	13,763	4,607	221,843
January 31, 1931	209,442	13,865	4,325	227,632
February 28	209,777	13,740	4,333	227,850
March 31	207,239	13,436	4,106	224,781
April 30	206,770	13,242	4,030	224,042
May 31	207,109	13,305	3,689	224,103
June 30	207,209	13,286	3,345	223,840
July 31	208,155	13,512	1,817	223,484
August 31	209,409	13,563	1,705	224,677
September 30	209,424	13,276	1,626	224,326
October 31	208,987	13,061	1,517	223,565

PRODUCTION OF GOLD IN RHODESIA.

	1928	1929	1930	1931
	oz.	oz.	oz.	oz.
January	51,356	46,231	46,121	45,677
February	46,286	44,551	43,385	42,818
March	48,017	47,388	45,511	42,278
April	48,549	48,210	45,806	43,776
May	47,323	48,189	47,645	43,731
June	51,762	48,406	45,208	44,118
July	48,960	46,369	45,810	44,765
August	50,611	46,473	46,152	43,292
September	47,716	45,025	46,151	42,846
October	43,056	46,923	45,006	—
November	47,705	46,219	44,351	—
December	44,772	46,829	46,485	—

RHODESIAN GOLD OUTPUTS.

	September.		October.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,800	9,803	23,600	9,794
Globe and Phœnix	6,064	5,185	6,058	5,441
Lonely Reef	7,500	3,350	7,500	3,294
Luiri Gold	1,106	871	1,237	999
Rezende	6,400	2,633	6,400	2,633
Sherwood Star	4,600	£9,251	4,600	£8,930
Wanderer Consolidated	14,900	3,278	14,800	3,643

WEST AFRICAN GOLD OUTPUTS.

	September.		October.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	4,839	£8,301	4,428	£8,393
Ashanti Goldfields	12,683	15,302	12,787	14,776
Taquah and Abosso	9,854	£14,864	9,837	£14,705

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
October, 1930	39,687	1,685	628
November	33,708	2,174	436
December	42,097	3,105	260
January, 1931	27,306	—	405
February	38,370	4,458*	458
March	34,946	4,482	898
April	38,891	3,250	732
May	38,255	4,196	784
June	47,507	3,194	893
July	38,785	3,018	1,220
August	52,501	—	610
September	38,173	—	—
October	—	—	—

* Jan. and Feb.

AUSTRALASIAN GOLD OUTPUTS.

	September.		October.	
	Tons.	Value £	Tons	Value £
Associated G.M. (W.A.)	5,218	8,046	5,266	8,267
Blackwater (N.Z.)	3,869	8,674	4,020	8,011
Boulder Persev'ce (W.A.)	7,426	18,762	7,232	19,946
Grt. Boulder Pro. (W.A.)	9,585	26,219	10,624	29,679
Lake View & Star (W.A.)	—	—	—	—
Sons of Gwalia (W.A.)	12,576	14,742	13,094	14,206
South Kalgurli (W.A.)	8,761	16,078	9,026	16,537
Waihi (N.Z.)	17,771§	{ 5,780* / 38,733†	17,900‡	{ 5,865* / 41,910†

* Oz. gold. † Oz. silver. ‡ To October 17. § To Sept. 19.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	September.		October.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,600	2,107	3,600	2,623
Champion Reef	8,120	5,456	8,450	5,405
Mysore	14,170	7,003	15,503	9,694
Nundydroog	10,248	6,725	12,078	7,778
Ooregum	12,050	5,908	12,497	7,080

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	September.		October.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	9,900	15,150	9,710	15,730
Frontino Gold (C'lbia)	3,720	16,180	3,750	15,593
Fresnillo	81,476	10,102*d*†	—	—
New Goldfields of Venezuela	6,159	—	6,974	2,300*
Oriental Cons. (Korea)	16,699	96,837*d*	—	91,044*d*
Remance	2,800	3,835	—	—
St. John del Rey (Brazil)	—	44,000	—	39,500
Santa Gertrudis (Mexico)	30,120	47,954*d*	—	—
Viborita	—	—	—	1,640
West Mexican Mines	1,460	31,000*d*	—	—

d Dollars. * Oz. gold. † Loss

PRODUCTION OF TIN IN FEDERATED MALAY STATES

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

January, 1931	5,450	July, 1931	4,757
February	5,470	August	5,375
March	4,461	September	2,449
April	4,510	October	3,282
May	5,089	November	—
June	4,813	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	August	Sept.	October.
Ayer Hitam	—	101½	41½
Batu Caves	38	27	18
Changkat	95	70	25
Gopeng	37	32	42
Hongkong Tin	9¼	131½	—
Idris Hydraulic	34	27½	18½
Ipoh	23¾	24	122¾
Kampar Malaya	32	16	29
Kampong Lanjut	90	45	56
Kamunting	197	158½	155½
Kent (F.M.S.)	28	34	14½
Kinta	18	13¾	16
Kinta Kellas	—	—	23¾
Kramat Tin	95	—	30
Kuala Kampar	21	29	40
Kundang	10	7	12
Lahat	17½	16	10½
Lower Perak	—	—	88
Malaya Consolidated	39¼	—	—
Malayan Tin	102	85	85
Malim Nawar	27	22	28
Pahang	221	123	125
Penawat	—	65¾	—
Pengkalen	13½	55½	34
Petaling	87	69	45
Rahman	71⅓	40	40¼
Rambutan	4	12	4
Rantau	17	28	34
Rawang	122	40	40
Rawang Concessions	68	30	45
Renong	37	38	38¾
Selayang	15	15¾	15½
Southern Malayan	120	84½	84½
Southern Perak	—	30½	30½
Southern Tronoh	—	30	12
Sungei Besi	58	32	33
Sungei Kinta	23	33¾	31½
Sungei Way	32¾	74½	59½
Taiping	21	20	21
Tanjong	—	35¾	9
Teja Malaya	—	—	—
Tekka	44½	22	31
Tekka-Taiping	51	51	35
Temengor	7½	9½	10
Temoh	—	—	—
Tronoh	72	60	60
Ulu Klang	—	28¾	16⅛

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	August	Sept.	October.
Anglo-Nigerian	44¼	48¾	52
Associated Tin Mines	247	227	242
Baba River	4	4	4
Batura Monguna	1¾	—	2¼
Bisichi	39	43	43
Daffo	6½	5¼	—
Ex-Lands	54	50	51
Filani	3½	—	3
Jantar	22	23	15
Jos	13	13	—
Juga Valley	8½	9	10
Kaduna Syndicate	21	25	23
Kaduna Prospectors	17	23	12
Kassa	10	11	12½
London Tin	144	200	160
Lower Bisichi	4½	4½	—
Naraguta Extended	—	—	—
Nigerian Consolidated	7½	11	—
Offin River	3½	3½	1⅜
Ribon Valley	16	14½	10
Tin Fields	—	5¾	—
United Tin Areas	16½	18	17
Yarde Kerri	5	4	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	August	Sept.	October.
Anglo-Burma (Burma)	48	41	—
Aramayo Mines (Bolivia)	169	190	189
Bangrin (Siam)	101¾	111½	110¾
Beralt	34*	32½	30*
Consolidated Tin Mines (Burma)	180	140	130
East Pool (Cornwall)	48½	46¼	—
Fabulosa (Bolivia)	45½	54	56
Kagera (Uganda)	6	16	—
Kamra	54½	34	—
Malaysiam Tin	6½	8½	8½
Mawchi	209*	219*	—
Patino	992½	1,058	—
Pattani	150	—	—
San Finx (Spain)	21*	21⅓*	—
Siamese Tin (Siam)	214	190½	203¾
Tavoy Tin (Burma)	75	62	75
Tongkah Harbour (Siam)	40	65	38
Toyo (Japan)	68	66	61
Zaaiplaats	17½	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		Sept.	October
Broken Hill South	Tons lead conc.	5,692	5,140
	Tons zinc conc.	6,110	5,867
Burma Corporation	Tons refined lead.	5,880	5,880
	Oz. refined silver	460,000	470,000
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	351	350
Messina	Tons copper	717	780
Mount Isa	Tons lead bullion	2,286	—
Mount Lyell	Tons concentrate	3,537*	—
North Broken Hill	Tons lead conc.	5,690	5,390
	Tons zinc conc.	5,180	5,000
Rhodesia Broken Hill	Tons V_2O_5	34½	30
	Tons slab zinc	—	—
Roan Antelope	Tons concentrates	6,660	5,158
	Tons blister copper	—	506
San Francisco Mexico	Tons lead conc.	3,808	3,887
	Tons zinc conc.	3,536	3,433
Tetiuhe	Tons lead conc.	675	—
	Tons zinc conc.	2,201	—
Trepca	Tons lead conc.	2,972	3,531
	Tons zinc conc.	3,787	3,435
Zinc Corporation	Tons lead conc.	3,759	—
	Tons zinc conc.	2,929	—

* To Oct. 7.

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

		August.	September.
Iron Ore	Tons	154,739	112,843
Manganese Ore	Tons	4,466	3,563
Iron and Steel	Tons	201,920	220,285
Copper and Iron Pyrites	Tons	25,697	8,719
Copper Ore, Matte, and Prec.	Tons	2,871	1,503
Copper Metal	Tons	14,362	13,076
Tin Concentrate	Tons	5,530	4,922
Tin Metal	Tons	586	231
Lead Pig and Sheet	Tons	16,503	29,747
Zinc (Spelter)	Tons	7,920	10,699
Zinc Sheets, etc.	Tons	2,599	1,880
Aluminium	Tons	869	652
Mercury	Lb.	95,446	100,746
Zinc Oxide	Tons	1,421	576
White Lead	Cwt.	16,655	13,884
Red and Orange Lead	Cwt.	3,824	3,071
Barytes, ground	Cwt.	37,685	30,265
Asbestos	Tons	723	854
Boron Minerals	Tons	607	1,124
Borax	Cwt.	28,956	11,614
Basic Slag	Tons	2,633	4,630
Superphosphates	Tons	655	3,075
Phosphate of Lime	Tons	34,542	5,722
Mica	Tons	114	158
Sulphur	Tons	12,457	756
Nitrate of Soda	Cwt.	51,760	2,120
Potash Salts	Cwt.	454,596	309,633
Petroleum : Crude	Gallons	31,774,442	17,496,196
Lamp Oil	Gallons	17,629,876	24,733,200
Motor Spirit	Gallons	81,105,620	63,287,700
Lubricating Oil	Gallons	10,101,059	8,200,146
Gas Oil	Gallons	8,080,657	9,373,011
Fuel Oil	Gallons	51,911,440	32,769,654
Asphalt and Bitumen	Tons	7,992	9,167
Paraffin Wax	Cwt.	87,149	108,474
Turpentine	Cwt.	87,416	69,036

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	August.	September.	October.
Anglo-Ecuadorian	20,662	19,854	19,521
Apex Trinidad	46,450	42,970	46,100
Attock	1,483	1,628	1,659
British Burmah	4,410	4,285	4,443
British Controlled	46,648	42,761	41,636
Kern Mex	971	957	981
Kern River (Cal.)	3,027	2,883	3,138
Kern Romana	996	1,048	979
Kern Trinidad	5,037	4,721	4,684
Lobitos	26,250	25,260	26,141
Phœnix	64,565	50,433	44,532
St. Helen's Petroleum	5,127	5,389	5,592
Steaua Romana	80,550	85,580	87,120
Tampico	2,801	2,727	1,471
Tocuyo	2,026	1,924	1,911
Trinidad Leaseholds	18,800	18,600	16,550

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted

	Oct. 10, 1931.			Nov. 10, 1931.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		6	0		8	0
Anglo-Egyptian B.	1	3	9	1	5	9
Anglo-Persian 1st Pref.	1	3	3	1	4	6
,, ,, Ord.	1	18	0	2	0	6
Apex Trinidad (5s.)		8	9		9	6
Attock		11	3		15	0
British Burmah (8s.)		3	0		3	0
British Controlled ($5)		1	6		1	6
Burmah Oil	2	1	3	2	1	3
Kern River Cal. (10s.)		1	6		1	9
Lobitos, Peru		16	9	1	1	9
Mexican Eagle, Ord. (4 pesos)		6	6		6	3
,, ,, 8% Pref. (4 pesos)		7	0		6	9
Phœnix, Roumanian		4	0		4	9
Royal Dutch (100 fl.)	15	12	6	15	0	0
Shell Transport, Ord.	2	1	3	2	1	3
,, ,, 5% Pref. (£10)	8	10	0	9	0	0
Steaua Romana		4	0		4	9
Trinidad Leaseholds		18	9	1	1	3
United British of Trinidad (6s. 8d.)		3	0		3	6
V.O.C. Holding		19	0	1	1	9

PRICES OF CHEMICALS. November 10.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		18	9
,, 80%	,,	1	16	3
,, Glacial	per ton	58	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	0
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	6	10	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	24	10	0
Barium, Carbonate, 94%	,,	4	10	0
,, Chloride	,,	11	0	0
,, Sulphate, 94%	,,	7	15	0
Benzol, standard motor	per gal.		1	3½
Bleaching Powder, 35% Cl.	per ton	7	0	0
Borax	,,	15	10	0
Boric Acid	,,	25	0	0
Calcium Chloride, solid, 70/75%	,,	5	5	0
Carbolic Acid, crude 60's	per gal.		1	8
,, ,, crystallized, 40°	per lb.			5½
Carbon Disulphide	per ton	16	10	0
Citric Acid	per lb.		1	1½
Copper Sulphate	per ton	18	0	0
Creosote Oil (f.o.b. in Bulk)	per gal.			5
Cresylic Acid, 98-100%	,,		1	9
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per lb.	1	5	0
Iron, Nitrate 80° Tw.	per ton	6	10	0
,, Sulphate	,,	2	2	6
Lead, Acetate, white	,,	35	0	0
,, Nitrate (ton lots)	,,	28	10	0
,, Oxide, Litharge	,,	28	10	0
,, White	,,	38	10	0
Lime, Acetate, brown	,,	7	0	0
,, ,, grey, 80%	,,	10	0	0
Magnesite, Calcined	,,	8	5	0
Magnesium Chloride	,,	5	10	0
,, Sulphate, comml.	,,	3	15	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	1
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	2	4	0
Phosphoric Acid. S.G. 1·500	per ton	29	15	0
Pine Oil	per cwt.	2	5	0
Potassium Bichromate	per lb.			5½
,, Carbonate, 96/98%	per ton	28	0	0
,, Chlorate	,,	34	0	0
,, Chloride 80%	,,	11	5	0
,, Ethyl Xanthate	per 100 kilos	7	0	0
,, Hydrate (Caustic) 88/90%	per ton	39	0	0
,, Nitrate	,,	19	17	6
,, Permanganate	per lb.			6½
,, Prussiate, Yellow	,,			8½
,, ,, Red	,,		1	8
,, Sulphate, 90%	per ton	12	10	0
Sodium Acetate	,,	20	0	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3½
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	31	0	0
,, Cyanide 100% NaCN basis	per lb			8
,, Ethyl Xanthate	per 100 kilos	6	10	0
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	8	10	0
,, Phosphate, comml.	,,	13	0	0
,, Prussiate	per lb.			4½
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	2	17	6
,, Sulphide Conc., 60/65%	,,	10	10	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	10	10	0
,, Roll	,,	11	0	0
Sulphuric Acid, 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw.	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	9	0
Tartaric Acid	per lb.		1	0½
Turpentine	per ton	53	0	0
Tin Crystals	per lb.			10½
Titanous Chloride	,,			10½
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	10	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Oct. 10, 1931. £ s. d.	Nov. 10, 1931. £ s. d.
SOUTH AFRICA:		
Brakpan	3 1 3	3 3 0
City Deep	5 6	6 3
Consolidated Main Reef	1 0 6	1 2 0
Crown Mines (10s.)	5 1 0	5 2 6
Daggafontein	2 13 9	2 13 0
Durban Roodepoort Deep (10s.)	16 0	18 0
East Geduld	3 3 0	3 5 6
East Rand Proprietary (10s.)	12 3	15 6
Geduld	4 8 0	4 6 6
Geldenhuis Deep	9 6	11 3
Glynn's Lydenburg	5 0	5 0
Government Gold Mining Areas (5s.)	1 14 0	1 15 0
Grootvlei	—	1 9 6
Langlaagte Estate	1 6 0	1 7 6
Meyer & Charlton	18 9	1 0 6
Modderfontein New (10s.)	2 13 9	2 13 9
Modderfontein B (5s.)	11 0	11 3
Modderfontein Deep (5s.)	18 0	19 6
Modderfontein East	1 8 9	1 10 0
New State Areas	2 12 6	2 11 6
Nourse	17 0	17 3
Randfontein	1 6 9	1 8 3
Robinson Deep A (1s.)	15 6	16 3
" B (7s. 6d.)	9 6	11 6
Rose Deep	5 9	7 0
Simmer & Jack (2s. 6d.)	3 6	4 3
Springs	3 11 6	3 10 6
Sub Nigel (10s.)	3 7 6	3 11 6
Van Ryn	10 6	11 6
Van Ryn Deep	1 0 0	1 3 0
Village Deep (9s. 6d.)	2 3	2 3
West Rand Consolidated (10s.)	10 6	11 6
West Springs	13 0	14 6
Witwatersrand (Knight's)	11 0	11 6
Witwatersrand Deep	3 9	4 3
RHODESIA:		
Cam and Motor	1 5 6	1 6 3
Gaika	3 6	3 6
Globe and Phœnix (5s.)	12 6	12 0
Lonely Reef	16 3	15 0
Mayfair	4 0	4 6
Rezende	1 0 0	1 2 6
Shamva	1 0	1 0
Sherwood Starr (5s.)	13 9	13 0
GOLD COAST:		
Ashanti (4s.)	1 16 0	1 16 6
Taquah and Abosso (5s.)	4 6	5 0
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	2 6	2 9
Great Boulder Propriet'y (2s.), W.A.	1 0	1 9
Lake View and Star (4s.), W.A.	8 0	9 0
Sons of Gwalia, W.A.	4 0	5 9
South Kalgurli (10s.), W.A.	11 9	12 3
Waihi (5s.), N.Z.	15 0	14 6
Wiluna Gold, W.A.	7 6	10 0
INDIA:		
Balaghat (10s.)	2 6	3 3
Champion Reef (10s.)	6 9	8 0
Mysore (10s.)	7 9	8 0
Nundydroog (10s.)	15 9	16 0
Ooregum (10s.)	2 9	3 9
AMERICA:		
Camp Bird (2s.), Colorado	3	3
Exploration (10s.)	2 0	2 3
Frontino and Bolivia, Colombia	10 0	11 3
Mexican Corporation, Mexico (10s.)	3 9	5 3
Mexico Mines of El Oro, Mexico	1 6	1 6
Panama Corporation	9 0	11 0
St. John del Rey, Brazil	18 6	17 3
Santa Gertrudis, Mexico	7 9	10 0
Selukwe (2s. 6d.), British Columbia	1 9	1 9
MISCELLANEOUS:		
Chosen, Korea	2 3	6 0
Lena Goldfields, Russia	6	6

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	3 3	4 3
Esperanza Copper	13 9	13 9
Indian (2s.)	9	1 3
Loangwa (5s.), Rhodesia	1 9	2 3
Luiri (5s.), Rhodesia	1 0	3 3
Messina (5s.), Transvaal	6 0	7 0
Mount Lyell, Tasmania	15 0	18 0
Namaqua (£2), Cape Province	4 6	4 6
Rhodesia-Katanga	10 0	11 3
Rio Tinto (£5), Spain	16 15 0	18 2 6
Roan Antelope (5s.), Rhodesia	9 6	13 3
Tanganyika Con.	17 0	1 0 0
Tharsis (£2), Spain	2 0 0	2 10 0

LEAD-ZINC:	Oct. 10, 1931. £ s. d.	Nov. 10, 1931. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	6 3
Broken Hill Proprietary, N.S.W.	9 6	12 6
Broken Hill, North, N.S.W.	2 1 3	2 16 3
Broken Hill South, N.S.W.	1 7 6	1 17 6
Burma Corporation (10 rupees)	8 6	10 6
Electrolytic Zinc Pref., Tasmania	12 6	16 3
Mount Isa, Queensland	6 3	12 6
Rhodesia Broken Hill (5s.)	1 0	1 3
San Francisco (10s.), Mexico	7 6	11 0
Sulphide Corporation (15s.), N.S.W.	6 3	10 6
ditto, Pref.	8 0	12 6
Zinc Corporation (10s.), N.S.W.	17 6	1 6 3
ditto, Pref.	2 10 0	2 17 6

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

DIAMONDS:		
Consol. African Selection Trust (5s.)	6 3	7 6
Consolidated of S.W.A. (10s.)	2 6	3 3
De Beers Deferred (£2 10s.)	2 17 6	3 12 6
Jagersfontein	12 6	16 9
Premier Preferred (5s.)	1 5 0	1 5 0

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

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, 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.

REFRACTORIES

In the *Chemical Engineering and Mining Review* of Melbourne for September 5, an abstract is given of a paper on refractories and their uses, which was read by P. F. Thompson before the Melbourne University Metallurgical Society. The author points out that the ideal refractory would be a material retaining the solid phase at any required temperature, insoluble in the materials to be treated, impervious to liquids and gases, unaffected by sudden cooling or heating, highly resistant to mechanical erosion, of low thermal expansion, and, in addition, cheap and easily accessible. Ideality and technology rarely going hand in hand, one has to be content with a compromise or a balancing of antithetical properties.

Nature has provided, along with metallic ores, abundant supplies of earthy bodies mostly made up of the oxides of the elements silicon, aluminium, calcium and magnesium. Each of these oxides in the pure state is very heat resistant, but they rarely occur in this condition in quantity. The effect of impurities is in general to lower the refractory properties. The exigencies of manufacture of the containers from these materials usually require a further diminution of their valuable properties. The physical rule concerned in these matters is that the melting point of a substance is depressed by the presence of other substances which will form a liquid solution with it. This is only a part of the more general phase rule. The difficulty of applying this great generalization to the study of refractories is that its predictions are only fulfilled when complete equilibrium is reached—a state seldom attained in refractories owing to the highly viscous nature of the solutions and to the size and variety of the constituent grains. Phase rule diagrams, however, give two important limitations: (*a*) the lowest possible melting point (eutectic) occurring at the point of contact of two or more different substances, and (*b*) the lowest temperature at which the whole mass of known composition will become a homogeneous fluid. It is somewhere between these two points that a refractory material is said "to fail." The more a refractory material approaches homogeneity the closer do these points come together.

A classification of refractory materials into homogeneous (uniform) and heterogeneous (grained) would be useful if one could draw the line between them with any certainty. The first would have a definite set of physical properties directly connected with chemical composition and easily reproducible. The second class would be an aggregate of the properties of the different grains sometimes compensating and sometimes additive. Until quite recently the users of most refractory containers have been content to regard them as being homogeneous and constant in properties instead of being, as they usually are, unstable, variable, and heterogeneous, tending with time and temperature towards the goal of homogeneity. In assessing the properties of either of these classes the total chemical composition, as ascertained by analysis, may be very useful in the homogenous, but may become very misleading in the heterogeneous class where the physical condition of materials of quite dissimilar composition plays such an important part. The homogeneous refractory articles form, however, a very small division, and include some of the higher melting point metals such as iron, nickel, platinum, iridium, molybdenum, tungsten, etc., pure fused oxides like alumina (alundum), zirconia, and silica, together with some special products of the electric furnace, and graphite. They are mostly expensive and are used only for experimental purposes.

The natural substances kaolin, magnesia, etc., are practically homogeneous, but are generally used in a heterogeneous state owing to the necessity of grinding and bonding the grains, in the preparation of bricks, retorts or crucibles, by a fusible cement. Curiously enough, this bond is a source of both weakness and strength—a good bond in the cold may become a poor one in the heat, and vice versa.

The intelligent manufacture and use of refractory containers will naturally depend on a knowledge of the changes undergone during manufacture and use; in both cases the modifications produced by heat and time alone, and during use by heat, time and the effect of the contained substances treated. In every case, the general principle enunciated previously, namely, that the heterogeneity factors are continually diminishing and the whole is tending towards homogeneity and equilibrium applies. Cooling, of course, during the process may give a slight set back by causing the separation of certain crystal phases, but these are mostly held in metastable solid solutions, or "glasses," as a rule.

Changes Undergone during Heating Alone.—Volume changes may be of two kinds: (*a*) thermal or reversible, (*b*) permanent or very slowly reversible. The ordinary thermal expansion common to most bodies varies considerably with the nature of the material and texture. If it is marked, as in magnesia, and is not counteracted by porosity (air spaces), by another material of low thermal expansion or buffered by an elastic bond, it gives rise to serious rupture between the grains which may extend throughout portion of a brick particularly during rapid changes of temperature. Flaking, due to this, is known as "spalling," and is a cause of serious loss. Heat conductivity is bound up with spalling and it is important to remember that it changes with temperature; the conductivity of magnesia decreases with temperature increase, while the converse is true of silica and fireclay.

Permanent expansion is due to the transformation of a given crystalline form of a substance

having a characteristic specific gravity into another form with a lower specific gravity and a consequent greater specific volume. Silica shows this property to a marked degree ; ordinary quartz has a specific gravity of 2·65, and on heating undergoes several minor changes until 870° C. is reached when it changes to a new mineral (tridymite) having a specific gravity of 2·30 ; again at 1,470° C. this changes to the mineral cristobalite (sp. gr. 2·21) corresponding to a total expansion of about 16%. This would be disastrous in a large firebrick structure.

These changes are very sluggish, but are greatly assisted by the presence of a fusible bond, which functions as a solvent for the less stable and therefore more soluble form, while the more stable and less soluble variety crystallizes out from the magma. It is because of these changes undergone by silica that quartz or quartz sand is quite useless as the raw material for silica bricks. To transform the quartz to tridymite or cristobalite would require such prolonged heating at a high temperature that the cost would not compensate for the cheapness of the material. Partly or wholly transformed natural materials, such as the quartzites, are much more economical to use.

Reactions between Grains and Bond during Heating.—(*a*) *Silica Bricks.*—The bond formed on firing these bricks is commonly calcium silicate with a minimum melting point of about 1,450° C., and as the amount of bond is comparatively small in relation to the silica body the silica tends to dissolve into the bond as the temperature rises above the eutectic point. The diffusion goes on as far as temperature, time and viscosity of fluid permit. The resulting bond has a higher melting point than that formed at the beginning, though its strength or resistance to shock may diminish as the higher silica content increases the "glassiness" of the cementing material. Should the silica grains themselves be porous, intrusion of the bond into the grains may take place and the layer of bond between them becomes thin and weak, giving to the mass a tendency to crumble. This friability is common in certain types of silica brick which have been submitted to high temperatures for a long time.

(*b*) *Fireclay Bricks with Siliceous Skeleton.*—In these the amount of free silica is much less than in the true silica brick and the bond consists of a considerable amount of plastic clay as free from fusible impurities as possible. Quartz sand is often used in place of quartzite, since the shrinkage of the clay due to dehydration and the closing up of the minute pores left during the expulsion of the water compensates for the expansion of the silica on transformation. At the point of contact between clay and silica the eutectic will form at first and the melting point will rise or remain constant as each constituent diffuses in at a different or an equal rate respectively. The bulk of the bond being so large and the clay becoming plastic on heating, bricks of this description collapse very gradually under pressure. The silica grains being non-plastic oppose this deformation by interlocking to some extent. As the temperature rises still higher the constituents inter-diffuse until surface tension draws the mass into a globular form. Microscopical examination, however, shows that the completely homogeneous state is not fully reached even at this point, since particles of undissolved silica can be detected as a rule in the globule.

(*c*) *Grog-Fireclay Bricks.*—These are composed of preheated fireclay (grog) which is ground to the required size and mixed with the raw clay as a plastic bond. In this case the mixture is of practically the same nature and the bonding relied on is the natural fusible constituents of the clay ("fluxes") consisting of iron oxide, lime, magnesia and sodium and potassium silicates. These substances form eutectics at temperatures round about 1,000° C. ; they act as bonds on the minute colloidal particles of the clay and, when molten, as lubricants allowing these to slip over one another and so give rise to high temperature plasticity. This can be detected by applying pressure at temperatures very little above 1,000° C. in most clays containing some of the above fluxes. Owing to the finely dispersed condition of the fluxes in the clay and grog these bricks soon become homogeneous ; but if high in alumina, they form very viscous melts with the fluxes, and the plastic stage may be long drawn out and attain quite high temperatures before serious deformation under the stresses required in furnaces takes place.

Changes on Cooling.—If no transformations have taken place the thermal contraction will equal the expansion. Usually quick chilling is more common than sudden heating, so that spalling is more noticeable during the cooling process. A very coarse structure with plenty of air spaces (high porosity) is the best texture for refractories exposed to extremes of temperature change. Coarse grains bonded only at a few points of contact may have these bonds ruptured without necessarily endangering the bonds of surrounding grains ; while in a finely-grained material with an almost continuous and perhaps glassy bond extending throughout the whole mass such a crack will extend and possibly radiate in all directions. Incipient cracks may repair themselves if on reheating a sufficiently high temperature is reached.

A possible source of inter-granular cracking, which apparently has not been previously considered by investigators is an action analogous to the drying and contraction of a jelly on a sheet of glass. The adherence of the jelly to the glass is such that as the jelly shrinks it tears pieces out of the surface of the glass. If the semi-fused melt of the silica or clay grains should have a marked change of volume on solidifying, adhering portions of the grains may be torn off in a similar manner. Clinkers on furnace walls may behave in this way in detaching the underlying brick surface.

If transformations have taken place, the reverse transformations have little chance of occurring owing to their sluggishness and the rapidity of cooling. The physical properties of the transformed may be quite unlike those of the unchanged material. Quartz has quite a different coefficient of thermal expansion from that of tridymite and tridymite different from that of cristobalite. Tridymitic materials are less liable to spalling than either those of quartz or cristobalite. This is due to the lower thermal expansion of the former at high temperatures and also to the steady decrease at low temperatures, while for both quartz and cristobalite a rapid fall in the magnitude of this property takes place on cooling.

Reactions with Substances being Treated.—(*a*) *Action of Gases.*—Stagnant gases have little physical effect, but they may have marked chemical action. The so-called dissociation of carbon monoxide, $2CO \rightleftarrows CO_2 + C$, results in the deposition

of free carbon in the pores of bricks; while this action is at a maximum about 400° C. it is quite inappreciable over 1,000° C. Carbon monoxide reduces ferric oxide, which is but slightly soluble in silicate melts, to the readily soluble ferrous oxide. Rapidly moving gases laden with flue dust may have an erosive action similar to the sand blast, but if the gases are carrying easily fusible ash or volatilized alkali salts mechanical erosion may be replaced by slagging of the furnace walls exposed. This molten material either runs down the wall or, if the brickwork is badly set, cracked or notably porous, the fluid material penetrates and in time destroys the whole of the refractory. To combat this condition firebricks of high aluminous content, which are not readily soluble in the usual fused silicate ash or form highly viscous melts, which have little power of penetration, are useful. Carborundum materials are coming into favour because of their low solubility in fused ash or clinker. The solidified material is easily detached because it is not fused into the material of the brick. Ash high in iron, however, is not without action on carborundum.

(*b*) *Action of Liquids.*—Molten metals have a certain abrasive effect on refractories when flowing through spouts or tap-holes, but as a rule, have little solvent action. The free elements associated with metals have little solvent action either. It is not until they are oxidized that they dissolve silica, alumina or magnesia. It is usual to provide for this by forming a slag of easily fusible materials, and so save the more expensive refractories of the containers. It has been the custom in the past to call those substances which in the molten condition dissolve silica "basic" materials, while the siliceous substances which dissolve basic materials are called "acidic." Alumina will dissolve in both and is dubbed "amphoteric." This division into acidic and basic materials is purely an arbitrary one for we have nothing corresponding to hydroxyl and hydrogen ion, to which the terms base and acid belong, in the molten magmas, we detect nothing like neutralization in equivalent proportions, nor do we know anything of the condition of the oxides when dissolved in one another. Union to form definite crystalline silicates appears to take place only on solidification. The latter, in the case of refractory materials high in silica, is often held up by the formation of glass. Kaolinite ($Al_2O_3.2SiO_2.2H_2O$) might be regarded as a neutral substance but it will dissolve on dehydrating and melting, both alumina and silica and also calcium and magnesium oxides. A number of substances used as refractories are indifferent to the fused magmas and are therefore called neutral materials. Chromite, graphite and carborundum are examples of these.

(*c*) *Action of Slags on Refractories.*—When temperature conditions permit, such as in shaft furnaces where fuel and charge are mixed, the difficulty is surmounted by the use of water jackets which present a layer of chilled charge to the molten material so that no damage is done to the metallic containers. In reverberatories and such-like furnaces this chilling effect is not permissible, and the provision of suitable refractories for use in contact with the slag becomes a matter of great importance. The controlling conditions are temperature, composition, and viscosity of the slag in contact with the refractory container, and the composition and texture of the latter. Increase of temperature means an increased solubility of the refractory in the slag. Even if it be a "basic" slag it will be capable of dissolving more base; if "acidic" it will dissolve more siliceous material from the lining. The behaviour here is quite the same as that taking place between grains and bond within the refractory material, the action of the slag being, however, much more rapid on account of its fluidity and free movement. Dense materials, like compressed magnesia or fireclay with low porosity and smooth texture, are required to cut down the surface exposed to the molten material to a minimum, but this resistance may only be obtained along with a greatly increased tendency to spalling.

Testing of Refractories.—The best test of a refractory, like that of the proverbial pudding, is in the usage thereof, but this, in the case of a large installation, is likely to prove a costly and long-drawn-out business. There has arisen, therefore, a desire to form a prognosis of the probable behaviour of the refractory material during use, from laboratory experiments. The weaknesses of such a procedure are the difficulty of assessing all the conditions under which the material is to be used and that the tests carried out in a minimum of time cannot be representative of changes which may go on over a long period. Certain physical characteristics measured at ordinary temperatures may be quite different at high temperatures. Known conditions may be plotted against evaluations of certain properties, a curve drawn and, by a process of extrapolation into the region of unknown conditions, the new properties read off. The value of this process depends on our having obtained the right slope of the curve in the first place and on the correctness of the assumption that the function of the curve is the same throughout. The "refractoriness" of a fireclay was at one time calculated from its composition as found by ultimate chemical analysis. The heterogeneity factors were not taken into account, the amount of free silica, the nature of the fluxes, texture and so forth, were disregarded, and a most unreliable interpretation of its behaviour was made. There is still a tendency, particularly in standard specifications, to reduce very complex matters to a very simple formula.

The "examination" rather than the "testing" of refractories would be a more suitable term to apply to the laboratory evaluation of their presumable properties. It is desirable to know chiefly how they will behave in respect to (*a*) high temperature, (*b*) sudden changes of temperature, (*c*) action of any material to be heated in them, and (*d*) their capacity for and their retention of heat. The first is called their "refractoriness," though this term is taken to include the effects of both (*b*) and (*c*) as well.

The methods of determining refractoriness at one time consisted of a comparison of heat effects at indefinite high temperatures with certain standard clays. This developed into the use of standard mixtures of these with fluxes to give comparisons at shorter intervals, and later to entirely artificial mixtures in the form of cones (Seger). Wedgewood first attempted pyrometric measurement by using the progressive shrinkage of clay. With the coming of pyrometers the cones are made to correspond to certain temperatures and are very convenient in ceramic work as indicators. There is still a considerable vagueness about the

point to be measured between the first eutectic fusion and the complete liquefaction of the mass. Such expressions as "stand up to," "melting point," "softening point," and "signs of fusion," found in refractory specifications indicate an uncertainty of measurement and interpretation of results. The point of complete melting of the material merely indicates the maximum possible temperature which the mass may attain when completely homogenized, and is of little practical importance since its useful life is generally ended long before this state is reached. The point, or one near it, when a small cone collapses under its own weight, sometimes called the softening point, is useful as a means of comparison with other refractories.

The commencement of high temperature plasticity is an important point, which is indicated by heating under compression. The greater the load the lower will this point be found until the eutectic of the bond is reached and plasticity ceases. As a "practical test" loads varying from 25 lb. to 100 lb. per sq. in., simulating possible stresses in firebrick structures, are used. In addition the temperature of 25% deformation in the length of the specimen, which amounts practically to complete collapse, is taken. This is known by the expressive term "squatting." Some specifications arbitrarily take some fixed temperature about 1,300–1,400° C., and demand not more than a certain percentage deformation under a specified load. This takes no account of the way in which the material "squats" and is one of those wooden requirements that creep into specifications when there is little true understanding of the mechanism of a process.

The advent of the recording pressure-temperature-time apparatus makes it possible to obtain an idea of the way in which a refractory material behaves under combined temperature and pressure effects. This instrument shows with firebricks three types of curves, plotting temperature against contraction: (*a*) a rapid collapse over a very short range of comparatively high temperature, characteristic of a "short" or "dry" bond giving way suddenly, such as occurs in silica bricks; (*b*) a slow gradual collapse extending over a considerable range, probably indicating a fine diffusion of the eutectic-forming material throughout the mass, such as might occur in grog bricks; (*c*) a short range of plasticity, as shown by a gradual curve downwards followed by a sudden collapse, which may represent a combination between (*a*) and (*b*) in structure. Some of the temperature-contraction curves have slight inflections in them which are possibly records of partial slip between grains, and so on. It may not be too much to expect when this method has developed and the curves are correctly interpreted that each refractory article made will be accompanied by its characteristic temperature-contraction-expansion chart so that the user may select scientifically the one best suited to his needs.

Porosity is an important property to be evaluated in refractory containers and its importance is many-fold. Air space might be a better term to apply, since like grain size the size and number of the cavities in the brick, etc., is of much greater moment than the percentage amount of free space in the material, which is the only determination made at present. The questions of which type of porosity is best suited to prevent spalling, how this may be combined with the best resistance to slags, and how much capillarity and surface tension contribute to absorption of liquids, require for their answer something more than a mere percentage total. A large porosity value may not mean a large absorption capacity, since a considerable amount of air must still be entrapped as is shown by the presence of large numbers of air bubbles in fused firebrick. Spalling tests involving immersion in cold water of materials previously heated are surely open to very grave criticism since the action of steam in the pores and on the bonds, particularly of basic bricks, is likely to be very severe.

The whole field of refractory examination at present is analogous to that of engineering testing at one time. A piece of steel was tested merely for strength and possibly a chemical analysis accompanied this. It was soon found that the way of breaking was as important as the ultimate stress borne, so ductility, percentage reduction, elastic limit, etc., became factors. Then followed resistance to shock stresses, fatigue stresses and the latest—"corrosion fatigue," all requiring measurement before the metal is passed as satisfactory. We have in the case of refractories the analogue of the tensile strength in the refractoriness and the undeveloped squatting test, but we go little further in the simile. The study of metals became a science when the microscope was called in, and may not one put in a plea for the use of the microscope in the examination of refractories? The difficult technique of the petrologist is not required, nor even the polished surfaces of the metallographer, for with the aid of the binocular stereoscopic microscope the life history of a refractory article is laid bare at every fractured surface. The changes produced by heating to various temperatures can be seen, and the effect of compression, the penetration of fluxes, porosity cracks, grain size and bonding are all brought to light. One may be sure that in time a fuller understanding, rivalling that of the metals, will grow out of the slough of empiricism in which the study of refractory materials has long been struggling.

BLAST FURNACE PRACTICE AT BROKEN HILL

One of the two papers read before the Institution of Mining and Metallurgy at the October meeting, and which was printed in the *Bulletin* for June last, appeared simultaneously in the *Proceedings* of the Australasian Institute of Mining and Metallurgy, N.S. No. 82, 1931. This paper, by O. H. Woodward, of which extracts are given here, deals with certain features of operating practice at the Port Pirie works of the Broken Hill Associated Smelters Proprietary, Limited, in the smelting in a blast furnace of lead ores carrying a high concentration of zinc. These are:

(1) The effect of zinc on lead blast-furnace operations, together with an outline of the methods adopted in actual practice in dealing with the zinc problem.

(2) Development of the height of tuyere above the bottom of the jacket and the extension of the tapping interval, and the combined effect of both factors upon the lead content of blast-furnace slag.

One phase of the investigation carried out in connexion with the effect of zinc on blast-furnace operations was largely responsible for the decision to increase to a marked degree the height of the tuyere above the bottom of the jacket.

The high concentration of zinc in the lead-bearing materials smelted at Port Pirie has brought with it those troubles which are associated with zinc in the smelting operation. In the early stages of the history of The Broken Hill Associated Smelters Pty. Ltd. the trend towards increasing cost for labour, fuel, and stores, etc., rendered it necessary to increase the lead content of the charge, and reduce to a minimum the quantity of barren flux used. This naturally resulted in an increase in the zinc content of the blast-furnace charge, and consequently the problem resolved itself into one of counteracting to a maximum degree the harmful effect of the higher concentration of zinc. It was necessary to arrive at the highest admissible concentration of zinc in the charge having regard to—

(*a*) The production of a slag carrying an optimum concentration of zinc to permit of commercial recovery of such zinc at a later date.

(*b*) Maintenance of good operating conditions in the blast furnace.

It was decided that the production of a slag carrying around 18% zinc would meet both requirements.

Zinc in Blast-Furnace Operations and Dealing with the Zinc Problem.—Broadly, the zinc problem as encountered at Port Pirie could be divided into two classes, i.e.—

(1) When, due to imperfect roasting, sufficient zinc sulphide remained in the roasted material to bring such troubles as formation of zinc mush, top matte, and tendency of furnaces to have hard ends, etc. By improvement in the blast-roasting practice, the quantity of zinc sulphide remaining in the roasted material has been reduced to such a degree that, during the past ten years, the above-mentioned troubles have been non-existent.

(2) When the zinc oxide present in the charge functions, under certain conditions existing in the blast furnace, as probably the chief factor tending to the formation of shaft accretions.

In the blast furnace smelting of lead ores carrying a high concentration of zinc, shaft accretions, more than any other factor, tend to upset the smooth running of the blast furnaces. Typical furnace troubles attendant on the presence of shaft accretions are :—

(1) Even distribution of the blast is not obtained, and, the blast being forced through a restricted area, forms blow holes.

(2) The blow-pipe action of the blast tends to carry the fire to the top of the furnace, partial fusion of the upper portion of the charge follows, and the furnace develops " Hot Top."

(3) When blow holes are formed, it becomes necessary to ease the blast, and so the regularity of the furnace operation is interfered with, and, as is generally the case, this irregular operation is reflected in a higher lead-content than is normal in the slag.

(4) When the furnace has developed " Hot Top," there is a distinct danger that the Dwight-Lloyd sinter will be partially fused before the other fluxes are affected. Thus, if the composition of the new slag contained in sinter is out of balance in regard to the ratio of ZnO and CaO to FeO and MnO, the zinc is freely driven off, and accretion trouble quickly follows.

(5) The blow-pipe action of the blast liberates dense fumes on the feed floor, increasing the health hazard of the workmen, and the metal loss.

(6) The necessity of removing shaft accretions means a direct loss of output from the furnace.

As previously indicated, those furnace troubles, which follow the presence of zinc sulphide in the blast-furnace charge, have been eliminated, and any trouble now experienced arises from the presence of zinc oxide. The troubles which arise from the presence of zinc oxide in the charge can be arbitrarily described as being partly of mechanical and partly of chemical origin.

Mechanical Source of Accretion Trouble.—(*a*) When treating Dwight-Lloyd sinter of such physical quality that it tends to break into small pieces and give a charge of small average size, a condition is set up predisposing to the formation of " Hot Top," and, as a result of this, accretions rapidly form.

(*b*) When smelting a charge carrying a high concentration of zinc it is most desirable that a good smelting rate be maintained.

The maintenance of a good smelting rate is largely dependent upon the class of coke used, and experience at Port Pirie has definitely indicated that the quality of the coke used is a matter of vital importance. From the point of view of low lead loss in slag, it is essential to ensure that a proportion of the coke reaches the tuyere zone, while for the maintenance of good smelting rate it is desirable that the quantity of coke reaching the tuyere zone be within certain limits. Due to the difficulty experienced in ascertaining the actual conditions existing in a blast furnace, it has been found difficult to indicate the extent to which coke can accumulate at the tuyere zone, without adversely affecting the furnace speed. However, operating experience indicates that an accumulation of coke above the tuyere level beyond a certain point is not desirable. When coke accumulates above such point the smelting rate is retarded, and very unsatisfactory conditions are set up in the furnace shaft. At the tuyere zone, due to excessive accumulation of coke, there is an intensely reducing atmosphere, together with high temperature, and under these conditions there is a tendency to cause the zinc in the charge to distil from the tuyere zone and condense in the upper portion of the furnace shaft.

The question as to the form in which the zinc leaves the tuyere zone and is deposited in the upper section of the furnace shaft is not of so much concern as is that of its ultimate effect As the coke accumulation continues, the furnace speed naturally slows up, the heat is driven farther up the shaft, cementing action by zinc oxide is accentuated, until under the influence of all these factors the charge column ceases to sink. This condition continues until the coke accumulation is burned away, when the charge falls and the cycle repeats itself. This naturally results in heavier and heavier shaft accretions forming, with consequent adverse effect on furnace capacity and conditions generally.

After dealing with furnace operations during the years 1921–22, the author goes on to say that the first step taken to prevent or reduce the accumulation of coke above tuyere level was an attempt to break down the large coke pieces. At that time coke was the last of the charge components added to the charge truck, and labour was employed breaking by hammer the coke pieces,

as the charge truck travelled to the furnace. Naturally, this was a costly and at the same time very inefficient operation, but, despite its inefficiency, benefits resulted, and the degree of furnace trouble was reduced. It may be thought that crushing the coke to the desired size would be the solution of the problem, and while, from the purely metallurgical aspect, this would probably be so, the solution was not attractive, by reason of direct cost and abnormal quantity of fine coke which could be expected to arise from the crushing process.

The next step towards a possible solution was to reduce the quantity of coke added to the furnace, the degree of reduction being governed by the speed of the furnace. The volume of blast admitted to each blast furnace is controlled by separate Kent recording meters. Since the volume of the blast was controlled, and since the coke was added on the per-charge basis, it followed that the faster the furnace speed the greater was the quantity of coke added per unit of blast, a condition likely to result in the accumulation of coke above the tuyeres. On these lines variations in the quantity of coke added were made by reducing the quantity added to each charge, or by adding at intervals an ore charge with no coke addition, the variations being governed as before-mentioned by the furnace speed. While, from the point of view of accretion troubles, beneficial results followed the adoption of this procedure, the vagaries of the blast furnace, in regard to rate and position in which coke burns, resulted in irregular lead content of slag produced, and this factor offset any other advantage.

Interpreting the results so far obtained, it appeared to be definite that the prevention of an accumulation of coke above the tuyeres would be the solution of the problem. It seemed inadvisable to attempt to reach this end point by varying the quantity of coke added to the furnace from time to time, as such procedure brought into play variable conditions, which affected the smooth running of the furnace. It was therefore decided to seek a coke of such quality, as regarded porosity and size in relation to porosity, as would carry down to the tuyere zone and yet not accumulate above the tuyeres. Such a coke was eventually procured, and from the date when this coke was used a most marked improvement resulted in furnace operations, the furnace speeds being good, and the trouble due to shaft accretions reduced to such a degree as to bring the smelting of lead ores, carrying a high concentration of zinc, on to a commercial basis. Thus it seemed that the problem of coping with what can be classed as the mechanical trouble, arising from high concentration of zinc in the lead blast-furnace charge, was that of preventing an accumulation of coke above the tuyeres.

Following this, steps were taken to modify the coking practice at the company's Bellambi works, and eventually the porosity of the coke was increased to such a degree that the necessity of procuring coke from outside sources has been reduced to a minimum. After a wide experience in operating with different classes of coke, the opinion is held that the ideal coke for Port Pirie requirements should have a porosity of from 50% to 53%. Coke with such porosity should be of large average size, the ideal size being larger than a 6-in. diameter ring.

Shaft Accretion Trouble.—High concentration of CaO in the presence of high concentration of zinc in the charge is undesirable, and also that high concentration of FeO + MnO is desirable. Neglecting the theoretical interpretation of the interdependence of ZnO, CaO, FeO + MnO, from the purely practical standpoint, there has been evolved an empirical formula to permit the control in the field of the above variables to such a degree that formation of shaft accretions is controlled within definite limits, thus ensuring that the conditions on the feed-floor level of the furnaces are relatively good. This formula probably applies only to Port Pirie practice, where the variations in slag constituents are within certain rather narrow limits. This empirical formula is applied to the slag analysis as regards ZnO, CaO, FeO + MnO, and is as follows :—

$$\frac{\text{ZnO} \times \text{CaO}}{\text{FeO} + \text{MnO}} = \text{a factor X.}$$

In general, it is found that, in order to maintain good furnace conditions, the factor X should be 8·5, or lower.

It was not until November, 1927, that it was possible to definitely isolate the effect of silica content of the charge upon furnace conditions, as indicated by the empirical formula. On that date, in order to preserve a rapidly diminishing stock of siliceous lead ore, this material was excluded from the blast roasting charge. The sinter produced was of excellent physical grade, and yet it was found that blast-furnace conditions, as regards shaft troubles, rapidly became worse, despite the fact that the empirical formula applied to the slag analysis was only 7·5. Since silica was the only variable isolated, its addition to the blast roasting charge was immediately reverted to, and a return to normal conditions in the blast furnaces immediately followed. With this knowledge the blast-furnace record sheets were again carefully reviewed, and as a result the following conclusions in respect of the application of the empirical formula finally arrived at :—

(*a*) A factor of 8·0 or lower holds when the SiO_2 in slag is around 20%.

(*b*) A factor of 9·0 to 9·5 holds when the SiO_2 is around 22%.

(*c*) A factor of 7·0 to 7·5 should be held when the SiO_2 is around 18%.

In considering the blast-furnace charge, the following points should be borne in mind :—

(*a*) The quantity of zinc in ores treated is a very constant amount, and the control of this is not possible by the lead smeltery.

(*b*) It is considered advisable for blast roasting requirements that sufficient lime-sand (a disintegrated limestone) should be present in the charge to give around 5%–6% CaO in resultant sinter.

(*c*) The quantity of FeO + MnO present in ores treated is very regular in amount, and that extra FeO can only be obtained by addition of ironstone to the blast-furnace charge.

Thus, by force of circumstances, the quantity of ZnO and CaO in the charge is more or less a fixed amount, and an avenue for adjustment lies in addition of ironstone.

(2) Development of Height of Tuyere and Extension of the Tapping Interval.—In the early part of 1927 a phase in blast-furnace operations was experienced when the lead content of slag produced was abnormally high. The coke used had a porosity of 53%, and was a free-burning coke. However, its general average size in relation to its porosity was small, and it seemed that the cause of the high lead in slag was that insufficient

coke eventually reached the tuyere zone. It will be realized that a coke having a high porosity is more subject to breakages in transit to Port Pirie than coke of low porosity, and, while the majority of cargoes received were of fair average size in relation to porosity, many cargoes reached the works in a bad condition as regards general average size. Thus, with these cargoes, two-fold trouble was experienced on the blast furnaces, i.e.—

(*a*) Irregular reduction, giving high lead in slag.

(*b*) Tendency of furnaces to run with "Hot Tops," and consequently formation of shaft accretions.

It is of interest to compare this phase of conditions with that given earlier. When using coke of small average size it was apparently impossible to carry sufficient coke down to the tuyere zone, and so produced a slag of high lead content. Previously, the chief trouble was due to the fact that too much coke was carried down to the tuyere zone, and shaft accretion trouble resulted. The end result was that, when forced to use coke of high porosity and small average size, the lead content of slag produced was so high as to affect the general average figure.

In an attempt to confirm the theory that the cause of the high lead in slag was due to inability to carry sufficient coke down to the tuyere zone, the method of coke addition to the furnace was modified.

As a result of tests carried out the following points were definitely established :—

(1) The lead tenor of slag was consistently reduced after the addition of extra coke.

(2) In the case of No. 1 furnace, the furnace top became very hot, following the addition of coke at every eighth charge.

(3) In the case of other furnaces, "Hot Tops" developed to such a degree as to practically offset the advantages gained by lower lead in slag.

The next step was to apply the method followed on No. 1 furnace in regard to coke addition to the other furnaces, and, while these furnaces showed an improvement in the lead content of slag, the resultant "Hot Tops" were found to be troublesome to such a degree as to distinctly hamper furnace operations.

Having arrived at this position, the problem appeared to be one to ensure the maintenance of a good bed of coke below the tuyeres, while, at the same time, a minimum of coke would accumulate above the tuyeres. A study of the problem brought forward the suggestion that probably a solution would be to increase the height at which the tuyere is placed in the furnace jacket and consequently it was decided to test out this proposal.

In the original furnace jacket the centre of the 5-in. diam. tuyeres was 12 in. above the bottom of the jacket, so that the maximum depth of coke which could be carried was only 9 in., this being the difference between tuyeres and slag tap hole levels. An examination of the original jacket showed that a tuyere could be added to the jacket at a point just about the height of the bosh, and in this position the new tuyeres would be 12 in. above the original tuyere. The decision to adopt this more or less arbitrary height for the new tuyere was governed by :—

(1) The ability to use the existing patterns (with slight modification).

(2) Should the new tuyere prove successful, existing jackets could be placed on all furnaces while they were in operation, a procedure possible only if the bosh of jackets was not altered.

First tests showed small improvement in the lead content of the slag. In searching for an explanation for the slight reduction in lead content of slag, it seemed beyond contradiction that best results could be obtained as regards lead loss in slag when such slag remained for the maximum time in contact with the reducing agents, be they incandescent coke or ordinary gases. Further, if settling of slag to permit separation of lead globules from the slag proper is advantageous, then the best place to carry this out is in the furnace itself. Thus it seemed that, to ensure maximum effect as regards the above factors, the tapping interval should be extended.

It was decided to conduct a series of tests to ascertain the relationship between lead in slag and the tapping interval. Such tests were conducted over a period of several weeks, and, although an occasional anomaly crept in, the results obtained showed without doubt that within a certain range of figures the lead content of slag was dependent on the tapping interval. Naturally, since other factors than tapping interval operate on a furnace, the order of figures of lead content of slag varied ; but, irrespective of this, on all tests it was found that to a considerable extent on each furnace, irrespective of its general condition, there was a well-defined relationship between lead in slag and the tapping interval.

Realizing the effect of the tapping interval on the lead content of the slag, it was decided to investigate the performance of No. 6 blast furnace, which furnace for the past 12 months had operated very satisfactorily. The tuyeres on this furnace were, in the period under review, located at the original height of 12 in. above the bottom of the jacket. This investigation had for its object an analysis of results, to ascertain the lead content of slag at various treatment rates. In effect, since the tapping interval is practically proportional to the furnace speed, the figure obtained showed under actual working conditions the effect of the tapping interval on the lead content of slag, the investigations indicating that there is a definite relationship between tapping interval and lead content of slag.

Following the installation of the high tuyere on all furnaces, no harmful effect whatever has been experienced from the point of view of general operating conditions. Subsequent to the installation of the high tuyere, an unexpected improvement resulted in regard to the growth of shaft accretions. With the original tuyeres, shaft accretions extended well down on to the jackets, and, by reason of the depth of the furnace column, i.e., 18 ft. (from tuyere to feed floor), these deep-seated accretions could not be moved, so that consequently big banks of accretion were always present in the jacket zone of the shaft.

However, subsequent to the installation of the high tuyere, it was found that these accretions gradually disappeared, until at a later date no accretions were found on the jackets, and the shaft accretions proper became a fringe in the upper section of the shaft, and were consequently easily removed. Thus, after each barring, it was possible to clean right back to the walls of the shaft.

Experience has shown that the presence of shaft accretions adversely affects the furnace performance, as even distribution of air is prevented, blowholes are formed, and the charge does not move uniformly down the shaft. Undoubtedly, these factors influence the lead tenor of slag, and it seems that the ability to obtain a clean furnace shaft has

helped to improve the lead content of slag, since in two years' operations the lead content of slag was 0·52% lower than when the low tuyere was used.

It may be thought that factors other than the high tuyere have played a part in this general all-round improvement, and while this may be so the author has been unable to isolate any such factor. Prior to the introduction of the high tuyere, the coke used was of similar quality to that subsequently used.

The material treated at Port Pirie, coming as it does from one source, is remarkably uniform, very little variation being shown in the physical quality and sulphur content of sinter.

After three years' continuous operation with furnaces equipped with tuyeres at the higher level, the conclusions reached are summarized as follows :

(1) The higher tuyere has resulted in a reduction of lead content of slag to an extent of around 0·5%.

(2) The slags produced have a remarkably even lead content, and the wide variations which previously were encountered, when the old level of tuyere was in use, have practically disappeared. This does not imply that an even grade of lead in slag is consistently held, but rather when certain groups of slag higher or lower than the average are met, the tenor of slag at such times is more regular than was the case previously.

(3) The general operating conditions of the furnaces are probably better than those previously existing and the practical men operating the furnaces distinctly favour the higher tuyere.

(4) With the higher tuyere, deep-seated accretions have practically disappeared, and shaft accretions are in general formed nearer the top of the shaft than was previously the case, thus permitting greatly improved work in the removal, and giving a cleaner furnace shaft.

(5) The furnace stoppages, due to the necessity of removal of shaft accretions, have been reduced.

(6) The high tuyere gives greater flexibility in regard to quality of coke used, since the maintenance of a good bed of coke below the tuyeres can be attained without such accumulation rising above tuyere level.

(7) The effective settlement of the slag within the furnace is an advantage and replaces the work done by the large settlers outside of the furnace.

MINE TIMBER PRESERVATION

An article on the preservation of mine timbers by J. F. Harkom was summarized in these columns in June, 1930, and the appearance of a similar article in the *Canadian Mining Journal* for October, enables us to return to the subject. In this last article the authors, R. J. Vaughan and R. J. Prettie, say that from the standpoints of safety and economy of installation treated mine timber is certainly worthy of more consideration than it has received in the past. Mine timbering is one of the most important operations in the entire work of the mine. A far greater percentage of accidents occur from falls of the roof and sides of a mine than from all other causes combined and yet far more money is spent in an attempt to eliminate these cave-ins than even the mine operator himself realizes. The engineer has always regarded timber as "temporary" structural material in contra-distinction to so-called "permanent" materials, such as stone and steel and is not usually conversant with the causes of failure of timber. An attempt is made in the article to throw some light on this angle of mine operation.

Wood has, as no other material, the essential properties that fit it to meet the varied condition of service required in underground support. It has relatively great stiffness in proportion to its weight. It compares favourably with good steel in bending strength on a weight to weight basis. The average pressure at which an ordinary mine prop will fail is not less than 1½ tons per squ. in. Where steel has a tendency to suddenly buckle under severe strain, wood gradually crushes or squeezes under load, thus giving ample warning of impending failure. Timber is cheaper in first cost, it is easy to handle, can be obtained in required sizes, and is easily framed. It is without doubt the most logical material to be used in mine timber construction. If timber would only last longer it would be entirely satisfactory.

Since structural timbers are commonly regarded as "temporary" what are the causes of this lack of permanence ? In very few cases does timber wear out, only where there is heavy mechanical wear, such as in mine and railway ties. Even here, this is not the most important cause of failure. Railways in the past century have found a method of increasing the useful life of their ties from six to thirty years. As far back as 1912, a survey was made of the causes of failure in mine timbers, by the U.S. Department of Agriculture and the following results were shown—

Failure due to decay and insects	50%
Failure due to breakage and fire	20%
Waste	25%
Wear	5%

When consideration is taken of the fact that partially decayed timbers have lower resistance to breakage, fire, and wear, the percentage of failure attributed to decay directly and indirectly is still greater. Therefore, if wood is to be made more permanent decay must be eliminated, so we now focus our attention to this end.

Causes of Decay.—Decay is not caused by a chemical disintegration of timber at a point where the elements of the ground and air meet, as is the general concensus of opinion. Decay is caused by small plant growths. These attach themselves to the wood and spread their small roots through the tissues of the wood and into the wood cells, feeding upon the cellulose that is to be found there. Most fungi are microscopic in size and cannot be seen by the naked eye, only the very large fruiting bodies are noticeable to the average person. Fungi reproduce both by means of mycellium, which spread all through any sound timber in the immediate vicinity and by spores. That is the plant itself breaks up and forms two or more fruiting bodies that are blown and carried to some new timber or feeding ground. Hence, where rotten timber has been taken out and replaced by sound timber the fungi immediately commence to feed on the new stick. This accounts for the considerably shorter life in replacement timbers than in original installations. Spores and mycellium of the fungi are already present and are searching for food. This, the mine owner is constantly supplying. Fungi require air, warmth, moisture, and food to

grow. If any one of these factors are missing the plant cannot germinate.

Decay will not occur in timber placed in an atmosphere containing little moisture, nor will it occur in timber completely saturated in water. It can be seen then, that for this reason alternate wet and dry conditions favour rapid decay, as at some particular range of moisture content, conditions will be most favourable for the fungus to thrive and grow.

Moisture conditions vary considerably in mines. Generally speaking, return air has a higher moisture content than intake air and from this, one would infer that mine timber would come to a moisture equilibrium with the surrounding air. However, the air stream has a drying effect and hence it cannot be stated definitely that mine timbers contain more moisture than timbers on the surface. It can be definitely stated that untreated timber will decay more rapidly in moist parts of a mine, other conditions being equal, than in those parts with a dry atmosphere. The most favourable temperature for decay is between 75° and 90° F. The temperature conditions in mines are generally such as to favour rapid decay, and intake air quickly comes to the same temperature as the surrounding strata, so that there is very little fluctuation from season to season. In one of the more important mines in Northern Ontario the dry bulb temperature varies from 52° in the upper levels to 56° F. in the lower levels. This increase is fairly constant, and the air throughout the mine is practically saturated with moisture (rel. humidity is 97%). It is estimated that the life of timbers on the lower levels is 28% less than that of those timbers on the levels near the surface. In this case, the rise in temperature seems to be the factor governing the increased rate of decay.

Prevention of Decay.—Only one method is practicable for preventing decay of timber in mines, viz., poisoning of the food supply which is accomplished most effectively by impregnating the wood cells with highly toxic preservatives. This is precisely what is done to preserve timber against fungus attack. The most effective preservative will, therefore, be the most toxic substance that can be injected into the wood and be held there. Some preservatives are very toxic but they are so volatile that they are only effective for a short period of time. Others are not volatile but neither are they toxic. After a lot of study and extensive experiments, both in the laboratory and in practice, by many governments and large railway companies, two preservatives have been universally adopted and accepted as standard. One of them is coal-tar creosote oil and the other is zinc chloride salt. These preservatives have both been found very satisfactory and have been accepted as standard by the American Wood-Preservers' Association and the American Railway Engineers' Association. Many others have been tried and are being tried with varied success, and, no doubt, as they prove their merits will become recognized. However, for the purposes of this article, comparisons and remarks will be restricted to these two.

Creosote Treatment.—Either creosote or zinc chloride will greatly prolong the life of mine timbers, but creosote will likely be found more efficient that zinc chloride, especially where the conditions are very moist and leaching is likely to take place Creosote has been known to preserve timbers fifty years and upwards. Before treatment, the timber is peeled and all the framing done, so there will be no surface exposed to rot once it is treated. It is then thoroughly seasoned either in the open air or by artificial means in the treating cylinders. The treating cylinders are about seven feet in diameter and vary in length from fifty to one hundred and eighty feet. The timber is placed on small trams and run into the cylinders, and the huge air-tight iron doors are bolted on. An initial air pressure of from thirty to fifty pounds is applied. This fills the small wood cells and acts as a cushion for the creosote. Hot creosote is then pumped quickly into the cylinder against the initial air until the pressure reaches about one hundred and eighty pounds per square inch. This pressure is maintained for several hours until slightly more than the required amount of preservative has been forced into the wood. The pressure is then released and the timber allowed to lie in the hot oil for a few minutes. During this time, the air that was originally imprisoned in wood cells expands, forcing out some of the surplus creosote. A final vacuum is then drawn, to withdraw the remainder of the surplus oil and dry off the wood. This leaves the cell walls lined with preservative, and the wood is " poisoned " against decay. There is no decrease in strength nor is there any increase in fire hazard. After the light oils have had a chance to evaporate creosoted material is less inflammable than untreated wood.

Zinc Chloride Treatment.—In wood-preserving, the following specification for zinc chloride is recommended. " Zinc Chloride shall be acid-free and shall not contain more than 0·1% Iron. Fused or solid zinc chloride shall contain at least 94% chloride of zinc. Concentrated zinc chloride shall contain at least 50% chloride of zinc."

Zinc chloride treatment is much the same as the creosote full cell treatment—the chief object being to force as much preservative into the timber as it will take. The Burnett process is most commonly known. It entails the following stages :—

A vacuum of from twenty to twenty-four inches is drawn—to take as much air as possible from the wood cells. After a period of from ten to thirty minutes, a 3 to 5% solution of zinc chloride is dropped into the cylinder while the vacuum is still maintained. When the cylinder is full of solution the pressure is raised to about 190 lb. per squ. in. and held until the timber refuses to take any more preservative.

Timber treated with zinc chloride will at first be wet and heavy ; but, when air seasoned again, there will be left in the wood from ½ lb. of dry zinc chloride salt to a pound and a half, according to the desire of the user.

Zinc chloride treated timber is dry and clean to handle and can be painted over. Although it is not entirely fire resistant zinc chloride is an effective fire retardant. It has been used for a number of years by the Delaware, Lacawana and Western mines with entire satisfaction, giving upwards of fifteen years' life as compared with two years for untreated timber.

Sound wood is harder to ignite than partly decayed wood and will withstand flames a longer time without failure. The saving in labour charges for replacing decayed timber greatly favours the use of treated timber, because decaying timber is liable to sudden brash failure, and it constitutes a greater accident liability than sound timber. The strength of timber can be reduced very greatly

by decay without such evidence being noted by an inexperienced observer. Untreated timber may look all right and yet be in dangerous condition. In short, treatment with preservatives enables timber to maintain its original strength for a long time.

Inasmuch as nothing better than a skin penetration can be obtained by any of the so-called dipping and non-pressure processes and since the first bruise, scratch or cut leaves the inner wood open to fungus attack, only pressure processes have been considered here. For complete protection a penetration of from a half an inch to an inch, or deeper, is necessary. This can only be obtained by the pressure process.

Pressure Processes.—There are two pressure processes, the full cell, where the tiny wood cells are left full of preservatives, or empty cell where the wood cells are only lined with creosote. Where timber is subjected to insect attack the full cell treatment is used, leaving from 12 to 20 lb. of oil per cu. ft. in the wood. In most mines, however, an empty cell treatment of from 6 to 8 lb. is sufficient. Either of the two mentioned preservatives is quite satisfactory for mine use and will give from twice to ten times the life of untreated timber. Even when timber can be obtained at the mouth of the mine for practically nothing it will often pay to ship this timber out hundreds of miles to a treating plant, have it treated and shipped back.

THE FELIXBURG GOLDFIELD, SOUTHERN RHODESIA

Short Report No. 18 of the Geological Survey of Southern Rhodesia, which dealt with the Felixburg Goldfield, is now out of print, but a new report has been issued. This, Short Report No. 27, by J. C. Ferguson, owes something to the earlier report, the accompanying map being based on that of A. M. Macgregor. The following notes summarize the earlier pages of the new report:

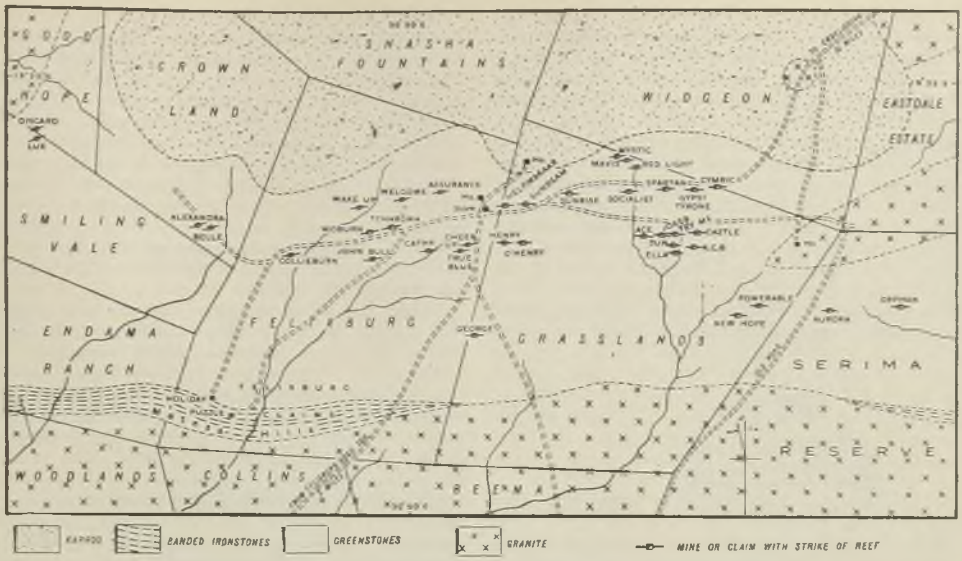
The Felixburg Goldfield is situated 45 miles north of Fort Victoria, in a narrow belt of Basement Schists, running in a general east and west direction. It lies at an altitude of nearly 5,000 ft. in gently rolling country, a great deal of which is treeless. The centre of the field is distant seven miles by road from Felixburg Road Siding on the Fort Victoria line. Gold-bearing reefs have been discovered over a distance of some ten miles, but mining activity has been almost confined to an area about six miles long and a mile and a half wide. The first outputs—those from the Cheer Up and Wake Up mines—were made in 1905, and up to the end of 1909, when nearly all work ceased on the field, about £40,000 worth of gold had been taken out. There was a slight revival in 1915 and 1916, and again during the past six years, the principal producers during the latter period having been the Castle, Sunrise, and Tchargwa mines. Comparatively few of the Felixburg mines have made regular monthly outputs, for in most cases mining operations have not been on a scale large enough to keep a mill running continuously. There are at present three mills on the field—the Castle and Tchargwa mills (5 stamps) and the Sunrise mill (2 stamps).

The field has not been an easy one to prospect, for outcrops are scarce and there is often a good deal of clayey overburden. There are no ancient workings on the quartz reefs, the only ones in the district being those on the banded ironstones of the Metesa hills, further reference to which is made later. For these reasons a good deal of the prospecting has been done by loaming. Work has been hampered to a considerable extent in the past by water. Except in the eastern part of the field (notably in the Tchargwa mine), the actual flow has not as a rule been very heavy, but almost everywhere water is encountered within 60 ft. from the surface, so that prospecting has been difficult and expensive. In addition to this, the flatness of the ground makes it liable to become water-logged during a wet season. The field has, however, acquired a worse reputation for heavy water than it really deserves, and perhaps an equally serious difficulty has been the scarcity of fuel and mining timber. The very shallow nature of most of the workings may be attributed to these causes. The only producing mines at present are the Castle and the Sunrise, but work is in progress at a number of other properties, whilst a considerable amount of prospecting is going on, the greatest activity in this direction being on the Felixburg claims, in the south-western part of the area, and on the claims held by the Felixburg Gold Syndicate, most of which are in the neighbourhood of the Castle mine.

Geology.—The schist belt in which the Felixburg goldfield is situated is from one to five miles wide, and is bounded by granite intrusions. The northern granite mass is overlain to a great extent by sandy beds of Karroo age, which frequently spread for some distance over the schists as well, but the granite on the south side of the belt is not hidden in this way. The greater part of the schist belt is occupied by rocks of the Greenstone series, consisting of hard, fine-grained epidiorites and softer greenstone schists. Among the latter, biotite-schist is probably commonest, but actinolite-schist has also been observed. Along the southern granite contact the greenstones are bordered by a belt of banded ironstone, which is most strongly developed in the Metesa hills, and appears to be interrupted farther east. The cleavage of the schists is usually parallel to the general strike of the belt, but on the Felixburg claims it is noticeably oblique to the general strike indicated by the banded ironstone ridges. The schists usually dip steeply to the south, but northerly dips are sometimes seen.

The epidiorites have resisted weathering as a rule, and sometimes give rise to surface outcrops, such as those at the Sunrise and Welcome mines. The biotite-schists, on the other hand, have usually been greatly weathered, and are represented near the surface by soft whitish or pale green rocks, overlain very often by a thick layer of heavy subsoil.

The banded ironstones which flank the southern granite intrusion are of the usual types, and call for little general description. They are banded rocks consisting of alternations of quartz and hæmatite or magnetite, and show considerable variation in the degree of closeness of the banding. Those with a high iron content weather to soft red material near the surface, whilst those in which silica predominates give rise to strong surface outcrops. Soft yellow ochre occurs in places, as a result of the weathering of iron-rich layers. There are several distinct outcrops of banded ironstone, which together make up the greater part of the belt shown on the map.



Sketch Geological Map of the Felixburg Goldfield.

The gold reefs of Felixburg are, with a few exceptions, somewhat small, lenticular bodies of quartz, conforming to the country in strike and dip. At the surface they are often mere leaders a few inches wide, which are found to open out at shallow depths. Two principal lines of strike traverse the field, the northerly one passing through the Alexandra, Wake Up, Welcome, Assurance, Sunrise, Socialist, Spartan and Gypsy claims, and the southerly one through the John Bull, Cathy, Cheer Up, Henry, O'Henry, Ace, Joker, Try Me, and Castle. Most of the known reefs occur along or near one or other of these lines. In the eastern part of the field, however, there appears to be a third line passing through the New Hope, Aurora and Orphan claims, and its westerly prolongation, towards the George, might be worth further prospecting. The ore shoots are small but rich, and it is believed that they usually pitch to the west. They have rarely been followed down to any depth, but in many cases this has probably been the result of difficulties such as heavy water or scarcity of timber, and does not necessarily mean that the values went out. There is no doubt, however, that the exceptionally high values sometimes encountered near the surface are the result of secondary enrichment. The payable quartz is not uncommonly of a somewhat sugary appearance, but other types also occur. The ores are free-milling, and the gold is of a very high degree of fineness.

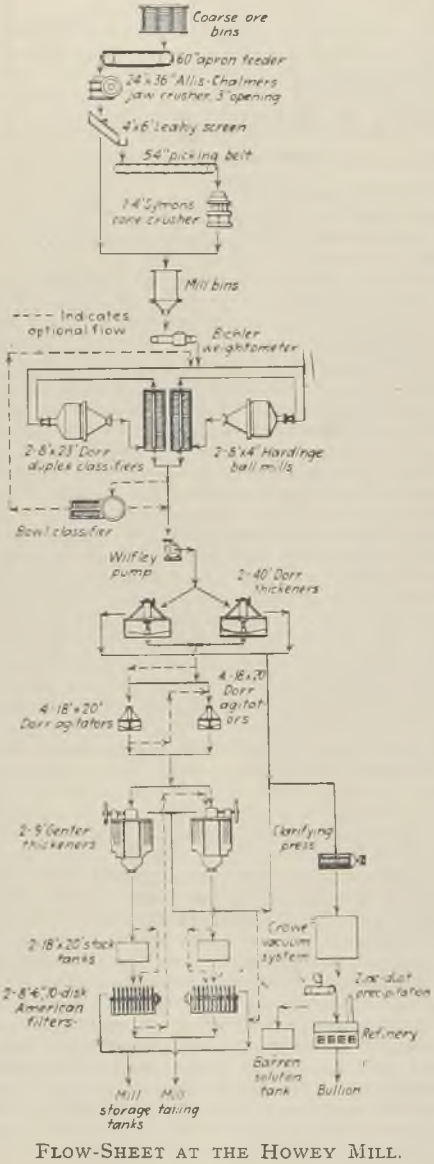
Not very much is known about the behaviour of the reefs in depth, for the deepest mines are the Cheer Up (440 ft.), and the Sunbeam (about 300 ft.). No information is available about the Sunbeam, but in the bottom level of the Cheer Up the reef had broken up into small stringers and the mine was abandoned as unpayable. In addition to that present in the quartz reefs, gold has sometimes been found in the greenstone schists and banded ironstones. When the schist carries gold it is usually owing to the values extending from a reef into the walls, but a different type of occurrence is now being vigorously prospected on the Felixburg claims, where gold has been found throughout a comparatively wide area of schist, not necessarily in association with quartz veins. The banded ironstones received a good deal of attention some years ago, on the Holiday claims, and work is now being done on them in the southern part of the Felixburg claims. The values appear to be rather widely distributed, and no very definite results have been obtained up to the present.

Full notes on the various mines make up the remainder of the report.

MILLING PRACTICE AT THE HOWEY GOLD MINE

Outside of the two large producing camps, Porcupine and Kirkland Lake, the only large active gold mine in Ontario is the Howey at Red Lake in the Patricia district. Practice at this mine is described by W. M. Goodwin in *Engineering and Mining World* for September and in his article the writer states that the mine is 175 miles by water route from Hudson Station, on the Canadian National Railways. This route is remarkably good, for comparatively large steamers operate for two-thirds of the distance on Lac Seul, as far as its outlet at Ear Falls, near Gold Pines, where there is a dam and water power capable of developing 25,000 h.p. At Ear Falls freight is transferred to 10-ton scows, which are towed down the English River a few miles and then up a tributary, the Chukuni River, to Red Lake. On the Chukuni River are two rapids, round which the scows are taken, without unloading, on marine railways. The cost of transporting freight from the railway to the Howey mine is at present $40 a ton. This adds only a few cents per ton to the cost of treating the ore. A mail and passenger service is conducted by airplanes, which operate winter and summer with equal facility. Their headquarters is Sioux Lookout, 12 miles east of Hudson, a town with banking, hotel, and other facilities that makes a good "jumping-off place."

The Howey mine is a model of expeditious development. It was discovered in the autumn of 1925, and was diamond-drilled in 1926. In 1927 and 1928 the mine was developed on four levels, to a depth of 500 ft., with 12,000 lineal ft. of lateral work and 6,000 ft. of diamond drilling. During 1929 development was extended on four more levels to a depth of 1,000 ft., with 4,000 ft. of lateral work. In the summer of 1929 the construction of a 500-ton mill was started, and this plant was placed in operation in March, 1930. Thus, two years and nine months after the first small steam plant was landed on the property, the mine was developed to 1,000 ft. in depth and a modern 500-ton mill completed. The plant is operated by electric power received from a hydro-electric installation at Ear Falls, 40 miles away.



FLOW-SHEET AT THE HOWEY MILL.

The Howey ore-deposit is part of a dyke of porphyry which has been sheared and intersected by irregular veins of quartz. Both the quartz and the porphyry within the ore zone are mineralized liberally with pyrite and sparsely with other sulphides. Although coarse gold is found occasionally, the bulk of the metal is fine and evenly distributed. The dyke contains gold for several thousand feet in length and across its full width of 80 to 120 ft.; but the payable concentration, so far as exposed, is mainly within a zone about 1,000 ft. long on both sides of the Howey shaft and from 10 to 50 ft. or more in width along the footwall of the dyke.

When the mine was first opened to a depth of 500 ft., the intention was to mill only the higher-grade portion of the ore-deposit, averaging $6.50 across 16 ft. As development continued, however, the stopes could apparently be made much wider than this with profit, at the expense of lowering the grade. In consequence, the mine as developed at present averages $4·65 across 34 ft., the profitable ore being increased by one-half by this widening of the stopes to double the original estimate. The additional 18 ft. of ore of $3 average grade is obtained without any appreciable additional development—merely at the cost of widening the stopes.

Stoping operations during recent weeks on the two lowest levels, at 875 and 1,000 ft., tend to show still greater widths of ore, of better than average grade. The stope on the 1,000 level, for instance, in May of 1931, was 260 ft. long and averaged $6·09 for a width of 44 ft. Diamond drilling from the haulage drive beneath had indicated the same value and width for several hundred feet additional in length. But a still more interesting feature was the fact that some cross-cuts over the full width of the gold-bearing zone, 80 ft., showed a payable grade for the whole distance, so a good reason exists for hoping that the stoping width on this level will reach 80 ft.

These wide and long stopes, one below the other in compact fashion, permit of unusually low costs, both in development and in extraction. This provides one of the reasons for Howey's low total costs. The ore is continuous and free from cracks or slips. Moreover, it drills and breaks well, so no problems arise in stoping even these great widths. Shrinkage stoping is used, and the ore is trammed to ore passes, through which it moves to two levels for hoisting.

The simple milling of the Howey ore comprises the second important reason for the low total cost. Preliminary tests indicated that grinding to 40 mesh would give an excellent extraction with straight cyaniding, and the plant was designed to this end. The flowsheet was designed to treat 500 tons a day, and has proved to be of 600 tons' capacity. The mill building and units are disposed so that the present tonnage can be doubled by simply increasing the grinding, classifying, and filtering sections. This can be done at a trifling expense and on short notice. The crushing plant, adjoining the 106-ft. headframe, has lately been adjusted to include a 60-in. apron feeder and a 54-in. picking belt, along which six men are employed taking out waste. This raises the mill grade 50c. a ton.

The most striking feature of the mill practice is the fact that 95% or more of the gold is recovered by grinding to 40 mesh. At first a belief prevailed that the coarseness of this material might cause serious trouble in some parts of the mill; but simple

adjustments overcame all such difficulties as soon as they appeared. As indicated by the flowsheet, the arrangement is the simplest possible for a cyanide mill. It is operating smoothly and efficiently. A feature impressive to a visitor is the position of the classifiers following the ball-mills, which are placed above the mills instead of below, as is customary, thus permitting the mills to be on an unobstructed floor at a low level. This arrangement has been proved to be a particularly convenient one.

As already mentioned, Howey costs are notable among the gold mines of Ontario, owing largely to the advantages of a large and compact ore-body and easily milled ore. During the last year the total cost per ton, including interest on a half-million-dollar loan, but excluding charges for depreciation and taxes, has ranged from $3.25 to $3.60 per ton. Throughout this period the shrinkage stopes have been filling up and in May the first two were completed. From now on, therefore, 200 tons of ore a day will be drawn from broken reserves, which will reduce the average daily cost about 50c. a ton. This, with the economy effected by hand sorting of waste, will reduce the cost to $3 per ton or less. If, and when, the mill tonnage is doubled, the cost per ton will again be reduced considerably below $3 a ton, probably to about $2.50. Flotation may possibly be employed, to effect a further economy. Tests to this end are still under way, but a decision has not yet been reached.

Average costs when 15,500 tons a month of ore is being treated are as follows: Development, $0·15; haulage levels, $0·02; box-holes, $0·10; mining, $1·75; crushing and conveying, $0·16; milling, $0·81; general, $0·17; head office, $0·34; total, before depreciation and taxes, $3·50. The plant will handle 18,000 tons a month, and the above costs on that basis will drop to about $3 per ton.

TIMBERING SHAFTS IN LOOSE GROUND

In the *Canadian Mining Journal* for October, J. H. Robertson gives some notes on timbering shafts in deep-seated placer deposits. The author states that his remarks are concerned only with timber sizes for loose ground. He continues by saying that the sizes of the various timbers are dependent on the depths to be sunk and the nature of the soils to be passed through. Before a shaft is started it is imperative that the depth and nature of the soil be known; this must be done by drilling. The engineer or designer of the shaft must stand by and see the drilling done. He must make careful observations, with tests and gaugings, of the materials of the various strata passed through, as without complete data he is not in a position to design a shaft.

The stresses coming on the timbers in a shaft are dependent on the depths from the surface, and the "angle of repose" of the dirts throughout the mass. The lateral pressures produced, which apply to the timbers of the shaft are given by the formula $P = \frac{1}{2}Wh^2\cos^2\phi$, where ϕ is the angle of repose, W. the weight of one cu. ft. of soil (100 lb.), and h. the height or depth from which the forces coming on the timbers at any depth in a shaft can be worked out.

A good "tough" soil can stand up at an angle of around 45°, whereas a fine silt, heavily impregnated with water, will behave like water, i.e., its angle of repose will be nearly horizontal, in which case calculations will have to be made as though the timber were under hydrostatic pressure, in fact, in extreme cases hydrostatic pressure is insufficient, because a fluid composed of mud and water, since it is of greater specific gravity, will exert a greater pressure than simple hydrostatic pressure.

In sinking a shaft in stiff soil it can be seen that the pressures due to the effects of the angle of repose do not come on right away. A bank of good stiff material may stand practically vertical for years, but eventually it will conform to the angle of repose of such material; therefore in designing a shaft which will have to give service for a prolonged period, the eventual stresses must be allowed for. Anyone who has worked in shafts is aware of the groaning and creaking that goes on. In a properly designed shaft this is merely the adjustment of the timbers in conformity with the gradual application of the stresses and the creaking need cause no qualms; but in an improperly designed shaft the matter may be serious.

To consider a practical example:

A shaft 21 ft. by 7 ft. of three compartments has to be sunk to a depth of 100 ft. The upper soil is "stiff" for a depth of 50 ft., thereafter there is a series of strata of "free" soil. The sizes of timbers required to be calculated.

Preliminary considerations.—It is plain that, though the upper stratum of soil is "stiff," since it overlies a "free" stratum it would be injudicious to consider the whole of the upper stratum as under the influence of the angle of repose of "stiff" dirt. True, if the timbering of the shaft into the lower or "free" stratum is sufficiently strong to withstand the stresses of the lower stratum, theoretically the upper stratum could be treated according to its angle of repose. But other factors come into the problem; for instance, in the course of sinking, water from the under stratum may force its way into the upper stratum "following" the timbering, bringing about a change in the nature of the dirt in the upper stratum. (This feature has to be carefully observed in sinking.) To get to something definite on which to base calculations a compromise has to be made, and in an instance of this kind, it would be sufficient to regard the upper stratum as affected by the lower stratum half-way up, i.e., up to 25 ft. from the surface, making the height of "free" stratum to be dealt with as 75 ft.

What is, or what is not, "free" strata is a matter which must be left to the engineer; his knowledge, experience, and investigations by drilling will determine. In the present instance the first 25 ft. has an angle of repose of 45°, and the 75 ft. beneath must be treated as eventually coming under the effects of hydrostatic pressure. It is sufficient for this purpose meantime to make the timber calculations for the point where the maximum stresses come on, i.e., at 100 ft. depth. The sizes of the timbers above this will be proportionally less and they can be worked out from the stress diagram.

The total stress per sq. ft. that has to be taken care of at 100 ft. depth is 1,250 lb. plus 4,687·5 lb., which totals 5,937·5 lb. per ft.^{2} The area of dirt

supported by a beam may be approximately 14 sq. ft. In this case the bending moment is:

$$\frac{W \times l}{8} = \frac{5937 \times 14 \times 6 \times 12}{8} = 748{\cdot}062 \text{ lb. in.}$$

Taking the moment of resistance as $\frac{f.b.d.^2}{6}$ and allowing a safe stress f as 1000 lb./in² (load factor 4.), and taking width of timber as 14 in.; working out, we have $d^2 = 320$ . . . therefore $d = 18$ in.

This means that, to satisfy conditions of safety at a depth of 100 ft. in such soil, the beam would have to be 14 in. wide by 18 in. deep, the beam being placed so that its depth resists the thrust, since the strength of a beam varies as the square of the depth. This merely gives the stress in bending; the shear and bearing stresses, etc., will have to be worked out, and provision made to meet them according to the method of jointing and bracing used. Care will have to be exercised in proportioning and making the joints. The required sizes of the "lagging" or "sheet-piling" can be worked out as above.

This gives an idea as to how to go about the problem in respect of sizes of timbers required in this class of work, and shows the necessity of making proper investigations before commencing operations. There is limit to the utilization of timber for such shafts, as a point is reached when the amount required is excessive; steel or concrete caissons then have to be used.

Concentrating Practice at Morenci, Arizona.—Concentrating practice of the Phelps Dodge Corporation at Morenci, Arizona, is described in Information Circular 6460 of the United States Bureau of Mines, by A. Crowfoot. The plant occupies a rather unique position among the concentrators of the south-west United States in that it is one of the oldest of the large mills and has developed from a capacity of 900 tons daily in August, 1906, to a capacity of 5,000 tons daily at present. The ore treated is mined by block-caving from the Humboldt group of mines at Morenci. It is a monzonite-porphyry and contains chalcocite as the principal sulphide copper mineral and some oxidized copper in the forms of oxides, carbonates, and silicates.

The ore is crushed to −6-mesh by jaw crushers, cone crusher, and a closed circuit of rolls and vibrating screens. The −6-mesh product is rough concentrated on tables which produce finished concentrates and tailings. The table tailings comprise the feed to the primary grinding system. Treatment in the primary grinding and flotation departments consists in dewatering the table tailings, grinding to 7% + 48-mesh in ball-mills operated in closed circuits with drag classifiers and flotation treatment. The flotation treatment is effected in roughing and cleaning cells; the later cells produce finished concentrates and tailings which join the rougher-cell tailings as feed to the secondary-grinding and flotation units.

The secondary-grinding and flotation equipment comprises bowl classifiers which deliver sands to secondary ball-mills and overflow products to secondary rougher flotation cells. The bowl classifiers operate in closed circuit with ball-mills and produce overflow pulp, the solids of which contain 1·5% of + 65-mesh material. The rougher flotation concentrates are treated in two stages in cleaner cells, the second cleaner cell producing finished concentrates. The middling products of the cleaner flotation cells are returned to the grinding circuit. The tailings of the secondary rougher cells are treated in flotation scavenger cells. These cells produce waste tailings and low-grade concentrates which are returned to the secondary grinding circuit. Flotation reagents used are potassium xanthate, pine oil, and lime. Table concentrates are dewatered by rake classifiers equipped with vacuum chambers and flotation concentrates are dewatered, after thickening, by filters.

In 1929, the concentrator treated an average of 4,728 tons of ore per day which contained 1·92% of copper. The recoveries amounted to 82·29% of the total copper and 91·56% of the sulphide copper. The concentrate contained 23·44% of copper. Total milling costs for 1929 amounted to $0.579 per ton of ore treated.

Flotation at Verde Central.—Milling practice of the Verde Central Mines is described in Information Circular 6489 of the United States Bureau of Mines, by R. H. Dickson and E. M. Smith. This paper is one of a series being prepared by the Bureau and the following is a brief summary of the contents.

The Verde Central concentrator, of 400 tons daily capacity, is located about one mile west of Jerome, Arizona. It treats ore from the Verde Central mine and is 1,000 ft. distant from the main shaft of this mine. The ore-bodies occur in veins and are composed of quartz, pyrite, and chalcopyrite, the sulphides occurring in both disseminated and massive forms. The mine ore averages 2·7% of copper, 0·4 oz. of silver, and a negligible amount of gold.

Concentration is effected by flotation in a lime, xanthate, and pine oil circuit, which permits of the bulk of the pyrite being depressed and of the production of a chalcopyrite concentrate which contains approximately 20% of copper. Crushing of mine ore to $\frac{5}{8}$ in. size is done by a 12 by 24 in. jaw crusher set at about $2\frac{1}{2}$ in., followed by a No. 3 coarse cone crusher set at $\frac{5}{8}$ in. The product of the cone crusher is fed to a vibrating screen which has $\frac{1}{4}$ by 1 in. holes. This screen operates in closed circuit with a pair of 56 by 24 in. rolls set $\frac{1}{4}$ in. apart. The screen undersize, which is minus $\frac{1}{4}$ in., comprises the feed to the grinding unit. Grinding, to 3·5% plus 48-mesh size, is done by two 8 ft. by 36 in. conical ball-mills. These mills are arranged in parallel and each is operated in closed circuit with a 6 by 26 ft. rake classifier.

The classifier overflow pulps are treated in two primary flotation machines operated in parallel as roughers. The tailings of the primary machines are mixed and distributed to two secondary machines also operated in parallel and as roughers. The tailings of the secondary machines are final waste products. The concentrates produced by the primary and secondary roughers are delivered to one cleaner cell. The cleaner cell produces finished concentrates and middlings which flow by gravity to the heads of the primary rougher cells. The concentrates are thickened and further dewatered by a 6 ft. disc filter. They are hauled by truck to the Verde Tunnel and Smelter Railway, 2 miles distant, for shipment to the United Verde Extension Smelter at Clemenceau.

During the months of May and June, 1930, the concentrator treated an average of 392 tons of ore per day which contained 2·67% of copper. The concentration ratio was 7·95 tons into 1; the concentrate produced contained 19·83% of

co[illegible]r and 16·1% of insoluble. The recovery of co[illegible]r amounted to 93·2%. Concentrator costs for the period June 1, 1929, to August 1, 1930, were $1·26 per ton of ore treated.

Underground Chute Gates.—Information circular 6495 of the United States Bureau of Mines by C. F. Jackson and J. B. Knaebel—one of a series dealing with special mining problems—deals with underground chute gates in metal mines. Underground transport is an important part of mine operation and absorbs an appreciable part of the total underground cost at most ore mines. In mining ore-bodies of considerable vertical height the ore is usually loaded into cars through the medium of chutes provided with gates or doors. These chutes form an important link in the transport and handling of broken ore and waste and it is important that they be designed and constructed to suit the conditions at each mine. The important influencing conditions are physical nature of ore and rock, dip of deposit, tonnage handled, size of cars, cost of construction, and cost of operation.

The authors classify gates into 10 types and several sub-types and describe and illustrate each type with the aid of line drawings of which there are 40. Of particular interest is a new type of gate which the authors term the " flexible " or " curtain " type, consisting of a number of heavy chains with iron balls attached to the lower end and which are suspended from the head cap of the chute. The field of application of each type and its advantages and disadvantages are discussed. Finally examples of costs of installing gates and chutes of various types are given.

SHORT NOTICES

Coal Mine Ventilation.—At a meeting of the Coal Division of the American Institute of Mining and Metallurgical Engineers held at Bluefield, Virginia, last month, a proposed safety code for coal mine ventilation, drawn up by the A.I.M.E. Committee on Ventilation, was discussed.

The Spanish Mine, California.—Mining and milling practice at the Spanish mine, Nevada County, California, is described by J. Bradley in *Mining and Metallurgy* for October.

Concentration.—The correlation of metal prices with concentration practice is discussed by D. C. Deringer in *Mining and Metallurgy* for October.

Electrical Prospecting.—Technical Paper 502 of the United States Bureau of Mines by I. Roman, deals with the computation of tables for the determination of electrical resistivity of underlying beds and their application to geophysical problems.

Gold in Northern British Columbia.—F. A. Kew analyses the possibilities of northern British Columbia as a future gold producer in the *Canadian Mining Journal* for October.

Great Bear Lake.—Memorandum Series No. 51 of the Department of Mines at Ottawa, by H. S. Spence, deals with the occurrences of pitchblende and silver ores at Great Bear Lake in the North-West Territories.

Radium.—In the *Canadian Mining and Metallurgical Bulletin* for October, G. W. Adams and M. S. Stevens give a comprehensive account of radium, its properties, uses, mode of extraction from ores, and its occurrences.

The Homestake Enterprise.—*Engineering and Mining World* for October contains a series of articles describing the activities of the Homestake Mining Company.

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.*

4,870 of 1930 (355,211). A. D. J. Elié, Madagascar. Flotation process and apparatus for the separation of such minerals as graphite.

5,333 of 1930 (355,235). E. W. Wescott, New York. Iron oxide and other values in iron ores are recovered by an improved chlorination process.

5,965 of 1930 (355,302). Vereinigte Stahlwerke A.-G., Düsseldorf, Germany. Iron is recovered from iron carbonyl by the thermal decomposition of the carbonyl on small inorganic non-metallic bodies.

17,302 of 1930 (355,840). H. M. Cyr and R. Kerr, Palmerton, United States. Lead and cadmium are recovered from zinciferous materials by subjecting them to a sintering operation in the presence of a chloridizing agent and water vapour, without loss of zinc.

17,934 of 1930 (357,159). Colorado Iron Works Co., Denver. An ore classifier embodying an inclined trough having feed and delivery means, fitted with a rotary shaft carrying a spiral agitator and convevor.

21,299 of 1930 (356,380). W. Kangro and A. Lindner, Braunschweig, Germany. Beryllium is recovered by a simplified process from beryllium compounds, by treating them at a high temperature with gaseous chlorine, in the presence of carbon or some other reducing agent.

22,585 of 1930 (356,404). Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij and A. G. H. Straatman, The Hague. A wedge device for deflecting a slanting bore-hole into the vertical.

36,212 of 1930 (355,613). Antimon Berg und Hüttenwerke A.-G., Banska Bystrica, Czechoslovakia. Commercial antimony oxide is produced from concentrates by admixing fusible oxides before or during oxidation.

680 of 1931 (356,077). J. Leemans and Société Generale Metallurgique de Hoboken, Hoboken-lez-Anvers, Belgium. Black copper is refined by smelting the slag obtained from refining in the presence of black copper, the latter acting as a precipitating agent for the copper in the slag, while the slag acts as a purification agent for the black copper.

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.

Flotation. By E. W. Mayer and H. Schranz. Paper covers, 593 pages, illustrated. Price R.M. 33. Leipzig : S. Hirzel.

Bekampfung hoher Grubentemperaturen. By B. Stoces and B. Cernik. Cloth, octavo, 311 pages, illustrated. Price R.M. 36. Berlin : Julius Springer.

Firedamp Explosions and Their Prevention. By W. Payman and I. C. F. Statham. Cloth, octavo, 158 pages, illustrated. Price 12s. 6d. London : Humphrey Milford, Oxford University Press.

Stainless Iron and Steel. By J. H. G. Money-penny. Second edition, revised and enlarged. Cloth, octavo, 575 pages, illustrated. Price 25s. London : Chapman and Hall.

Elements of Optical Mineralogy. Part I. Principles and Methods. Fourth edition, revised and enlarged. Cloth, octavo, 248 pages, illustrated. Price 21s. London: Chapman and Hall. New York: John Wiley and Sons.

The Mineral Industry during 1930. Vol. xxxix. Edited by G. A. Roush. Cloth, octavo, 815 pages. Price 72s. New York and London: McGraw Hill.

Petroleum Engineering Handbook. Second edition, 1931. Cloth, royal quarto, 461 pages, illustrated. Price $5. Los Angeles: Palmer Publications Inc.

Petroleum Development and Technology during 1931. Papers presented before the A.I.M.M.E. Petroleum Division at Tulsa and Los Angeles during October 1930 and February 1931. Price 30s. New York: American Institute of Mining and Metallurgical Engineers.

Geological Survey of Great Britain. Summary of Progress, Part III. Paper covers, 92 pages, illustrated. Price 2s. London: H.M. Stationery Office.

List of Mines in Great Britain and the Isle of Man, 1930. Paper covers, 375 pages. Price 10s. London: H.M. Stationery Office.

Safety in Mines Research Board. Publications, Vol. VI, 1930. Reports and papers relating to research into coal dust, firedamp and other sources of danger in coal mines. Paper covers, 10 pages. Price 2d. London: H.M. Stationery Office.

Coal Distillation. Department of Scientific and Industrial Research—Report of Test by the Director of Fuel Research on the plant of the Leicestershire (L & N) Coal Distillation Co., Ltd., at Newbold, near Ashby de la Zouch. Paper covers, 28 pages, illustrated. Price 9d. London: H.M. Stationery Office.

Imperial Institute. *Bulletin*, Vol. XXIX, No. 3, 1931. Paper covers, pp. 271–406, illustrated. Price 3s. 6d. London: John Murray.

Quebec: Annual Report of the Bureau of Mines, 1930. Part B. Paper covers, 117 pages, illustrated, with maps. Quebec: Bureau of Mines.

Fort William and Port Arthur, and Thunder Cape Map-Areas, Ontario. By T. L. Tanton. Memoir 167 of the Canadian Geological Survey. Paper covers, 222 pages, illustrated, with map. Price 30 cents. Ottawa: Department of Mines.

Rouyn-Harricanaw Region, Quebec. Geology and Ore Deposits. By H. C. Cooke, W. F. James, and J. B. Mawdsley. Memoir 166 of the Canadian Geological Survey. Paper covers, 314 pages, illustrated, with map. Price 45 cents. Ottawa: Department of Mines.

South Africa: A Bibliography of South African Geology for the years 1926–1930. Author's Index by Dr. A. L. Hall. Memoir No. 27 of the South African Geological Survey. Paper covers, 160 pages. Price 5s. Pretoria: Geological Survey.

North-Eastern Pretoria District: Geology. An Explanation of Sheet No. 18 (Moos River) of the Geological Map of South Africa. By B. V. Lombaard. Paper covers, 43 pages, illustrated, together with map. Price 5s. Pretoria: Geological Survey.

Southern Rhodesia: The Geology of the Country around Shamva, Mazoe District. By R. Tyndale-Biscoe. Southern Rhodesia Geological Survey Bulletin No. 18. Paper covers, 87 pages, illustrated, with map. Price 3s. 9d. Salisbury: Geological Survey.

Oil in Australia: Report on a tour of inspection of the oil-fields of the United States of America and Argentina and on Oil prospects in Australia. By Dr. W. G. Woolnough. Paper covers, folio size, 118 pages, illustrated. Price 5s. Canberra: Government Printer.

British Guiana: Report on the Lands and Mines Department, 1930. Paper folio, viii + 16 pages. Georgetown, Demerara: Department of Lands and Mines. London: Crown Agents for the Colonies.

Oregon. Geology and Water Resources of the Middle Deschutes River Basin. By H. T. Stearns. United States Geological Survey Water-Supply Paper 637-D. Paper covers, 220 pages, illustrated, with map. Price 35 cents. Washington: Superintendent of Documents.

Mineral Resources of the United States, 1930. Part I, pp. 1–15, Antimony, by P. M. Tyler. Part II, pp. 69-71, Fuller's Earth, by J. Middleton; pp. 73–86, Salt, Bromine, and Calcium Chloride, by A. T. Coons. Washington: Superintendent of Documents.

NEW COMPANIES REGISTERED

Aurum, Ltd.—Registered as a private company October 12. Capital: £2,000 in £1 shares. Objects: To carry on the business of a prospecting, developing, and financial association, etc., and to adopt an agreement with the Gabait Tributing Syndicate.

Consolidated Platinums.—Registered October 21. Capital: £1,000 in £10 shares. Objects: To regulate the sales of the major portion of the world's platinum output. Subscribers: Lord Prabourne, Mr. J. G. Lane, Mr. J. E. Jansen, and Mr. D. Owen Evans. Managers: Mr. P. L. Ginsburg and Mr. F. B. Howard White. Office: Imperial Chemical House, Millbank, S.W. 1.

Electrolytic Copper Corporation.—Registered as a private company. Capital: £50,000 in £1 shares. Objects: To acquire from F.C. Metal Processes inventions relating to metals.

H. A. Watson and Co. (Liverpool and London).—Registered as a private company on October 5. Capital: £100,000 in £1 shares (25,000 Six per Cent. Cumulative Preference and 75,000 Ordinary). Objects: To carry on the business of mineral and metal brokers, merchants and commission agents, formerly carried on by H. A. Watson and Co. Directors: Messrs. W. W. Moyers, L. G. Beaumont, T. R. Whitehead and W. G. Moyers. Office: K30, Exchange Buildings, Liverpool.

DIVIDENDS DECLARED

Oriental Consolidated.—50 cents., less tax, payable November 5.

North Broken Hill.—2s., less tax, payable December 14.

Pengkalen.—Pref., 3d., less tax., payable October 31.

Petaling.—1½d., less tax, payable October 31.

Rawang Concessions.—6d., less tax, payable November 30.

St. John del Rey.—Pref., 1s., free of tax; Ord., 9d., less tax, payable November 20.

Trepca.—3d., less tax, payable November 30.