The Mining Magazine

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CONTENTS

EDITORIAL

IN the issue of the MAGAZINE for November an extract was given of a report on cassiterite deposits in Uganda, the author of which was Mr. A. D. Combe, of the Uganda Geological Survey, not Mr. E. J. Wayland, as stated.

IN its forty-fourth year, that hardy annual Skinner's "Mining Year Book" makes its appearance on the 18th of this month. This reference work, invaluable to all associated with the industry, contains the particulars of all mining companies registered in this country or known on the London market.

IN August last the developments regarding the Imperial College Union and Hostel were noted here. It is now announced that, thanks to the generosity of Sir Otto Beit and the City and Guilds of London Institute, the new building is to be completed to the full height of five storeys. The College is now assured, in the course of a year or two, of a resident population of 120, provided that in the meantime the required balance of £13,000 can be raised.

IT has been proposed that the Department of Mineralogy in Cambridge University should be replaced by two departments, each with its own chair—a Department and Chair of Crystallography and a Department and Chair of Mineralogy and Petrology, which latter should be in closest possible relation with the Department of Geology. It is urged that the future development of crystallography lies mainly in fields bordering upon both physics and chemistry. Few will dispute that such is the case; yet there are the strongest possible reasons for maintaining a close *liason* between the three studies.

FURTHER progress has been made during the past month in the direction of restricting tin production, the ranks of those to adopt the recommendation of the Tin Producers' Association having been joined, among others, by the Osborne Chappel group and the Patino interests, whilst Nigeria is to reduce its output for the first quarter of the year by 20 per cent. Whether the policy of restriction will give the relief anticipated remains to be seen, the view held in some quarters being that a very much higher price for the metal will be necessary in order to counterbalance the effect on earnings of the reduced output.

THE revelation that what were thought to be the bones of a dinosaur near Tetuan are in fact nothing more than the relics of a hay-making machine belonging to a Spanish farmer who abandoned his property in 1917 during the Riff war marks the end of yet another "geological discovery." In spite of the fact that the original explorers made a mistake in believing the curved iron teeth of the automatic rakes to be the ribs of a species of this reptile hitherto known only in the Rocky Mountains, it is evident that they were right in giving their find a Transatlantic origin because the machine is marked with the name of a well known Canadian manufacturer.

IT is encouraging to note that the steel production of Great Britain in the past year at 9,654,700 tons is the highest, except for the maximum war output in 1917. But for the fact that the figures for the month of December fell off considerably there is no doubt that the total would have been a record. It is unfortunately not possible to speak in such optimistic terms of the industry as a whole. Little foreign competition was met with, owing to the demands on the Continent being in excess of supplies, but it is doubtful how long such conditions will prevail, as production in Germany and France is getting abreast of consumption and costs are lower in those countries.

THE position of the Lena Goldfields, to which reference was made in the January issue, would appear to have gone from bad to worse during the past month. Alleging delay in the payment of the wages of the workers, action was taken against the company, which was fined 25,000 roubles, its representative at the same time being sentenced to eight months' compulsory labour. Notice has also been given for the cancellation of the agreement between the Government and the concessionaire. Although the sentence of compulsory labour on the company's representative has since been remitted, recent events indicate that agreements with the Soviet Government are not too secure. Under the circumstances those contemplating the acceptance of appointments in Russia will doubtless appreciate that they run a great deal of risk.

PROFESSOR J.G.LAWN has been elected President of the Institution of Mining and Metallurgy for the coming year and he

will take office at the annual general meeting, to be held in June instead of May on account of the South African congress. Professor Lawn was educated at the Royal School of Mines and, after early practice and teaching experience in Cumberland, was appointed in 1893 assistant to Sir Clement Le Neve Foster at South Kensington. Three years later he became Principal and Professor of Mining at the South African School of Mines, Kimberley. After leaving academic life for a time to work as assistant consultant to the Johannesburg Consolidated Investment Company, he returned to it when he was made Head of the Mining Department at Camborne. In the meantime the South African School, after the Boer War, had removed to Johannesburg, and there Professor Lawn returned to his former position in 1909. He definitely turned his back on teaching, however, only a short year later, when he was appointed Consulting Engineer to the Johannesburg group with which he had been previously associated, a position he has held to this day, in South Africa and in London. He is the author of a standard text-book of mine accounting. When Professor Truscott became President we said of him that he was fitly called a scholarly practitioner. Of this year's president-elect may we say that he is a practical academician.

Trade Conditions

The annual meetings of the leading banks are invariably anticipated with much interest; this year the pronouncements of the chairmen were awaited not only with interest but some measure of anxiety. Under the circumstances it is, therefore, satisfactory to learn that their summary of the present position is not unfavourable and that the future is not devoid of encouragement, although there is need for caution. Few years have witnessed more factors calculated to disturb business than 1929. General elections, whatever the result may be, are never welcome features and in addition the year witnessed serious international as well as home troubles. That the country should have come through the trying times experienced as well as it has is cause for congratulation.

Whether due to the advent of a Labour Government or not, it is significant that during 1929 there were no serious trade disputes involving protracted stoppages of work and this doubtless explains the improvement recorded in most of the industries of the country, Board of Trade figures showing increased production in many industries, including non-ferrous metals, iron and steel, and engineering. That this should be the case is certainly gratifying, in view of the many discouraging influences with which the country had to contend, one of the chief of which was dear money. If no great progress was made, there was no retrogression and the general trend was upward. Whether the movement in this direction is to continue seems to depend very largely on provision of further capital for the installation of new machinery, in order to bring processes up to date and enable the industries concerned to compete successfully in the markets of the world. As has been rightly pointed out, it is not the province of the banks to provide this; their function is to furnish money for their customers' current needs. Capital for permanent investment has to come from the individual and some doubt is felt, in view of the present high cost of living and heavy taxation, whether there is a sufficient sum available from this source to meet the demand.

As was only to be expected, reference was made at most of the meetings to the disturbing influences which during the past few months have so seriously affected the commercial life of the country, due to the inordinate desire of some people to make money quickly, and the hope was expressed that this would prove to be only a temporary aberration from the high traditions of financial and commercial morality on which not only those at home but those abroad have in the past been accustomed to rely. In dealing with this subject the President of the Society of Incorporated Accountants and Auditors at Liverpool last month advocated a drastic amendment of the company law and of Stock Exchange rules in order to restore the confidence of the public and referred particularly to the irregularities associated with the formation of interlocking companies and to the necessity of re-introducing the Stock Exchange rule as to dealing in vendor shares. It is satisfactory to learn that the latter is likely to receive attention in the near future and it is to be hoped further amendments of the Companies Acts to meet the abuses which have recently been so prominently before us will not be long delayed.

The Institution Meeting

At the January meeting of the Institution two papers of a widely differing nature were presented—the first, "A Contribution to the Geology of the Manganese Ore-deposits in the Gold Coast Colony and in Ashanti," by Messrs. D. W. Bishopp and W. J. Hughes; the second, "The Influence of Wolfram on the 'Combined Tin' Content of Slags produced in the Smelting of Cassiterite," by Messrs. K. V. Christie and E. O. Jones. The authors were not at the meeting, the first paper being presented by Mr. J. Allen Howe and the second by Dr. Sydney W. Smith. In this connexion it is to be regretted that of late years many papers have been submitted in the absence of the authors. When they are abroad this is, of course, unavoidable, but when the authors are in this country it is surely desirable that they should sponsor their own work. The best-intentioned deputy finds it difficult to impart that conviction with which the author himself would present his chosen theme.

Prior to the introduction of the subjects before the meeting, the President spoke of the decline in the number of papers presented for discussion at the Institution meetings. As he remarked, many which formerly would have been received from overseas are now presented to the local societies. In these circumstances there is evidently some justification for the contention that it would be better if only one communication were accepted for discussion each evening, especially as almost invariably, when two papers are presented, only the first receives due attention. With the plea for more papers we are ourselves in sympathy and there is certainly much to be said for the suggestion that the younger and perhaps less experienced members of the profession should be encouraged to come forward with their theses, discussion of which by the older members would be beneficial to both. There is, however, another aspect of this matter. It is well known that some mining companies, wittingly or otherwise, place obstacles in the way of the publication of papers by their officials, but this difficulty would not be experienced if it were more generally realized how much the engineer benefits, and in turn the company with which he is associated, by the free discussion of his work.

To revert to the papers, the manganese deposits of the Gold Coast Colony, discovered in May, 1914, by the Director of the Geological Survey, came into prominence during the War, when those of the Caucasus were cut off and shipping difficulties curtailed the supplies from India and Brazil. Work during this period of activity was described in the MAGAZINE for December, 1917, by Mr. Stanley H. Ford. The paper of Messrs. Bishopp and Hughes, which will be found summarized elsewhere in this issue, contained a detailed account of the deposits of the Insuta area and this part of their communication appears to be the most valuable, as allowance should be made for the fact that the authors would probably have been prepared slightly to alter their regional geology had they been in possession of the provisional geological map of the Gold Coast and Western Togoland, which was only recently published. The work of the authors has, however, the stamp of thoroughness and, in spite of the difficulties of the country and the desirability for more evidence, they have realized that in commercial geological work, as indeed in any geological work, it is useless to make a plan in which a series of outcrops are left "hanging in the air." In the conduct of such work the utmost possible use must be made of time spent in the field, but in the office an intelligent interpretation of the collected data is advisable as it is possible that if the interpretation is not formed by the geologist himself someone less capable will have no hesitation in jumping to desired conclusions. Contributions to the discussion of this paper were made by Sir Albert Kitson, Mr. H. K. Scott, Mr. J. H. Goodchild, and Professor C. G. Cullis.

The work of Messrs. Christie and Jones was initiated by a consideration of the penalties imposed by a tin-smelting company in the Straits for the presence of small quantities of tungstic oxide in tin concentrates. The authors' line of attack may be judged from the summary of their paper, which will be found elsewhere. It was pointed out in discussion that the work was entirely on a laboratory scale, but the results obtained are nevertheless extremely useful. Dr. Smith gave the discussion a good send-off and useful contributions were made by Dr. W. R. Jones and the President.

Mining Laws

In April, 1927, Mr. Gilbert Stone read a paper on mining law before the Institution which was subsequently presented at the Second Empire Mining and Metallurgical Congress in Canada, but pressure of other important matter at the time prevented more than a bare reference to the subject in the MAGAZINE for May of that year. The presentation by the same author of a paper, which is in the nature of a sequel, before the Royal Society of Arts on January 22 affords an opportunity for examining a matter which does not often present itself as a subject for discussion among mining men. In his first paper Mr. Stone illuminated a number of aspects of the subject which tended to show, *inter alia*, the inter-dependence of the mineral development of a country and its wise administration and made a plea for the removal of uncertainties as to the ownership of rights to minerals, whether of the royal or base metals, and also for the intensive prospecting of sparsely-populated Crown lands.

The author introduced his present thesis by reference to an amusing anomaly. As is well known, many present-day legal codes are founded on the original Roman law and yet the framing of this law was substantially affected by a quaint belief current in those times that minerals grow and that a mine left alone long enough would be found to have replenished itself. Such a belief is comparable to the native Malayan conception of the growth of tin ore to which Mr. Scrivenor has so entertainingly alluded in his book "A Sketch of Malayan Mining." So far from minerals replenishing themselves, however, they must be regarded as wasting assets which once exhausted are lost. Moreover, they are essentially indigenous and belong to the country in which they are found and it is the duty of a Government to take care of the wealth that is but may cease to be.

Mr. Stone adumbrates several specific reforms which, in his position as legal consultant to the Advisory Council on Minerals of the Imperial Institute, will command respect. These deal with the rights of the prospector and of the miner, the need for the encouragement of both and of capital, the surety and length of title, the size of areas and terms of grant, and rents and royalties. His examination of each separate contention invests it with added interest and he makes it clear that the aim has been, not only that of bringing into conformity the mining regulations of the Empire, but also the encouragement of active mineral discovery and development by the removal of existing onerous conditions.

One important point which emerges more than once from this paper, and one which will be generally endorsed, is that it matters not the nationality of the prospector nor the country of origin of the development syndicate, except perhaps for reasons of sentiment. The foreigner who is assisting in the discovery and mining of natural resources is adding to the wealth of that country. In cases of emergency it is merely a matter of legislation to ensure that no mineral products are removed to alien countries. It is well to remember also in this as in other connexions that the chief gain to the State of the exploitation of mineral wealth lies, not in the fees, rents, and royalties received, but in the work done, the development effected, the industries thereby created, the labour employed, and the money circulated.

On the subject of the general question of prospecting and title, a prospecting syndicate which is committed to a large capital outlay of a very speculative nature in a region of which the geology is comparatively or quite unknown expects more favourable treatment in the matter of concessions than those who come later to exploit what has been made manifest, and provision ought to be made accordingly. In contradistinction to this, as the stage of production approaches the area licensed should tend to diminish, but it is less generally appreciated that the owners of such producing areas should have indefinite powers to expand in a direction which will enable them to work a proved ore-body.

The legal committee to which Mr. Stone acts in an advisory capacity is one in which resides a considerable power to benefit the mining engineer operating in the Dominions and Colonies. The personnel of this committee is one to commend itself. It is questionable, however, whether sufficient weight is always attached to its representations by some authorities overseas, though it is believed that the Colonial Office is fully aware of the value of the advice that has in the past been given and some overseas Governments have adopted its views and expressed their appreciation of the assistance rendered.

REVIEW OF MINING

Introduction.—With the price of tin continuing uncertain and the copper market in such a condition that prices seem to be artificially supported, the past month has been somewhat dull. A minor boom in Rhodesian copper shares has taken place on the news of high bore-hole values from the N'Changa western extension. Trade conditions should be better, as the Bank rate has been lowered from 5% to 4½%.

Transvaal.—The output of gold on the Rand during January was 848,245 oz. and in outside districts 34,556 oz., making a total of 882,801 oz., as compared with 851,134 oz. in December. At the end of January the number of natives working at the gold mines was 190,663, as compared with 184,280 at the end of December.

The returns of the Rand Chamber of Mines show that more than 31,000,000 tons of ore was milled during 1929, an increase of 446,000 tons on the previous year, and the gold obtained was 10,414,000 oz., an increase of 55,470 oz. Working costs at 19s. 10d. per ton show a decrease of 1d. per ton, but the revenue was 3d. per ton lower. Working profit was down £122,000 at £12,908,191 and dividends at £8,413,616 were £45,000 lower.

The Government of Northern Rhodesia is stated to have advised the Government of the Union that recruiting of Northern natives for work on the Rand mines will not be welcomed, as all available labour is needed for the development of the copper fields. It is probable that the authorities concerned will be forced to abandon recruitment in Rhodesia and the Union is re-opening negotiations with the Portuguese Government in order to obtain labour from Mozambique.

In the last issue of the MAGAZINE the adoption of an agreement between the Robinson Deep and the Village Deep was announced. It is now stated that the Government of the Union, exercising its powers under the Gold Law, will appoint a Commission to investigate the proposed amalgamation.

Southern Rhodesia.—The output of gold during December was 46,829 oz., as compared with 46,219 oz. in November and 44,772 oz. in December, 1928. Other outputs in December were: Silver, 6,694 oz.; copper, 180 tons; coal, 111,885 tons; chrome ore, 28,206 tons; asbestos, 3,971 tons; mica, 13 tons; diamonds, 9 carats. The total output of gold for 1929 was 560,813 oz., as compared with 576,113 oz. the year before, and the total mineral production was valued at £4,871,774, as against £4,448,311 in 1928.

In July last it was announced that developments at the Shamva Mines had been unfavourable and that the future depended on the results of work undertaken on the recommendation of Dr. Malcolm Maclaren. This has been so discouraging that development operations have been discontinued. The poor results are due apparently to the fact that the ore-bearing channels have become so wide that the ground can no longer be profitably treated for its gold content. The work done has shown that there are no indications of any contraction in these widths and it is intended to close down the mine after crushing and treating the payable ore available.

The Mayfair mine has been compelled, by the failure of a suction-gas engine, to cease milling. Development work will be carried on pending the replacement of the engine, which it is expected will be completed in about six months.

Southern Rhodesia Base Metals Corporation has informed its shareholders that the option to purchase 75,000 of the unissued £1 shares of the corporation, which was granted to the Rio Tinto Company, has not been exercised.

The ore reserves of the Globe and Phœnix mine at the end of 1929 are estimated at 100,500 tons, containing 115,600 oz. of gold, representing an increase of 14,300 tons as compared with the end of the previous year.

Northern Rhodesia.—Shareholders of the Rhodesian Congo Border Concession have been informed of results from three bore-holes situated in the "New Discovery" area of the N'Changa Copper Mines. Bore-hole N.E. 16 has cut the western extension of the "Dambo" lode at a depth of 285 ft. and from 285 ft. to 300 ft. was in ore averaging 3·26% copper. At 330 ft. another ore-horizon was encountered and from 330 ft. to 355 ft. the copper content averaged 13·04%. Bore-hole N.E. 8 is placed more centrally between the outer limbs of the N'Changa fold. This hole entered an ore-horizon at 1,270 ft. and was reported to be still in ore at 1,363 ft., the 93 ft. of ground averaging 11·05% copper. Bore-hole N.E.

10, situated about ¼ mile N.W. of the last hole, encountered ore at 1,160 ft. and at 1,170 ft. was still in payable ground, the 10 ft. averaging 5·56% copper. The results to date on the western extension of the N'Changa property and on the Chingola property seem to indicate that copper-values increase towards the west. Development work has been continued on the main vertical shaft, which is situated on the River Lode, and which at December 31 last had reached 634 ft. At this point sinking has been suspended, pending the installation of further power plant.

Rhodesian Selection Trust has issued preliminary results from bore-hole No. 28 on the Mufulira property. This hole, situated between bore-holes Nos. 7 and 15, has shown that a section through these three holes shows an average thickness of 99·6 ft. of mineralized ground averaging 8·88% copper. Baluba bore-hole No. 10, beginning at a depth of 796 ft., has passed through 5·8 ft. of ground averaging 4·83% copper.

Gold Coast.—In the annual report of the Ashanti Goldfields Corporation the ore reserves at the end of the financial year—September 30 last—are estimated at 590,200 tons, of an average value of 25·2 dwt., an increase of 40,800 tons in quantity and 1 dwt. in value for the year. The blocks of ore in Ashanti, Ayeinm, and Justice's mines are at present classed as " unpayable " and are not included in the reserves. During the year 108,007 tons of ore was treated and yielded 118,095 oz. of fine gold and 6,570 oz. of silver. In addition 41 oz. of gold was recovered from sundry sources. The total recovery averaged 21·88 dwt. per ton and the metallurgical plant gave a theoretical extraction of 92·7%. Improvements on the plant are not yet completed, but much larger tonnages can now be handled. There was a net profit for the year of £203,584 and £162,500 was distributed as dividends, equal to 65%.

Nigeria.—The fall in the price of tin has induced the Government to reduce rents on mining leases from 5s. to 1s. per acre and on mining rights from £1 to 4s. per 100 yd., whilst all labour obligations have been suspended for six months.

Australia.—At the last annual meeting of the Wiluna Gold Corporation it was intimated that additional capital would be required to bring the company to the producing stage. It is now announced that the Federal Government of Australia and the Western Australian Government have expressed their willingness to guarantee the provision of £300,000 for this purpose.

Developments at the Lake View and Star continue to be favourable. It is now stated that in cross-cutting east on the 3,260 ft. level of the Golden Horse-shoe section at a point 368 ft. south of the shaft ore assaying 65s. per ton over 7 ft. has been disclosed. It is also stated that the rich telluride ore disclosed west of the south drive on the 300 ft. level in the Lake View section has been driven on for 26 ft. The ore has been consistently rich, assaying in places 30 oz. per ton over 54 in.

The first section of the plant to treat the Golden Horseshoe tailings dump, estimated at 2½ million tons, value 7s. 10d. per ton, was due to be completed at the beginning of February and the second section is expected to be ready at the beginning of March. Each section is designed to deal with 20,000 tons a month.

A circular issued by Federation Tin Mines states that negotiations are in progress for the provision of the funds required to complete the mill. So far this has only been working at one-third of its capacity and losses have been incurred. With the full plant in operation it is calculated that it will be possible to work at a profit with tin at its present price. It is also proposed to extend the redemption period of the debentures for a further five years. Recent developments on the Fowler and Dunn lode are stated to have exposed ore averaging 6% over 3 ft.

Malaya.—Shareholders of the Taiping Tin Dredging Company are informed that it has been decided to acquire 40 acres of area " A " out of the 121 acres selected by Mr. Mungo Park. This area of 40 acres is estimated to contain 2,366,000 cu. yd. of ground averaging 0·4 katty per cu. yd. By their agreement with the Government the purchasers may move the electric transmission line which traverses the " A " and " B " areas and re-erect it on a mutually agreed site. Area " B " is gradually being acquired as the option agreements expire. This area contains 210 acres selected for dredging which are estimated to contain 13,950,000 cu. yd. of ground averaging 0·628 katty per cu. yd. Negotiations are proceeding with the South Taiping Company for the purchase of their dredge, which has a capacity of 130,000 cu. yd. per month.

A progress report issued by Kampar Malaya Tin Dredging shows that during the three months ended December 31 last 672,000 cu. yd. of ground was treated yielding 239 tons of tin concentrates. It was originally estimated that 150,000 cu. yd. of ground would be treated per month, recovering 58 tons of concentrates. It is also stated that working costs have been reduced to 3¾d. per cu. yd., which is equivalent to £45 per ton of concentrates.

Cornwall.—Wheal Reeth has been forced to close down owing to the fall in the price in tin. The company is endeavouring to raise fresh capital, as it is desired to double the capacity of the existing mill.

United States.—The effort of the copper producers in the United States to hold the price of the metal at 18 cents per lb. is probably responsible for the closing down of certain of the Montana copper mines. So far three mines have been closed down and other employees of the Anaconda Company have been placed on part time. It will be recalled that in the United States an agreement exists with the interested unions by which wages vary with the selling price of copper.

Panama.—A progress report issued by Panama Corporation, Ltd., contains encouraging results. The value of the Sabalo River deposits has been confirmed and prospecting operations are being actively continued in the Darien Concession. The upper tunnel of the Hatillos district, Mina Blanca, has now been driven for 541 ft. on the lode. Lead and gold values are persistent. The lower tunnel is now 1,597 ft. long and has also been driven entirely in ore. On Panama No. 1 the 4th level has been driven 2,000 ft. under the main ore-body and a series of cross-cuts made at the extreme end of the tunnel have disclosed an ore-body 29 in. wide, with an average value of £4 8s. per ton. Work has recommenced on the 6th level and at a depth of 467 ft. the lode is 72 in. wide and assays £5 5s. per ton.

Mexico.—The annual report of the San Francisco Mines of Mexico shows the estimated ore reserves at September 30 last to be 1,458,900 tons of ore fully blocked out and 435,600 tons partly blocked out, as compared with 1,194,000 tons and 349,000 tons respectively at the end of the previous year. The sulphide ore averages 8·17% lead, 10·33% zinc, 0·7% copper, and 230 gms. silver and 0·87 gm. gold per ton. The ore milled was 307,450 tons, as compared with 300,010 tons the year before. The net profit for the year was £333,589, out of which dividends amounting to 3s. 9d. per share were paid, the rate being 37½%. There was a shortage of power during the year and a 1,800 k.w. steam-driven electric power plant was erected, coming into operation on December 1 last.

Japan.—The last report of the Chosen Corporation showed that owing to the embargo placed by the Japanese Government on the export of gold it was not always possible for the corporation to obtain the best price for its products. The raising of the embargo on January 11 was followed by the first shipment of gold on January 21.

Diamonds.—The yearly report of Messrs. J. K. Smit and Zonen contains interesting information on small crystalline diamonds. As an effort to counteract the rising price of carbons, the use of small crystals for diamond drilling purposes has been developed. By the new method a drill-crown ready for use can be supplied at half the price of a single carbon and it is calculated that the large saving in cost is not offset by loss of drilling efficiency.

The production of alluvial diamonds in the Transvaal during 1929 was 1,046,802 carats, valued at £2,587,741, or 96,500 carats less than in the previous year.

The report of the De Beers Consolidated for the year ended June 30 last points out that, while accounts do not reveal any improvement in the company's diamond sales during the year, there has been evidence of a gradual absorption of stocks which have accumulated in the hands of the trade. The absorption has been made possible by the greatly reduced output from alluvial fields and should improve the state of the diamond market. During the year no mining was done at the De Beers or Kimberley mines, but 4,720,776 loads of blue ground, averaging approximately 0·23 carat per load, was hoisted from the Wesselton, Bultfontein, and Dutoitspan mines.

A circular to shareholders of the Consolidated Diamond Mines of South-West Africa states that prospecting on the marine terraces in the area north of the Orange River in the Sperrgebiet is proceeding favourably. Work has shown that the diamond-bearing terrace has a length of 20 miles and it is estimated that the reserves are 1,750,000 carats.

GEOLOGY AND MINERAL RESOURCES OF SIERRA LEONE

By N. R. JUNNER, D.Sc., D.I.C., M.I.M.M.
Director of the Geological Survey of Sierra Leone

INTRODUCTORY.—Sierra Leone is the oldest of the British West African Crown Colonies. It comprises the Colony, having an area of 250 square miles, and the Protectorate 27,000 square miles. The Colony was founded in 1787 as a permanent settlement for freed slaves, and in 1808 the Crown took over complete control. The Protectorate was proclaimed in 1896. It is bounded on the north-west, north, and north-east sides by French Guinea, and on the south-east by Liberia.

GRANITE HILLS NEAR KAMABAI.

The white population is about 1,000 and the total African population is a little over 1,500,000. The density of the population—57 per square mile—is slightly greater than that of Nigeria, and almost three times as great as that of the Gold Coast. The African population of the Colony consists largely of "Creoles" English-speaking descendants of the original settlers. The dominant tribes of the Protectorate are Mendes, Temnes, Limbas, Sherbros, Konnos, Korankos, Susus, Kissis, Lokos, and Yalunkas. For the most part these tribes are pagans, but in certain districts, for example, Port Loko, Kambia, and Karene, many of them have adopted the Mohammedan religion.

Freetown with its fine natural harbour and its beautiful surroundings, is the main port and principal town and it is the headquarters of the Government. Bonthe is the second port. The Government railway, 2 ft. 6 in. gauge, provides the chief means of communication with the Protectorate. The main line from Freetown to Pendembu is 227 miles long, and the branch line from Bauya to Kamabai is 104 miles long. At the present time there are about 500 miles of motor roads. These are mainly feeder roads to the railway. The Government is actively engaged in the construction of pioneer roads, and by the end of 1930 there will be nearly 1,000 miles of roads fit for motor transport.

The chief exports from Sierra Leone are palm kernels and palm oil. These comprise about 60% of the total annual value of the exports, and are the chief source of revenue to the Government. In consequence the prosperity of Sierra Leone is largely influenced by the price of these products. Kola nuts, ginger, and piassava rank next in the list of exports. Cocoa, coffee, and coconuts are grown in certain districts, but they have not yet become important exports. Rice is the principal food crop of the natives and both hill rice and swamp rice are grown on an extensive scale.

The latitude of Sierra Leone ranges from

6° 55′ N. to 10° N. The climate is tropical with a heavy rainfall and high atmospheric humidity. In the plateau area of the hinterland the humidity is less than near the coast and the climate is better.

There is a single rainy season lasting from about the end of May to the end of October. Near the coast about 75% of the annual rain falls during the period June to September, but inland the season is longer. The rainy season is preceded, and followed, by a period of thunderstorms. The average rainfall over the whole of the country is more than 100 in. per annum, and it decreases gradually from about 140–150 in. on the coast to about 90 in. at Kabala. Records kept at Freetown show that a marked reduction in the rainfall has taken place during the last 40 years.

In general the maximum range of shade temperature is from 70° to 95°, but from December to February or March the "harmattan"—a dry wind coming from the N.N.E.—blows and the days are hotter, and the nights cooler, than usual.

Physiographic Features.—The principal physiographic divisions of the country are as follows :—

(1) The mountainous peninsula of the Colony.

(2) The coastal belt.

(3) The inland plateaux and mountains.

(1) The Colony mountains consist of a complex of basic igneous rocks (gabbros, norites, etc.) elongated roughly parallel to the coast line. The mountains rise abruptly from the sea to an elevation of about 3,000 ft. They are thickly wooded and well watered, the average rainfall being between 150 and 200 in.

(2) The coastal belt extends inland for a distance up to 100 miles from the coast. It is relatively flat, and rises gradually from sea level to about 500 ft. at the foot of the scarp marking the edge of the plateau region. Isolated hills, and ranges of hills, rise from the plain. The coastal margin is low-lying and the chief rivers are tidal for many miles from the sea.

(3) The north-eastern portion of the Protectorate is an elevated plateau and mountainous region, the bulk of which is between 1,000 and 2,000 ft. above sea level. Rising above this are other plateaux and mountain ranges. The most important of these upland areas are as follows :—

(*a*) The Loma mountains, consisting of a prominent granite plateau nearly 200 square miles in area and about 5,000 ft. above sea level. Several peaks rise above this level. Bintumane with an altitude of about 6,000 ft. is the highest of these peaks.

(*b*) The Tembikunda highlands, at the source of the Niger River, consisting of a granite plateau, with a general altitude of between 2,000 ft. and 3,000 ft., surmounted by numerous peaks and mountains rising to above 4,000 ft. Sankan Birawa, with an altitude of nearly 6,000 ft., is the highest of these peaks.

The Niger River has its source in this plateau on the Anglo-French boundary at an elevation determined by aneroid barometer as about 2,650 ft. above sea level. The Sewa River, the largest river in Sierra Leone, and the Meli River—a branch of the Moa River—also have their source in this plateau.

(*c*) The Kagnari and Sula mountains extend in a north and south direction, for a distance of about 80 miles, from Mongeri (Central Province) to near Kondembaia (Northern Province). The Kagnari mountains are highly dissected and thickly wooded and reach an altitude of nearly 2,000 ft. The Sula mountains rise to 3,000 ft. in the Koinadugu district and for long distances range from 2,000 ft. to 2,500 ft. in altitude. The Kagnari and Sula mountains are composed of metamorphosed ancient sediments and lavas intruded by granite. Promising prospects of alluvial gold have been found at several places in streams draining these rocks. The Kambui hills in the Kennema and Panguma districts of the Central Province are composed of similar rocks to those in the Kagnari and Sula mountains. The Kambui hills are continuous with the Nimini mountains, which are composed largely of granite with patches of schistose rocks.

(*d*) The Saionya or Talla plateau (Karene District, Northern Province). This is part of the extensive Futa Jalon highlands of the neighbouring part of French Guinea. Near Saionya the plateau is bounded by an escarpment rising abruptly to an altitude of about 2,500 ft.

Geology. The Colony and Protectorate of Sierra Leone were geologically examined by Dr. F. Dixey [1] during the period 1919–21, and as a result of Dr. Dixey's work, and that of the present Geological

[1] The Geology of Sierra Leone, *Q.J.G.S.*, Vol. lxxxi, pt. 2, 1925, and Reports of the Geological Survey for 1919, 1920, and 1921.

Provisional Geological Map of Sierra Leone.

Survey, the broad geological features of the country are moderately well known, although very little detailed work has been undertaken up to the present.

A provisional classification of the main geological formations is given below. The accompanying geological map shows the surface distribution of these formations.

(1) Pleistocene ? Sediments.
(2) Basic Igneous Intrusions.
(3) Saionya Scarp Series.
(4) Rokell River Series.
(5) Igneous Intrusions. Granitic rocks and subordinate basic igneous rocks.
(6) Marampa Schist Series.
(7) Kambui Schist Series.
(8) Crystalline Schists and Gneisses of the Coastal belt.

The youngest rocks are the Pleistocene ? beds—sands and clays with, in places, some lignite—of the coastal belt. A few marine shells of recent type have been found in these beds near Freetown, and fragments of plants are common locally in the shales.

The next rocks, in order of age, are the flat bedded sandstones and shales, with intercalated sills of dolerite, forming the Saionya Scarp. Disconnected patches of false-bedded arkose and conglomerate in the Kambia District are probably of the same age. These beds are part of an extensive formation, named "Gres siliceux horizontaux" by the French geologists. Graptolites,[1] indicating a Middle Silurian age for the beds, have been found in shales of the "Gres siliceux horizontaux" at Telimele, French Guinea, N.W. of Saionya.

The beds of the Saionya Scarp Series rest unconformably on a thick series of shales, sandstones, and conglomerates, with intercalated silicified lavas and ashes, for which the name "Rokell River Series" [2] has been proposed. In general the rocks of this series are folded and cleaved, but only slightly metamorphosed. No fossils have been found in the sediments and apart from dykes of dolerite, no igneous rock is known to intrude the series.

The sediments of the Rokell River Series generally form plains covered by grass and orchard bush, while the volcanic rocks form hills and low ridges. The sandstones are water-bearing and the paucity of water in the streams draining these rocks is a characteristic feature.

[1] J. H. Sinclair. Discovery of Silurian Fossils in French Guinea, *Journal of Geology*, pp. 475–8, 1928.

[2] F. Dixey. The Geology of Sierra Leone, *Q.J.G.S.*, Vol. lxxxi, pt. 2, 1925, and Report of the Survey for 1920.

A vast unconformity separates the Rokell River Series from the older igneous and metamorphic rocks. The sequence of the metamorphic rocks is imperfectly known, but it is believed that the Marampa Schist Series is the youngest, and that the crystalline schists and gneisses of the coastal belt are the oldest, of these rocks.

The Marampa Series is composed largely of argillaceous phyllites and sericite-schists, with subordinate quartz-schists and green and black ortho-schists. Numerous small masses of granite intrude the rocks forming, in places, composite gneisses. The general trend of the Marampa schists is between N. and N.N.W. Dips are usually steep, but owing to the fact that the beds are in places puckered and contorted, the dip varies widely in direction and amount.

Mount Simba, North-east Konno.

In the Kambui hills, and in the Sula and Kagnari mountains, the prevailing rocks are highly metamorphosed schists of sedimentary and igneous origin having a general trend between N.N.E. and N.E. The name "Kambui Schists" is proposed for these rocks. The schists are older than the biotite granite of the Protectorate. They are also intruded by muscovite-granite, and are penetrated by tourmaline and muscovite-pegmatites, and by numerous quartz veins and dykes of dolerite. Quartzites, banded ironstones, quartz-schists, and mica-schists are the most prominent rocks of sedimentary origin, and hornblende-schists, talc-schists, amphibolites, serpentine, and chlorite-schists are the chief igneous types. Limestone and dolomite are very rare but it is possible that

some of the amphibolites have been derived from calcareous sediments.

Deposits of chromite, hematite, and gold have been found in the Kambui Schists.

The Crystalline Schists and Gneisses of the coastal belt form a wide tract running roughly parallel to the coast line. The prevailing rocks are gneisses and granulites rich in hornblende and garnet. In certain localities pyroxene-granulites and biotite- and graphite-gneisses are prominently developed.

Granite is the most abundant intrusive rock and covers about half of the Protectorate. The predominant type is a foliated biotite-granite, but hornblende-granite and muscovite-granite, and syenitic and granodioritic modifications, occur in certain areas. Near Kamabai and Binkolo, and in several other districts, the granite forms vertically fluted domes and pinnacles rising to as much as 2,000 ft. above the surrounding country.

Sewa Falls—110 ft. high—near Pundaru, Central Province.

The mountain mass of the Colony of Sierra Leone together with the Banana Islands, is a portion of a very large basin-shaped sheet of basic igneous rocks of uncertain age. The floor of the intrusion is not visible and the roof rocks have been removed by erosion.

The rocks have a stratiform arrangement, and they show a well defined primary banding (fluxion structure).

Olivine gabbro (including olivine-rich troctolite and olivine norite) is the most abundant rock in the intrusion. Ordinary gabbro and norite are next in order of importance. These are followed by moderate amounts of anorthosite, and small volumes of peridotite, and other rocks. The peridotites are unusually rich in FeO and they are intermediate in composition between the ordinary peridotites and the unique hortonolite dunites of the Bushveld. Dykes of beerbachite, dolerite, and micropegmatite occur in concentric and radial tension fissures formed by the sagging of the central portion of the cooled mass. Titaniferous iron ores (ilmenite and titanomagnetite) form persistent bands on one horizon in the lower part of the intrusion. Chromite is apparently rare. Deposits of alluvial platinum have been found in the York district.

Several other similar basic intrusions and swarms of related dolerite dykes occur close to, and parallel to, the coast line between French Guinea and Liberia. It is possible that the fissures in which these linear intrusions occur were developed by crustal movements connected with the formation of the coast line.

Mineral resources.—Prior to the formation of the present Geological Survey very little was known regarding the mineral resources of Sierra Leone. There had been practically no mining (apart from native workings for iron ore), and minerals did not figure in the list of exports. No mineral deposits of commercial importance had been found and it was genefally believed that the mineral resources of the country were negligible. During the past three years the Geological Survey has discovered deposits of gold, platinum, hematite, chromite, ilmenite,

and other minerals, and it is believed that the exploitation of the mineral resources will soon become an important factor in the economic development of the country. Sierra Leone, with her great potential water-power resources, her waterways and fine harbour, and her proximity to Europe and North America, has many natural advantages and these will materially assist in the development of the mineral resources.

Gold.—Recent work by the Geological Survey has shown that gold is associated with the Kambui schists of the Kagnari and Sula mountains over a length of about 90 miles, from the Seli River near Kondembaia (Koinadugu district) on the north to near Mongeri (Moyamba district) on the south. This work was purely of a reconnaissance nature, but sufficient evidence was obtained to show that alluvial gold is widely distributed and that the Sula-Kagnari schist-belt is well worthy of very careful prospecting. The localities from which the most encouraging prospects were obtained are indicated on the geological map accompanying this paper. Exclusive prospecting licences for gold covering an area of about 50 square miles have been applied for in the neighbourhood of the Pampana River near Masombiri. Elsewhere in Sierra Leone alluvial gold has been found in several localities but not in encouraging quantities.

Platinum.—Alluvial platinum is widely distributed in beach and stream gravels in the Peninsula of Sierra Leone and promising deposits have been located in the York district. The platinum occurs in the native state in the form of small nuggets, as large and small pitted grains, and as crystals and dust. Two nuggets—one weighing 7·4 grams (4¾ dwt.) and another weighing 1·66 grams—were found by the writer in the branch of the Whale River heading from York Pass, and other nuggets up to about 4 dwt. in size have been found by the mining companies in the course of prospecting. The platinum is associated with large quantities of ilmenite (see analyses in Table II) and a little magnetite and scanty chromite. The ilmenite is likely to be a valuable by-product of platinum mining. An analysis made by the Imperial Institute of the crude platinum washed from the Big Water near York Pass gave the following result :—Platinum, 87% ; osmiridium, 1·3% ; palladium, 2·0% ; iron, 9·9%. No systematic examination of the rocks for platinum has been made and the alluvial platinum has not yet been traced to its source.

Field Camp, Saionya.

Exclusive prospecting licences aggregating about 20 square miles in area have been taken up for platinum. These licences are now being surveyed and prospected.

Iron.—Sierra Leone is very rich in iron ores and extensive deposits of high-grade hematite and magnetite containing from 50% to 65% iron are known. The Marampa hematite deposits, owing to their favourable situation, are the most promising from the commercial standpoint. The main ore-bodies form two prominent hills—Masaboitanki hill and Bafila hill—which are situated, respectively, about two miles and four miles W.S.W. of the village of Marampa, Port

Lokko District. Masaboitanki hill is about 550 ft., and Bafila hill about 250 ft., above the general level of the surrounding country. Smaller deposits of hematite form two ridges on the north side of Masaboitanki hill and a low ridge between Bafila hill and Limri. Development work, by means of shafts and adits, on Masaboitanki hill indicates that the main ore-body occupies the eastern half of the hill and has a strike averaging about N.N.E. true. At the N.E. end of the hill dips are near vertical, but elsewhere they are mostly to the S.E. at angles between 30° and 60°. The same features are to be seen in practically all the end of Masaboitanki hill, but large bodies of hematite are also exposed, and these should persist in depth.

At the foot of Masaboitanki hill on the northern side there is a large deposit, ranging up to 20 ft. or more in thickness, of cellular lateritic limonite and hematite with abundant included blocks of hematite. This deposit has been formed by the cementation of ore and lateritized rock debris fallen from the adjoining hill.

Hematite outcrops all over the top, which is roughly 300 yards in diameter, and the upper slopes of Bafila hill. Shafts have been sunk on the top of this hill and these show

Table I.—Analyses of Iron Ores.

	(1) %	(2) %		(3) %	(4) %	(5) %	(6) %	(7) %
SiO_2 .	1·90	1·55	Fe	61·89	58·22	56·43	60·50	60·59
Al_2O_3 .	3·18	4·16	Mn .	0·067	0·181	1·209	—	—
Fe_2O_3 .	89·40	88·93	SiO_2 .	2·93	0·71	1·436	0·69	0·96
FeO .	1·35	1·47	P .	0·048	0·021	0·035	0·008	0·007
MgO .	0·14	0·03	S .	0·117	0·115	0·096	0·165	0·162
CaO .	0·24	0·27	Ti .	0·002	0·003	0·002		
H_2O +	2·24	2·31	Cr .	Nil	0·008	0·004		
H_2O —	0·76	0·73	Cu .	0·007	0·003	0·006		
CO_2 .	None	None	As .	0·029	0·008	0·054		
TiO_2 .	0·23	0·23						
P .	0·04	0·04						
Cl .	Trace	Trace						
S .	0·09	0·10						
Mn .	0·14	0·18						
Total Fe	63·6	63·4						

(1) Bulk sample from top of Masaboitanki Hill, east end. (2) Bulk sample from top of Bafila Hill. (3) Bulk sample from " R " ridge near road. (4) Bulk sample of secondary ore at north foot of Masaboitanki Hill. (5) Bulk sample of secondary ore near west of Masaboitanki Hill. (6) Near Keimadugu, south-west Koinadugu District. (7) Near Sokoya, south-west Koinadugu District.

workings on the main ore-body, namely, a thin capping of loose boulders of hard ore beneath which is a layer—conforming roughly to the contour of the ground surface of hard red, brown, and black ore. This layer varies in thickness from a few feet up to at least 35 ft. and apparently averages between 15 and 20 ft. in thickness. Near the bottom of this layer the ore becomes softer, and darker in colour, and it passes gradually downwards into laminated high-grade pulverulent specular hematite. Parallel partings, and thin lenticular beds, of the wall-rock muscovite-schist occur in places in the specular hematite. These partings are often puckered and contorted in the same way as the surrounding hematite and wall-rocks.

A large quantity of cellular secondary ore—in places 50 ft. or more thick—composed of hematite and limonite, with some manganiferous iron ore, occurs in the western

that high-grade hard ore having an average thickness of about 17 ft. overlies pulverulent specular hematite.

The analyses (1 to 5) in Table I are of air-dried samples from the various deposits. Analyses (1) and (2) in Table I show a striking resemblance to one another, and prove that the ores are almost wholly hematite. At the surface, and in the mine workings, there are no indications of iron-bearing carbonates or iron sulphides from which the ores could have been derived, and the analyses show that this mode of origin is unlikely. The pulverulent specular hematite is believed to be the primary ore. There is very little evidence in favour of a replacement origin for this ore, and the available evidence supports the view that it represents ancient (probably Pre-cambrian) beds of iron ore which have been subsequently metamorphosed.

It is understood that the development work

up to the present time has indicated the existence of more than 10 million tons of high-grade hard ore averaging about 57% iron, and in addition about 5,000,000 tons of high-grade pulverulent specular hematite and it is anticipated that the quantity of the latter type of ore will be considerably increased with deeper development work. The falls and rapids in the Rokell River near Lankono, within 10 miles of the deposits, are capable of supplying large quantities of power, if needed for the development and smelting, of the ores. The company owning the Marampa concession is at present negotiating with the Government with the view of opening up the deposits on a large scale.

have a strike of 30° magnetic and they are intruded by foliated biotite-granite. Assays of a large number of samples show that the content of Cr_2O_3 in the two main deposits varies from 39·55% to 48% and averages about 45%. The physical condition of the chromite is good and the analyses indicate that it should be suitable for the manufacture of ferro-chrome. The specific gravity of samples of the ore ranges from 4·0 to 4·2.

Another large deposit of chromite was located at the village of Jalahun, situated 2½ miles south of Senduma, and 15 miles by road south of Blama, which is 169 miles by rail from Freetown. The chromite occurs in altered serpentine which in places is changed to talc-schist. Some chalcedony

Table II.—Analyses of Titanium Ores

	(A) %	(B) %	(C) %	(D) %	(E) %	(F) %	(G) %	(H) %
Fe_2O_3 .	51·21	25·06	76·64	46·90	—	50·56	—	—
FeO .	—	28·02	—	—	—	—	—	—
TiO_2 .	48·42	42·34	11·57	52·91	52·29	49·49	49·96	46·81
V_2O_5 .	—	0·38	0·69	—	—	—	—	—
Cr_2O_3 .	—	nil	3·76	—	—	—	—	—

(A) and (B) are from the deposit of massive ilmenite in the norite near Hastings. (C) is the average of two analyses of samples from Mt. Aureol. Samples (D) to (H) are from " black sand " deposits; (D) is from the Whale River estuary near York; (E) is from a beach deposit at York; (F) is from the Toke River; (G) is from the Orugu River near Hastings; and (H) is from the Big Water near York Pass.

Extensive deposits of high-grade hematite and magnetite with low phosphorus content occur in the banded ironstones near the villages of Sakasakala, Keimadugu, and Sokoya, in south-west Koinadugu District. Analyses of two samples of the ores are given in Table I.

Lateritic iron ores (ferruginous laterites) are found in many places in the Colony and Protectorate. Many of the deposits are extensive, but they rarely average 50% iron. Until recently, in the northern part of the Protectorate lateritic iron ores were smelted by the natives. This industry has now died out owing to the cheapness of imported iron tools.

Chromite.—Large lenses of massive chromite occur in the Kambui schists near the village of Gerihun, which is situated about 6 miles north of Hangha (188 miles by railway from Freetown), and about 3 miles west of the motor road from Hangha to Lago. Two large bodies, and one or two small occurrences, of chromite have been discovered, and others probably exist in the same district. The chromite occurs in talc-schists and serpentine, which are associated with hornblende-schist and subordinate banded ironstone and muscovite-schist. These rocks and good quality talc are associated with these rocks. An intrusion of granite occurs near by. The chromite varies from brownish black compact ore, showing in places the crystalline structure of the chromite, to a rock composed of fairly closely spaced octahedral crystals of chromite in a greenish matrix of flaky talc. The specific gravity of the chromite ranges from 3·8 to 4·05. Assays show that the Cr_2O_3 content ranges from 31·4% to 43·8% and averages 36·43%. This deposit is of lower grade than those near Gerihun, but a moderately large quantity of chromite assaying about 40% Cr_2O_3 can be obtained from the deposit and ore of this grade is in demand for use as a refractory. Furthermore, the grade of the chromite can be raised by concentration as it contains a good deal of interstitial talcose material.

The Kambui hills have not yet been carefully examined and it seems reasonable to expect that other deposits of chromite will be found in the course of time.

Titanium.—Ilmenite and titanomagnetite are widely distributed in the Peninsula of Sierra Leone. They occur as pseudo-stratified deposits, and as veins and segregations in the norite complex, and as large deposits, in places several feet thick, of

" black sand " in beach and river gravels in the same area. One prominent band of massive ilmenite and titanomagnetite has been traced from near Hastings to Mt. Aureol, Freetown. For a length of about half a mile near Hastings the ore-body appears to be at least 7 ft. thick and consists essentially of ilmenite. Analyses of these are given in (A) and (B) Table II. At Mt. Aureol one pit showed a thickness of at least 15 ft. of titaniferous magnetite.

Of the " black sand " deposits those of the Whale River estuary are probably the largest, and they are apparently the richest in TiO_2. It is of interest to note that these deposits, as well as those in the Big Water and Toke River, contain a good deal of alluvial platinum.

Owing to the close proximity of the ilmenite occurrences to the port of Freetown and their high content of TiO_2, it should be profitable to work some of them and particularly is this the case of the deposits containing both platinum and ilmenite. During recent years the demand for ilmenite for the manufacture of white paint has increased very considerably and there are indications that the demand will continue to increase.

Rutile is very abundant in the gravels of the little Scarcies River for a few miles below the confluence with the Mabole River. Abundant granular ilmenite accompanies the rutile.

Manganese.—Several occurrences of manganese oxides have been found over a length of about 45 miles in the Sembehun and Gbangbama districts, Southern Province. The deposits appear to have been formed by the weathering of granulites and gneisses rich in manganese garnet, and containing some graphite. An assay of a sample from a deposit near Bradford shows 16·7% Mn and 5·6% graphite, and a sample from near Gbangbama assayed 21·5% Mn, 37·2% SiO_2 and 7·8% Fe. The known deposits are conveniently situated for transport, but they are of too low a grade for commercial use. The Sembehun and Gbangbama districts have not been carefully examined and it is possible that other manganese deposits of a more promising nature exist in these districts.

Quartz Reef, near Kukuna, Great Scarcies River.

Corundum.—This mineral is abundant in certain districts where granitic rocks have invaded basic igneous rocks and sediments of the Kambui Schist series. Near Kondembaia, Koinadugu district, the corundum is said to occur in large boulders which are apparently shed from a lode near by. A large deposit of spinel, probably 100 ft. wide, occurs in talc-schists and serpentine in the same area. Near Kangama and Lago corundum is abundant in stream gravels, and concentrates from streams on the motor road north of Lago consist almost wholly of corundum and chromite. The bulk of the corundum is opaque and translucent, but a little of it is transparent.

Bauxite.—Bauxite of medium quality has been noted in several places in the Colony and in the Protectorate. No detailed work has been done on any of the occurrences and in consequence nothing can be said at present

regarding their size and average quality. The occurrences in the Colony, owing to their favourable position, are worthy of investigation. Some of the bauxite contains a relatively large amount of TiO_2. Three analyses of bauxite are given in Table III. Sample No. 1 is from Waia, Koinadugu district, and samples Nos. 2 and 3 are from near Bathurst and Hastings, respectively, in the Headquarters district of the Colony. The bauxite near Hastings is largely derived from the weathering of anorthosite and anorthositic gabbro.

TABLE III.—ANALYSES OF BAUXITE

	(1) %	(2) %	(3) %
SiO_2	1·83	0·77	1·35
Al_2O_3	49·58	52·37	54·13
Fe_2O_3	20·35	14·84	11·75
TiO_2	1·83	1·42	1·64
H_2O (total)	—	29·45	—

Other Minerals.—Other minerals, some of which may be of commercial importance, are talc, mica, lignite, graphite, asbestos, garnet, zircon, and monazite. Talc and brittle fibre asbestos occur in places in the Kambui schists; almandine garnet and graphite are common in the crystalline rocks of the coastal belt; mica is found in pegmatites in many parts of the country; and small seams of lignite have been found in the sediments of the coastal plain near Newton. Zircon and rutile are widely distributed and are heavily concentrated in the gravels of many of the rivers of the Southern and Northern Provinces near tide-water level.

Water Power.—The potential water-power resources of Sierra Leone are considerable. The average rainfall over the whole of the country is more than 100 in. per annum and the run-off is large. Nearly all the big rivers descend from the plateaux in the north-eastern portion of the Protectorate on to the coastal plain by a series of falls and rapids, and in their course over the coastal plain important falls and rapids exist in places. The following details are given of some of the more important falls on certain of the large rivers which have been examined.

The main fall on the Sewa River near Pundaru is 105 ft. high and the river falls about 300 ft. in about 1½ miles. The Rokell River above Bumbuna, Koinadugu district, drops about 200 ft. in two miles. At the Bitiri falls on the Pampana River above Masombiri the river falls about 120 ft in 0·15 mile. The Taia River below Jagbila, east of Mongeri, Moyamba district, descends approximately 275 ft. in 3 miles and includes a fall of 110 ft. in about 0·45 mile.

THE VOLUMETRIC ESTIMATION OF LEAD BY THE CHROMATE METHOD

By J. E. CLENNELL, B.Sc.(Lond.), A.I.M.M.

Introductory.—This is the method generally recommended for the estimation of small quantities of lead, say for amounts ranging from 5 to 50 mgr. Under suitable conditions the method may be applied to larger quantities, at least up to 200 mgr. Many modifications of the process have been suggested, but all depend on the precipitation of the lead from a hot acetate solution by means of a soluble chromate or bichromate.

The precipitate actually obtained is not the normal chromate shown by the reaction: $Pb(C_2H_3O_2)_2 + K_2CrO_4 = PbCrO_4 + 2KC_2H_3O_2$, but an acid chromate, which may be represented as $PbCrO_4 + xCrO_3$, the composition of which varies with the conditions of precipitation. This circumstance affects all the suggested modifications of the process described below.

Methods of Employing the Chromate Reaction.—In the following paragraphs, (1) to (6), are given a number of methods of employing the process, numbers (1) and (2) being direct methods and numbers (3), (4), (5), and (6) indirect methods.

(1) The lead solution is titrated by means of a standard chromate solution, the end-point being ascertained by means of an external indicator, for example, silver nitrate. (Ibbotson and Aitchison, "The Analysis of Non-Ferrous Alloys" (1915), pp. 58, 59.)

A very delicate end reaction is said to be obtained by using S-diphenyl carbazide as indicator, which will give a violet coloration with one part of chromate in a million of the acetic acid-lead solution. (Oddo and Beretta, Gaz. chim. ital. (1909), **39** (i), 671; Ibbotson and Aitchison, loc. cit., 59).

(2) The lead is precipitated as chromate from a boiling solution of the acetate (or of the sulphate dissolved in a soluble acetate); the precipitate is filtered off and washed free from soluble chromates. The lead chromate is then dissolved in cold concentrated sodium chloride and hydrochloric acid, or in cold HCl (1 : 1), and the chromic acid in this solution titrated by means of KI and thiosulphate. (A. H. Low, "Technical Methods of Ore Analysis," 5th edition (1911), 144–149.)

(3) A measured quantity of standard chromate or bichromate is added in excess, and the excess then determined by a colorimetric method. (C. and J. Beringer, "Text Book of Assaying," 9th edition (1904), 214–218.)

(4) Chromate or bichromate is added in excess, filtered from lead chromate, and the excess of soluble chromate in the filtrate titrated by means of ferrous sulphate or ferrous ammonium sulphate. (Ibbotson and Aitchison, loc. cit., 59.)

(5) Chromate or bichromate is added in excess, filtered, and the excess chromate determined by adding KI and titrating the liberated iodine with thiosulphate. (Diehl, Zeit, anal. chem. (1880), 306; Ibbotson and Aitchison, loc. cit., 49–50. Cervi. Chem. Centr. (1904); ii, 1343.)

(6) The lead is precipitated as chromate, filtered off and dissolved in NaCl + HCl as in (2). The solution thus obtained is then mixed with phosphoric and sulphuric acids, a few drops of diphenylamine and a measured excess of standard ferrous ammonium sulphate added, and the excess of the latter titrated with $K_2Cr_2O_7$ or $KMnO_4$. (W. W. Scott, "Standard Methods of Chemical Analysis," 4th edition, 278*b*.)

In the investigations described below, Method No. 2 only was used. This was selected because it appeared to be, on the whole, the simplest and most direct. Only one standard solution, namely, sodium thiosulphate, is required, and the amount of this used in each titration varies directly with the amount of lead present.

The indirect methods (3) to (6) involve back titration of excess reagent, and consequently require two standard solutions of known strength. Method No. 1, which is also direct, was rejected as it involves the use of an external indicator, which was not thought desirable in dealing with small quantities of lead.

Standardization of the Thiosulphate.—This is best done on weighed quantities of pure lead foil. The procedure is varied somewhat according to the amount of lead in the assay.

General Method of Standardization for Quantities of 5 to 100 mgr. Weigh out a quantity of lead foil approximately equal to the amount of lead in the portion of ore or alloy to be taken for assay. Place in a 200 cc. conical flask, add 10 cc. HNO_3 (1 : 4), warm to dissolve, cool, add 5 cc. conc. H_2SO_4, boil to strong white fumes, cool, add 30 cc. of water, boil, cool to room temperature, allow to settle thoroughly, decant the clear liquid through a 9 cm. filter leaving the bulk of the $PbSO_4$ behind in the 200 cc. flask.

(The washing with H_2SO_4 (1 : 9) which is necessary in the assay at this stage may apparently be omitted in standardizing without affecting the result. For very small quantities, such as 5 to 25 mgr., it is advisable to reduce the amounts of H_2SO_4 and of water to be added after boiling to fumes: thus for 5 mgr. Pb, use 1 cc. conc. H_2SO_4 and subsequently add 5 cc. water, and similar amounts in proportion for quantities of Pb up to 25 mgr., otherwise there is an appreciable loss of $PbSO_4$ by solution in the liquids used.)

Prepare a solution of ammonium acetate containing 2 parts by weight of the solid salt in 1 part by weight of water. The mixture must be warmed gently to dissolve; on cooling it forms a nearly saturated solution. In most cases 5 to 10 cc. of this solution will suffice for complete solution of the lead sulphate, but enough must be used in all cases to give a perfectly clear solution. Add the ammonium acetate solution, not more than 5 cc. at a time, direct to the precipitate in the 200 cc. flask, without dilution, heat just to boiling and see that all precipitate dissolves on agitation.

Pass the liquid through the 9 cm. paper previously used, collecting the filtrate in a clean 300 cc. flask. Extract thoroughly with hot water, rinsing the 200 cc. flask out with the same, and make the filtrate up to about 150 cc. If not distinctly acid, add a few drops of dilute acetic acid.

Add sufficient potassium chromate to precipitate all the lead and to give a distinct yellow colour to the solution, after boiling and settling. 5 cc. of normal solution (9·7% K_2CrO_4) is sufficient in all cases; when the amount of lead is small the amount

of chromate may be reduced. Heat to boiling and keep boiling gently, with occasional agitation for 7 minutes. The precipitate should be orange-coloured and should settle rapidly in a clear solution.

Allow to settle for a few minutes, then decant the clear solution through a 9 c.m paper filter. Wash by decantation with hot water until the liquid passes through colourless and no yellow stain due to soluble chromate remains on the paper. About 50 cc. of wash water is generally sufficient.

Place the funnel containing the filter in the neck of the flask in which the lead chromate was precipitated. Pass through the filter 15 to 20 cc. of cold HCl (1 : 1), pouring this round the edges of the paper and allowing the liquid to flow through into the flask. See that all precipitate is dissolved, and if necessary add more HCl (1 : 1). Now run 50 cc. of cold distilled water through the filter, collecting this also in the same flask. There should be no separation of $PbCl_2$ under these conditions. A small precipitate may be disregarded, but larger amounts, if formed, should be filtered off and washed free of soluble chromate.

To the solution of the lead chromate in HCl add 0·5 grm. KI. There is an immediate liberation of iodine in accordance with the reaction :—

$$H_2CrO_4 + 3KI + 6HCl = 3\ I + CrCl_3 + 3KCl + 4H_2O.$$

There should be no separation of lead iodide. If any forms, allow the solution to settle, carefully decant the bulk of the liquid into another vessel and add conc. HCl until the PbI_2 has dissolved. The decanted liquor may then be poured back, generally without any re-precipitation of PbI_2.

Titrate at once with a dilute solution of sodium thiosulphate, adjusted so that 1 cc. = about 1 mgr. Pb. (For the strength of thiosulphate required see a later paragraph headed "Standard Thiosulphate.") When only a faint iodine colour remains, add a few drops of starch solution to which a little caustic soda has been added, and finish the titration drop by drop, agitating after each addition, until the blue colour given by the starch changes suddenly to a very pale green. When the proper conditions are observed, the end-point is quite sharp.

Standardization for Quantities of 100 *to* 200 *mgr. of Lead.*—When less than 100 mgr. of lead is present there is seldom any difficulty in obtaining a sharp end-point in the titration, if the conditions detailed above are adhered to ; little or no separation of $PbCl_2$ or PbI_2 occurs and such quantities as are formed are quickly re-dissolved in the acid solution.

With larger amounts of lead, however, these substances may be formed in considerable amount and, although they do not appear to affect the result of the titration of the chromic acid otherwise than by obscuring the end-point, it is desirable to remove them, or at least to minimize the quantities present.

It was found that the best results were obtained by (1) largely increasing the amount of HCl (1 : 1) used in dissolving the $PbCrO_4$ and (2) increasing the dilution of the final solution before titration. If a sufficient quantity of HCl has been used there will be no precipitation of $PbCl_2$ on dilution, and no precipitation of PbI_2 on addition of KI. The amount of KI may also be increased, up to 1 grm.

The conditions given in Table I were found suitable.

Table I.

Lead taken. mgr.	$NH_4\bar{A}$ (2 : 1). c.c.	K_2CrO_4 9·7%. c.c.	HCl 1 : 1 c.c.	Total volume before titration. c.c.	KI. grm.
100	5	5	20	250	0·5
150	10	6	30	300	0·75
200	15	7	40	350	1·0

Instead of dissolving the settled precipitate of $PbSO_4$ in $NH_4\bar{A}$ and passing the whole of this solution through the filter, collecting in another flask (as described for small quantities), it is preferable, when the amount of lead is over 100 mgr., to proceed as follows :—

Place the funnel (containing the filter paper through which the H_2SO_4 was decanted) in the neck of the flask containing the bulk of the $PbSO_4$. Heat the required amount of $NH_4\bar{A}$ (2 : 1) in a small beaker nearly to boiling. Pour the whole or a part of this round the edges of the paper so that the whole of the paper is saturated with $NH_4\bar{A}$ solution. Any $NH_4\bar{A}$ not used in this way may be added direct to the precipitate in the flask. Place the flask (with funnel in neck as described) on the hot plate and allow the liquor to flow through. As the acetate solution filters very slowly in the cold it is necessary to maintain the heat near boiling point. When all or most

of the liquid has passed through and when the whole of the $PbSO_4$ in the flask has dissolved, wash thoroughly with hot water and dilute the filtrate to about 150 cc.

The rest of the process is carried out as described for smaller quantities, except that the larger amount of reagents indicated above must be used and the solution finally made up to a volume of 250 to 350 cc.

In dissolving fairly large quantities of lead sulphate in ammonium acetate (2 : 1) it was sometimes observed that a precipitate of needle-shaped crystals made its appearance. This is easily distinguishable from undissolved $PbSO_4$ and readily dissolved on dilution with hot water. The precipitate is possibly a double sulphate of lead and ammonium ; in any case its formation does not affect the final result.

precipitated separately by K_2CrO_4 exactly as described under standardization. These are filtered off, dissolved in HCl (1 : 1) and titrated separately with KI and thiosulphate as already described, and the sum of the results taken as representing the amount of lead in the sample.

Standard Thiosulphate.—A solution suitable for titration of small quantities of lead by the chromate method is prepared by dissolving 3·65 grm. of sodium thiosulphate, $Na_2S_2O_3 \cdot 5H_2O$, in water and diluting to 1 litre. 1 cc. of this solution = 1 mgr. Pb (approximately). The exact standard should be ascertained by trial, and as it varies slightly with varying quantities of lead, the thiosulphate should be standardized on approximately the quantity which will be present in the assay sample. A stronger

TABLE II.

Test No.	Lead taken. mgr.	K_2CrO_4. 9·7%. c.c.	HCl. 1 : 1. c.c.	Volume before titration. c.c.	Thiosulphate required. c.c.	Thios. 1 c.c. mgr. Pb.	Lead found. mgr.*
1	1	1	10	44	1·2	0·83	1·07
2	2	2	10	46	2·4	0·83	2·14
3	3	3	10	39	3·3	0·91	2·94
4	4	4	10	56	4·3	0·93	3·83
5	5	5	10	55	5·25	0·95	4·67

* Using the mean factor 1 c.c. thios. = 0·89 mgr. Pb.

If the final solution is too concentrated there may be a difficulty, even if no PbI_2 is precipitated, in distinguishing the end-point owing to the intensity of the green colour of the $CrCl_3$ solution produced, the change from blue to green not being sufficiently obvious. The degree of dilution should therefore be increased proportionally with increasing quantities of lead.

Application of the Chromate Method to the Assay of Lead in Galena.—The lead is brought into solution exactly as described in a previous article on the "Volumetric Estimation of Lead by the Molybdate Method," published in the MAGAZINE for September, 1929. Briefly, this is done by digesting a weighed quantity of the ore (say 0·5 grm.) successively with HCl, HNO_3, and H_2SO_4, evaporating to fumes, cooling, diluting with 30 cc. water, boiling, cooling, filtering, washing by decantation with H_2SO_4 (1 : 9), extracting the $PbSO_4$ from the filter-paper by digestion with hot NH_4A (2 : 1) and finally diluting with hot water.

When the portion of ore taken for assay contains over 200 mgr. of Pb, it is advisable at this stage to divide the solution into two or more portions, which are then

standard solution may, if desired, be used for larger quantities.

1 cc. $\frac{N}{10}$ thiosulphate = 6·82 mgr. Pb (approximately).

Experimental Results.—The remainder of this paper is occupied by a description of experimental results (1) in standardization, and (2) in estimation of lead in galena.

(1*a*) *Tests on very small Quantities of Lead.*—A solution of lead nitrate was prepared by dissolving 1 grm. lead foil in 20 cc. HNO_3 (1 : 4) and diluting to 1 litre, so that 1 cc. = 1 mgr. Pb. Tests were made on quantities ranging from 1 cc. to 5 cc. (that is, 1 to 5 mgr. Pb). It was not found practicable to precipitate these as $PbSO_4$ and convert to $PbCrO_4$ as described in the previous part of this paper. Dilute NH_4OH was, therefore, added in slight excess, giving a turbidity of $Pb(OH)_2$ which was cleared by addition of dilute acetic acid. The amounts of K_2CrO_4 shown in Table II were then added, boiled, filtered, and titration with KI and thiosulphate made in the regular way. The results show a progressive diminution in the amount of thiosulphate used per mgr. Pb as the amount of Pb is increased.

(1*b*) *Tests on Quantities of* 5 *to* 20 *mgr. Lead.*—These were made in the regular way, except that the amounts of H_2SO_4, of water added after boiling with H_2SO_4, and of K_2CrO_4 used were proportional to the amount of lead taken. The results are shown in Table III. 0·5 grm. KI was added in each case, and 50 cc. water after extraction with HCl.

(1*c*) *Tests made on Quantities of* 10 *to* 50 *mgr.*—These were carried out in the regular way (see Table IV). The quantities used in each test were 5 cc. conc. H_2SO_4; 30 cc. water after boiling with H_2SO_4; 5 cc. 2 : 1 $NH_4\bar{A}$; 5 cc. 9·7% K_2CrO_4, 15 cc. 1 : 1 HCl, 50 cc. cold water wash, and 1 grm. KI. The thiosulphate used was 5 times the strength of that used in the previous tests, or about 18·25 grm. $Na_2S_2O_3 \cdot 5H_2O$ per litre. In test No. 3 there was a separation of PbI_2; this was dissolved, after settling and decanting, by addition of conc. HCl and the solution added to the main liquid.

(1*d*) *Tests on Larger Quantities of Lead* (100 *to* 200 *mgr.*)—The conditions were as follows (see Table V) :— HNO_3 to dissolve lead foil, 10 cc. HNO_3 (1 : 4). H_2SO_4 conc. 5 cc., boiled to fumes. Water, after H_2SO_4, 30 cc. $NH_4\bar{A}$ (2 : 1) 5 to 15 cc. (as required), K_2CrO_4 5 to 7 cc.

It will be seen that the amount of HCl used was proportioned to the quantity of lead present, and that the final solution was largely diluted before titration. Under these conditions the results are closely proportional to the amounts of lead taken.

(2) *Estimation of Lead in Galena.*—0·5 grm. of the finely ground sample, marked L9, was taken, and treated with 10 cc. conc. HCl; 5 cc. conc. HNO_3 was then added and boiled gently for 10 min.; cooled, 5 cc. conc. H_2SO_4 added, boiled to strong white fumes, cooled, 30 cc. water added, boiled, settled and cooled to room temperature. The liquid was then poured off through a 9 cm. filter and the residue washed by decantation with 100 cc. H_2SO_4 (1 : 9) passing the washes through the filter. The filter-paper was then removed and placed in the flask with the settled precipitate, 10 cc. of $NH_4\bar{A}$ (2 : 1) was added, heated, and the liquid poured through a fresh 9 cm. paper. A further 10 cc. $NH_4\bar{A}$ was added, heated and poured off through the same filter. 50 cc. of water was then added, boiled and filtered as above, followed by 5 cc. $NH_4\bar{A}$ and 25 cc. water. The original filter-paper was then placed inside the second filter and extracted with 100 cc. of hot water. Total $NH_4\bar{A}$ (2 : 1) used 25 cc.; total water used 175 cc.; volume of filtrate 200 cc.

This filtrate was divided into two parts, which were separately precipitated by

TABLE III.

Test No.	Lead taken. mgr.	H_2SO_4 conc. c.c.	Water after H_2SO_4. c.c.	$NH_4\bar{A}$. 2 : 1. c.c.	K_2CrO_4. 4·85%. c.c.	HCl. 1 : 1. c.c.	Thiosulphate. used. c.c.	Thiosulphate. 1 c.c. mgr. Pb.	Lead found. mgr.*
1	5	2	5	5	2	15	5·1	0·98	4·94
2	10	4	10	5	4	15	10·4	0·96	10·07
3	15	6	15	5	6	15	15·7	0·96	15·20
4	20	8	20	10	8	15	20·55	0·97	19·89

* Calculated from mean factor 0·968.

TABLE IV.

Test No.	Lead taken. mgr.	Thios. required. c.c.	Thios. 1 c.c. = mgr. Pb.	Lead found. mgr.*
1	10	1·95	5·13	9·96
2	30	5·9	5·08	30·15
3	50	9·75	5·13	49·82
			Mean	5·11

* Calculated from mean factor 5·11.

TABLE V.

Test No.	Lead foil. mgr.	$NH_4\bar{A}$. 2 : 1. c.c.	HCl. 1 : 1. c.c.	Volume before titration. c.c.	Thios. required. c.c.	Thios. 1 c.c. = mgr. Pb.	Lead found. mgr.*
1	100·7	5	20	245	20·3	4·96	101·1
2	150·4	10	30	247	30·15	4·99	150·1
3	200·2	15	40	346	40·1	4·99	199·7

* Calculated from mean factor 4·98.

addition of 5 cc. K_2CrO_4 (9·7%) and boiling for 7 to 10 minutes, settled, filtered and washed with about 160 cc. hot water.

The residue from the $NH_4\AA$ extraction was tested by further treatment with 5 cc hot $NH_4\AA$ (2 : 1) and 25 cc. hot water; the filtrate gave no reaction with K_2CrO_4.

The $PbCrO_4$ was dissolved by passing cold HCl (1 : 1) through the filters; any undissolved residue, or $PbCl_2$ which separated on standing, was dissolved in conc. HCl.

Total HCl (1 : 1) used 80 cc.; conc. HCl 15 cc.; water wash 212 cc.; thiosulphate required 63·5 cc.; 1 cc. thiosulphate = 4·85 mgr. Pb; lead found = 308·0 mgr. = 61·6%.

This result agrees well with that obtained on the same sample by the molybdate method.

General Remarks.—The results obtained show that the method may be applied successfully for quantities of lead ranging from 5 to 200 mgr. provided that the proper conditions of precipitation and dilution are observed. The essential factors are :—

(1) Precipitation of the lead chromate from a boiling solution in the form of the orange precipitate which can be readily filtered and washed.

(2) Complete removal of all soluble chromate by hot water washing.

(3) Use of sufficient HCl to decompose the lead chromate and also to prevent precipitation of $PbCl_2$ or PbI_2.

(4) Sufficient dilution of the final solution before titration, this dilution being roughly proportional to the amount of lead to be titrated.

The author again desires to express his obligations to the authorities of the Chelsea Polytechnic for facilities accorded in carrying out these researches.

DEEP DREDGING IN MALAYA

By F. G. PAYNE

The author describes special problems associated with the design of a dredge for winning tin-concentrates from deep-lying alluvial deposits.

The problem of discovering new dredging properties in Malaya is becoming increasingly difficult, as the well known tin-fields have already been developed to a very large extent. Efforts are being made continually to improve the design of dredges in order that working costs may be decreased, and thus permit of the development of low-grade ground which would not be payable with the older type of machine.

A number of dredging areas in Malaya have not been developed previously on account of the depth of the ground being too great for normal dredges to bottom, and here an outline description is given of a type of dredge designed to dig to a depth of 120 ft. or more below water-level. Two dredges of this type are now in successful operation in the Federated Malay States. These are owned by the Ayer Hitam and Hongkong companies.

Dredging to a depth of 90 ft. and over was accomplished in New Zealand some years ago, by lowering the dredge below the surface of the ground and employing long elevators, thus dividing the depth between actual dredging depth below water and delivery of spoil above water. By this method a comparatively short ladder was sufficient. This system, however, is not practicable in Malaya, where the natural water level is, in most cases, very near the surface of the ground. It was necessary therefore to devise a system which would dredge the full depth from the surface of the ground.

The special problems associated with deep level dredging are essentially mechanical, as the method of treating the wash and the separation of the mineral are the same whether the dredging be deep or shallow. The main and obvious features necessitated by the deep dredging are, firstly, the provision of a specially long ladder and long chain of buckets, and secondly, the disposal of the large bulk of tailings. The ladder must be of such length as will permit of the depth being reached, and the additional length of bucket chain increases the pressure on the bucket pins and top tumbler bearings. These considerations in themselves do not involve methods of calculation other than those with which the dredge designer has normally to deal.

The above details, however, do not entirely dispose of the question, and it is necessary to make a close enquiry into what takes place as the buckets dig up the wash and gradually plough their way across the working face. The passage across the face is effected by the pull of the sidelines acting on the hull of the dredge. This pull is transmitted from the hull through the chafer bars to the ladder, and so through the flanges

of the bottom tumbler to the buckets. The buckets are therefore being forced across the working face by pressure exerted on the ladder chafer bars at the point where the ladder passes through the well of the hull. Even when dredging at modern normal depths this pressure is exerted at a disadvantageous point in the length of the ladder. It is this consideration which has in the past induced some designers to attach the forward sidelines to the ladder. This practice is no doubt almost ideal technically, in the rope. This laterally extended gantry frame can be observed on the accompanying illustrations (Figs. 1 and 2). The ladder is, therefore, relieved of the very severe side-bending stresses, and, what is of great importance from the dredging point of view, the buckets are carried across the working face in a more uniform and steady manner, because with such a long arm between the ladder chafer and the bottom tumbler, as would be involved in deep dredging, the buckets would tend to be carried across in

FIG. 1.—GENERAL VIEW OF THE AYER HITAM DREDGE.

but unfortunately it introduces practical difficulties which are not easily overcome, and these difficulties are increased with deep dredging. If, instead of applying the lateral pressure at the point where the ladder goes through the pontoon well, it could be applied at a point near the bottom tumbler, the severe lateral stresses would be avoided. This has been accomplished by carrying the ladder-line from the last sheave of the ladder hoist along an extended gantry frame, and down on to the ladder close to the bottom tumbler, and thus the bottom tumbler is drawn across the working face by the strain a series of jerky movements. There are obviously many matters of detail in regard to this arrangement which have required careful attention and design, but the attending difficulties have been overcome and on the dredge here shown the absence of heavy pressure on the chafer bars is very noticeable.

Special provision has been made to control the long swinging chain of buckets as they return to the bottom tumbler, by passing the buckets over a caterpillar track attached to the underside of the ladder. This caterpillar track is composed of two tumblers,

intermediate rollers, and an endless chain of links so shaped as to accommodate the lips of the buckets, which are thus carried without any perceptible jump from one bucket to the other. This arrangement serves three main purposes :—

(1) It avoids excessive slackness of the bucket chain when approaching the bottom tumbler, which would be particularly noticeable when dredging shallow with a long ladder.

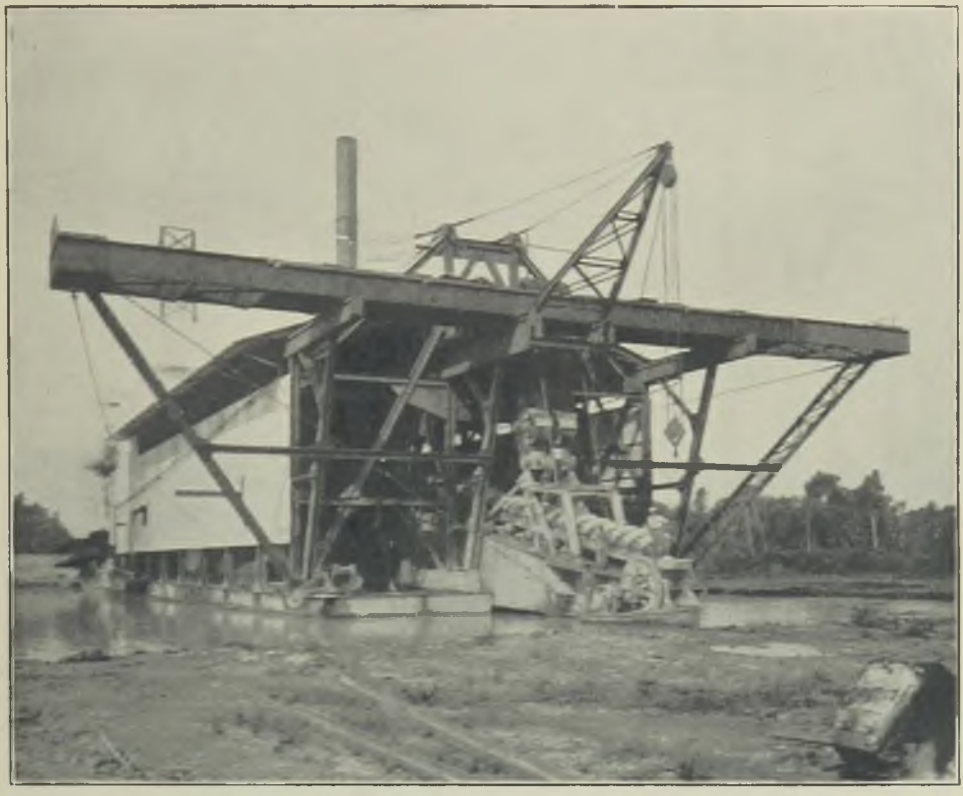


Fig. 2.—Front view of Dredge, showing bow gantry cross boom and hoisting line attached to bottom end of ladder.

(2) It prevents the excessive side-swing which would inevitably be set up in such a long chain, and which would put excessive strains on the bottom tumbler flanges, and would also be liable to cause the buckets to over-ride the flanges altogether.

(3) It provides more clearance between the drop chute and the bucket-lips, and thus ensures cleaner delivery.

In deep dredging particular attention has to be given to the disposal of the tailings, and it is necessary that they should be delivered well behind the dredge in order to avoid the danger of their drifting back onto the working face. The method adopted in the type of dredge here described is influenced by the fact that the ground being worked contains a considerable depth of barren overburden. This overburden is bye-passed from the drop chute through a long chute at the side of the screen, and is discharged considerably further astern than the normal discharge from jigs or launders. The overburden is, therefore, not treated in the screen at all, and the general result is that it is delivered in unbroken lumps which not only stack well, but also minimize the formation of slimes which would tend to foul the water in the dredge paddock. When the dredge is working tin-bearing alluvial material the tailings discharge in the normal way over launders, but to prevent them slipping back on to the working face they are pumped up from near the stern of the dredge, and delivered into a long pipe-line discharging 200 ft. or more behind the dredge. This pipe-line is clearly visible in the illustration (Fig. 3). It is carried in a cradle supported by staylines from the high steel framed tower. An alternative method of discharging these tailings well behind the dredge is through a pipe-line carried on floats and

bearers. The special provision for discharging the tailings described above, is particularly necessary during opening out operations, but when the paddock is fully developed the discharge can be shortened.

The dredge shown in the accompanying photographs is working a property owned by the Ayer Hitam Tin Dredging, Ltd., about 20 miles from Kuala Lumpur. The pontoon is 264 ft. long, 60 ft. wide, and 11 ft. deep. The buckets are of Messrs. Hadfield's "Era" manganese steel, of 12 cu. ft. capacity, and the bucket pins are of nickel-chrome steel 7 in. in diameter. The screen is 8 ft. in diameter, and has a total length of 44 ft. The tin-concentrates are saved on launders, which have a total area of 10,900 sq. ft. The bucket ladder is 190 ft. long between centres, and is constructed on the bow-girder principle. It has a horizontal tray to carry spillings from the buckets. A high pressure water supply is introduced into this tray in order to keep the ladder clear of obstructions, and the spillings are thus delivered back to near the bottom tumbler. A considerable amount of these spillings is undoubtedly captured by the buckets again, so that the tin they contain is ultimately saved. The maximum digging depth of the dredge is 120 ft. below the surface of the water.

The dredge is equipped with a Babcock and Wilcox boiler and chain-grate stoker, and triple expansion condensing engines using steam at 200 lb. per sq. in. pressure, and 150° F. of superheat. A sludge-pump is installed on the dredge to pump up the slime from a depth of about 70 ft. in the paddock, in order to keep the water in the paddock comparatively clean for dredging purposes.

FIG. 3.—STERN VIEW OF DREDGE, SHOWING OVERBURDEN CHUTE AND LONG TAILINGS DISCHARGE PIPELINE. THE HONGKONG DREDGE CAN BE SEEN WORKING IN THE DISTANCE.

The displacement of the dredge is over 3,000 tons, under normal running conditions.

Special plant for dealing with barren overburden and also pumping tailings and delivering them well behind the stern, as already described in this article, are also incorporated in this dredge.

New features in the design of this dredge are protected by letters patent.

LETTERS TO THE EDITOR

The Editor :

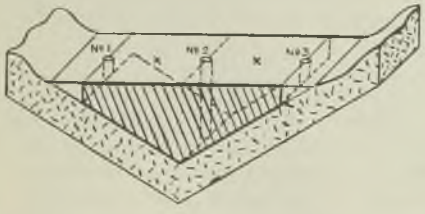
SIR,—I was very interested in an article published in the September issue of THE MINING MAGAZINE, namely, "The Geology of Sable Antelope and neighbouring Mines, North-Western Rhodesia," by R. Murray Hughes and A. A. Fitch. Under the sub-heading of "Regional Relationships," however, the writers group the deposits discussed, with those of Roan Antelope and neighbouring mines, into a metallogenetic province characterized by chalcocite of primary origin. This generalization appears to be much too sweeping, because the deeper drill holes at both the Roan Antelope and Mufulira Mines have proved the copper sulphides on the lower levels to be principally bornite and chalcopyrite, and while these minerals appear to be hypogene the overlying chalcocite is most certainly in part, if not entirely, of supergene origin. The great thickness of the chalcocite zone in some places is perhaps best explained by the topographic conditions under which it was formed.

A. C. SKERL, A.R.S.M., B.Sc.

Mufilira Mine,
Via N'dola, N. Rhodesia.
December 8.

The Editor :

SIR,—With reference to the article on "Testing Alluvial Tin Deposits" in the October issue of the MAGAZINE, I should like to point out a fallacy on p. 213, where attention is drawn to the error supposed to be made by the ordinary prospector in calculating the value of ground between



three bores. The real error is the author's in that he supposes that the ordinary prospector would place the bores in the position shown. Mr. Morrison places these bores as in the diagram, and proceeds to deal with the value and depth of the ground between them—that is, the shaded portion in the sketch.

Since the author has postulated a theoretical case with a geometrical figure and necessarily geometrically placed values, one can only adhere to geometrical considerations in examining the example put forward to illustrate his point. The first axiom of drilling is that theoretically bores should command equal surface areas. It is obvious from the author's example that he has violated this first principle—in fact, two of his three holes are only 50% effective. In theory, therefore, the same result could have been obtained by two correctly placed holes in the positions x, x, in the centre of each section, and with the geometrically placed values postulated by the author, each hole would have a value of 1·30 lb. and a depth of 25 ft.

The author may claim that his three holes give the theoretical shape of the valley bottom, but the ordinary prospector can get the same shape from his two holes and the edge of the valley or rim rock. Therefore, both on practical and theoretical grounds, the two holes of the ordinary prospector are as good as the author's three, with the additional advantage of a saving in cost.

GORDON MARRIOTT.

Penang.
November 7.

BOOK REVIEWS

☛ 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.

Tin. Its Mining, Production, Technology and Applications. By Dr. C. L. MANTELL. Cloth, octavo, 366 pages, illustrated. Price $7. Brooklyn, N.Y.: Pratt Institute.

This volume, as indicated by its sub-title, is intended to be a comprehensive survey of the many aspects from which those who are concerned with this metal are likely to be interested. Both in conception and in execution it is clearly entitled to a favourable consideration. A perusal of the General Introduction will show that it is one of a series of monographs which is the outcome of the Inter-Allied Conference of Pure and Applied Chemistry held in London and Brussels in 1919. The American Chemical Society and the American National Research Council undertook to prepare and publish scientific and technological monographs on

various subjects of general importance. No less than fifty of these monographs have appeared already, and many others are in course of preparation. These volumes are under the general editorship of a Board appointed by the American Chemical Society.

Two distinct purposes are claimed for these monographs. First, to provide chemists and others with the present available knowledge of particular subjects in a readable form, which will assist them in co-ordinating their own work with that in other fields which may have a real although, perhaps, at first sight, only an indirect relation to their own endeavours. The second purpose has been to afford a starting point from which further research may be promoted in regard to each particular field with which these monographs are concerned. Extensive references are given therefore to the literature of these subjects. The policy, which is wholly praiseworthy, has been to found an American Chemical literature without primary regard to commercial considerations.

The author of this particular monograph on tin explains his aims in the preface. With regard to production, he says he has treated this part of his work rather from the view-point of the metallurgical chemist than from that of the mining engineer. The industrial applications he treats from the view-point of the chemist rather than from that of the mechanical engineer. Valuable indications, too, are given of the economic side of certain questions, particularly that of the so-called "secondary" tin which may be recoverable from scrap or from material which has already served one useful purpose. The author freely acknowledges his indebtedness to standard works, such as Jones' "Tinfields of the World" and Taggart's "Handbook of Ore Dressing," and also to others from which he has made judicious selections. He has further benefited by the advice and assistance which he has received from many leading organizations and individuals.

A close perusal of the volume shows that the aims and objects with which the author set out have, in great measure, been achieved. The eighteen chapters—occupying some 350 pages—contain records of information which, although, of course, not exhaustive in regard to each of their widely differing aspects when viewed by specialists in these fields, are, nevertheless, sufficiently complete to afford a good general account within the limits of a volume of such a reasonable size. To the producer of tin the chapters on distribution and consumption, on ore deposits, mining and ore-dressing, on smelting, metallurgy and electrolytic refining, should furnish valuable sources of reference. To the user, the chapters on plating, on alloys, on hot-dipped coatings, thin foil and corrosion, should afford similar benefits, certainly as references of "first instance," if not, indeed, to matter which in many cases has been brought into an accessible form for the first time.

The concluding chapters on "secondary" or recoverable tin, deal with matters which are of daily increasing importance, while the last chapter, on analytical methods, although a short one, touches on the essentials of these important and necessary considerations.

SYDNEY W. SMITH.

Die Gravimetrischen Verfahren der angewandten Geophysik. By HANS HAALCK. Paper covers, pp. viii + 205, illustrated. Price 16.80 M. Berlin: Gebrüder Borntraeger.

In this interesting volume, the author sets out to give a comprehensive account of the gravimetric methods of practical geophysics, and, although the treatment can hardly be regarded as complete, has succeeded in producing a very useful and well-ordered exposition of the subject. The book is intended also to be a handbook of this special branch of applied geophysics.

The first two chapters, which occupy a little over 50 pages, are devoted to a simple mathematical introduction to the theory of potential and the level surface, and also to the measurement of the direction and magnitude of the earth's gravitational force. In this section various types of pendulum apparatus are figured and described, but as these are only of minor importance in connexion with the problems of geophysical prospecting, they are treated very briefly. Since the original publication by Eötvös some 40 years ago, which still remains unsurpassed for clearness of expression, an extensive literature has appeared dealing with the Eötvös torsion balance and related subjects, such as instrumental improvements, field operations, and methods of interpretation, and the author has aimed in this small book to give a clear account of the present state of development in these various branches. After discussing the mathematical theory of

the torsion balance, he describes the methods of determining the instrumental constants, and proceeds to give a full technical description of the instrument. Recent models, and certain distinctive types of instrument, are described in an interesting manner. The methods of determining terrain and topographical effects, and of applying the necessary corrections are discussed, and the procedure of constructing isogams explained. The interpretation of results is also considered, and the gravitational effects of certain inconformities and structures, as determined by Jung, are reproduced for reference purposes. Maps showing the results of surveys over a number of typical bodies are given and the gravitational results discussed in the light of known conditions.

The book concludes very fittingly with a useful bibliography, suitably divided into sections which facilitates reference to those articles more particularly connected with the subject concerned. As a handbook, designed to furnish useful and reliable information on practically all branches of the subject, this volume can be thoroughly recommended. The treatment, although not complete, is as comprehensive as might be expected from a volume of this size, but one feels that if the work of American, British, Hungarian and Russian geophysicists had received the same consideration as is given to that of the Germans, the value of the book, as an indication of the present state of geophysics, would have been considerably enhanced.

H. SHAW.

Gmelins Handbuch der anorganischen Chemie. 8 Auflage. Eisen.

Teil A, Lieferung 2. Paper backs, quarto, 88 pages, illustrated. Price 13.50 marks, to subscribers 10.50 marks.

Teil B, Lieferung 1. Paper backs, quarto, 312 pages, illustrated. Price 46 marks, to subscribers 36 marks. Berlin: Verlag Chemie.

The volume of Gmelins Handbuch dealing with iron has been divided into two parts, Part A being a treatise on the metal and its alloys, and Part B on the chemical compounds of iron. Sections of each part are published from time to time as soon as the matter leaves the printers. The first section of Part A was reviewed in the MAGAZINE in September; a second section describing the physical properties and electro-chemical behaviour of iron has now been issued together with the first section of Part B.

Gmelins Handbuch is pre-eminently a reference book. At the beginning of each chapter, and of each of the subsections into which the chapters are divided, a brief account is given of the subject matter treated therein. This is followed by a bibliography of all the relevant publications that the compilers have been able to trace; the publications are briefly abstracted, without any attempt at criticism. The comprehensiveness of the bibliography may be gauged from the fact that the chapter on the electro-chemical behaviour of iron contains more than 300 references to researches on the electro-potential of iron; many of the references are to papers published in 1929. The chapter on the physical properties of pure iron occupies 53 pages. This space is devoted to a discussion of the nature of the iron atom, the allotropic modifications of the metal, and the crystallographic and optical properties of the various forms. The other physical properties are to be described later.

As was explained in the earlier review, Part A of the volume on iron is of general interest to those connected with the extraction, manufacture, and use of iron and steel. Part B, on the other hand, is mainly a reference book for chemists. The first section of this part contains 312 pages, and deals only with the compounds of iron with hydrogen, oxygen, nitrogen, fluorine, and chlorine. The physical, mechanical, electro-chemical, and chemical properties of each compound are described. Copious references are given, and where necessary, illustrations (mainly phase diagrams) are included. As in Part A, the references to published data, which are complete up to 1929, are informative but not critical. Methods of preparing the various compounds on a laboratory scale and on a commercial scale are discussed, and the uses of the substances are described.

M. S. FISHER.

Geologic Structures. By BAILEY and ROBIN WILLIS. 2nd edition, revised and enlarged. Cloth, octavo, xvi + 518 pages, illustrated. Price 20s. London: McGraw-Hill.

In a review of the first edition of this work in the MAGAZINE (1923), I drew attention to the fact that the author had

permitted himself certain incongruities in method and scope of treatment of his subject ; that he had clearly in mind a more exhaustive text than he actually published, and that at some future date we might hope for the fuller results of his meditations and long experience. Six years is not a long interval and in this time not only has the first volume proved itself a success, but the much desired changes in the estimate of its purpose, together with the more comprehensive scope for which a plea was made, have both been realized ; in this second edition the senior author, with the collaboration of Mr. Robin Willis, removes much of the ground for criticism to which his initial effort was open.

The new book contains a delightful introduction under the sub-title "Our Changing Earth." In a few brief paragraphs the authors explain their purpose. The profession of the "geological engineer" has these days to be recognized, one "competent in mechanics, experienced in construction, able in hydraulics . . ." and possessing "knowledge of structural geology . . . of how rocks behave when deformed in the course of mountain building, and (who) can interpret folds, joints, and faults understandingly." In our own country modern training of the civil engineer includes a course in "engineering geology" in which this particular knowledge is duly stressed and imparted ; perhaps it is otherwise in America, though we can scarcely credit this. After all, in every project concerned directly or indirectly with the rocks of the earth's crust, more than a casual impression of geological principles is essential ; the day of the purely empirical or "practical" man, as such, if not actually over, is at least drawing to a close, and his place is rapidly being taken by the mining geologist, oil geologist, qualified civil, mechanical, mining, or electrical engineer, according to vocation and circumstances. Wherever geology is turned to economic account, the structure of the rocks is an inevitable quest. This is the theme of this book, and the rearrangement of original text, the newly written matter, and the lessons which the whole seeks to impart, do ample justice to this conception.

The chief differences between the two editions are as follows :—sedimentary processes are given more detailed consideration, the principles of stratification, warping, and flexuring of strata being fully expounded. The section on jointing is improved by the discussion of varied causes, significance of orientation and nomenclature. The chapter on faulting, by far the best in the original volume, still remains the outstanding part of this book ; in its new form, there is practically no fault-type which can escape the network of definition and explanation here accorded by the authors. There is also a separate discussion of the structures of metamorphic rocks with some valuable observations on rock-flowage, mashing, shear-flow, pore shortening, and flow by melting. The complete section (II) on the mechanics of rock-deformation comprises five chapters, whose substance is a great improvement on the original method of treatment.

The next section is the one to which I had to take exception in the first book : the "sandwiching" in of several pages on field methods, graphic methods, etc., here brought together under the title of "Method of Attack". This section is just as out-of-place here as before ; in fact it is probably more so, because it is now followed by a masterly consideration of the major problems of earth dynamics, including dissertations on earth genesis, the constitution of the earth, the forces of the earth, zones of pressure, strength and temperature of the outer crust, dynamic spheres of the globe, and so on, all of which emphasize the subject of geologic structure *as a subject*, certainly not as a peg on which to hang a series of more or less disconnected and irrelevant remarks on field equipment and methods of survey. The latter, in so far as it concerns modern practice in field-survey, is now-a-days sufficiently important to warrant its forming the subject-matter of a complete text-book, so that any superficial treatment, such as it receives in this volume, is totally inadequate. This, and the oft-offending spelling of reconnaissance with an "o" in the third syllable, is the only blemish in an otherwise admirable production.

H. B. Milner.

The Institute of Metals.—The annual general meeting of the institute will be held on March 12 and 13 in the Hall of the Institution of Mechanical Engineers, Storey's Gate, S.W. 1. On the evening of March 12 the annual dinner will take place at the Hotel Victoria. A visit has been arranged to the British Industries Fair at Birmingham on February 21.

NEWS LETTERS

JOHANNESBURG

January 9.

Huge Profit from State Diggings.—Some interesting facts concerning the results of operations at the State Diggings in Namaqualand are brought out in the annual report of the Auditor-General. It is stated therein that over £6,000,000 worth of diamonds were recovered in eleven months and that the expenditure during this period was under £100,000, indicating a net profit of over £5,900,000. The diamonds won totalled 586,914 carats; 204,261¾ carats were sold during the eleven months, leaving on hand 382,652½ carats, which at a rough estimate of £10 a carat should give £3,826,525. In addition there were 206½ carats held at the State Diggings at the end of March last. For the transport of diamonds £5,596 was paid, representing the cost of a weekly air service between Capetown and Port Nolloth. The Defence Department was paid £800 per month, including £400 per month received from the Merensky Syndicate, whose diamonds were also conveyed to Capetown by the aeroplane. The syndicate's contribution was subsequently reduced to £100 and in August last was discontinued. Insurance of diamonds cost £5,889, but this expenditure has fallen away as the Government, from June last, is carrying its own risks. In addition, the Treasury has undertaken to pay to the dependents of a mines official, who accompanies the aeroplane, a sum of £2,000 in the event of his being killed while flying on duty. The Auditor-General says that the diggings are protected by barbed wire entanglements and patrolled day and night by an armed guard. Further extensive fencing is contemplated. The diamonds are protected by armed guards at the diggings, and the aeroplane, upon its arrival in Capetown, is met by Mines Department officials and an escort, and the diamonds are taken to the valuer's office and after being checked are placed in safe custody.

The audit of the diamond account includes a check of the records maintained of diamonds found and their disposal, a check of the weight of the diamonds held by the valuer at the time of inspection and the verification of the records with the cash received from sales. The valuations and prices given by the experts must necessarily be accepted by the Auditor-General. The diamonds deposited in, and withdrawn from, safe custody have not come within the audit. The Auditor-General requested the Secretary for Mines and Industries to inform him whether the Treasury is satisfied with the safeguards instituted by his department and has mentioned that an important point requiring consideration is whether he should not be furnished with periodical certificates by an independent diamond expert, and an official of the department, that the balance of diamonds as shown to be in stock is actually held.

Accumulation of Diamonds.—The output of diamonds from the Transvaal alluvial fields visibly decreased during last year, in spite of the proclamation by the Government of several new fields. The total production from all sources to-day is about the average which has been absorbed in the world during the last few years, but overproduction in the past has brought about an abnormal accumulation of stocks. To deal with this situation, and thus make room for the ordinary production, a company is in process of formation to take over the surplus and to hold the diamonds over a number of years. The De Beers Consolidated Mines, Ltd., the Consolidated Diamond Mines of South West Africa, Ltd., and the New Jagersfontein Mining and Exploration Co., Ltd., will take 50% of the capital of this new company. This should prove of great benefit to the trade, as it is another proof of the genuine desire of the large companies to protect the industry and promote confidence.

412 Tons of Gold.—The annual report of the manager of the Rand Refinery shows that the bullion received for refining during the year ended September 30 last, amounted to 12,141,229 oz., while the gold delivered amounted to 11,689,892·71 standard oz., and was disposed of as follows :—

2,514·68 oz. to London on account of mining industry.

499,011·17 oz. to India on account of mining industry.

7,762,649·33 oz. to London on account of S.A. Reserve Bank.

299,340·74 oz. to India on account of S.A. Reserve Bank.

3,175,133·34 oz. to Royal Mint, Pretoria, on account of S.A. Reserve Bank.

1,243·45 oz. to sundry local sales.

The collection of bullion from the mines amounted to 11,997,113 oz., approximately 412 tons, and the distance covered was 19,903 miles. In view of the possibility of

conveying gold by aeroplane, a tripartite agreement has been concluded between the Municipality of Germiston, the Elandsfontein Estate Co., Ltd., and the Refinery, for the establishment and maintenance of an aerodrome within the vicinity of the refinery.

Increasing Lives of Mines. The shrinkage and resuing methods of stoping, and the methods of filling, adopted by several Rand gold mining companies are not only keeping down working costs, but there is good reason to believe that they will largely reduce the danger of rock bursts due to ever-increasing ground pressure as greater depths are reached, and they will also materially relieve the ventillation position. With the adoption of these methods, the outlook for profitable and economical mining on the Witwatersrand at depths of 8,000 ft. and over has materially changed for the better, and more especially is this the case on mines situated on the Central Rand.

An abridged description of a method adopted at the City Deep to meet the situation at great depths was given in the MAGAZINE for last month.

Emerald Mining Results.—According to an official statement, the Beryl Mining Co.'s mine, which is situated on a kopje, is now able to supply the new plant with 200 tons of crystal-bearing material a day. Development has opened up a much larger area than was exposed last year and has given the same average yield of crystals per ton. The area of the open-cast working is approximately 40,000 sq. ft., and the greatest depth at which material is being mined is 40 ft. This gives the company 200 ft. to mine before it reaches the level of the surrounding country. The bulk of the development has taken place on the east side of the workings. Several fine crystals have been found and the general average of the parcels shows distinct improvement each week. To meet capital expenditure, reserve shares were sold at a premium and the balance will be met out of the profits. The net profit on the year's working was £4,014 18s. 4d. The Board has adopted a wise policy in clearing off all initial liabilities, and the loss brought forward from the first year's working, caused by flotation and development charges, has now disappeared. After providing £350 for income tax a net profit of £2,107 18s. remains as the result of the first year's working which has been done under trying and difficult conditions. The company's holding has been increased by 72 claims.

FORT JAMESON, N. RHODESIA

December 7.

The importance of road communications in a country as yet not served by railways will be realized. For this reason the following information may be useful.

Great East Road.—Two or three years ago a motor road was pushed through from Lusaka (on the railway between Livingstone and Broken Hill) to Fort Jameson. This road was made by improving the existing roads and linking up the gaps with newly-made tracks. A good deal of money was spent, especially in the neighbourhood of the Luangwa and Lunsemfwa rivers, where the road passes through mountainous country. The road was completed in time for the visit of the Governor (Sir J. C. Maxwell) to Fort Jameson in 1928. The road was a dry-weather road only (approximately June to December) and the two rivers had to be crossed by pontoons (suitable for one ton lorries, unloaded, the loads being taken over on a second trip). When the Governor visited Fort Jameson he condemned the road and for nearly a year nothing much was done about it. The road is of great importance to the East Luangwa District (the part of N.E. Rhodesia lying east of the Machinga Mountains and the Luangwa River) as it was the only link, beyond footpaths, between that district and the remainder of N. Rhodesia. All the natural communications are through Nyasaland. Now, however, a new route for the road has been surveyed. The new road is to cross the Luangwa below its junction with the Lunsemfwa and a bridge is to be built there (at or near Fundu), the cost of which will be defrayed, in great part at least, by the Beit Trustees.

When the Governor was here recently he stated that a road along the new line of survey would be through in about two and a half years and that eventually the road would be improved so that it would become a "commercial road." When that time comes, the Rhodesian Railways are contemplating running their own lorries from Lusaka to Fort Jameson, in order to give this part of the country a link with the railway.

Salisbury–Blantyre Road.—This road already exists as a dry-season road (about July–December), the route being through Mrewa and Mtoko in S. Rhodesia and

through Tete in Portuguese East Africa. The Zambesi is crossed by pontoon drawn by motor-boat at Tete and the Mazoe River is crossed by pontoon pushed by natives. As roads go in Africa, this is very good already (except for a part in S. Rhodesia) and a lot of money is being spent on it in Nyasaland, Portuguese East Africa, and S. Rhodesia. It is intended eventually to make it an all-weather road.

Blantyre–Fort Jameson Road.—This road is the best main road in Africa. It is an all-weather road (via Zomba) for cars and light lorries and a dry season road (via Matope) for traffic up to 5 ton White trucks with trailers. The bridges are good (brick and steel) and much money is continually being spent on the road to improve it. The wet season route (December–May) via Zomba is about 40 miles longer than the dry-season route (June–November) via Matope. The road passes through Dedza (good hotel) and Lilongwe (tobacco district), entering N. Rhodesia about 20 miles from Fort Jameson after passing the Nyasaland frontier station of Fort Manning.

Tete-Dedza Road.—This road has just been completed. It is only a dry-season road at present, its route being by Furunkungu and Vila Cotinho.

Tete–Fort Jameson Road.—A direct road from Tete to Fort Jameson is in course of construction and is expected to be complete in 1930. This road will save over 200 miles in the motor trip from Fort Jameson to Salisbury over the present route via Blantyre, and it is anticipated that much of the tobacco exported from Fort Jameson will be taken by this road and thence down the Zambesi to Chindio by barges, resulting in a saving of transport charges over the present route via Blantyre and the very inefficient and expensive railways from there to Beira. This road joins the Tete-Dedza road at Furunkungu.

Distances.—

(1) G.E. road (present road) :
Fort Jameson–Lusaka, 380 miles.

(2) Salisbury–Blantyre road :
Salisbury–Tete, 250 miles.
Tete–Blantyre, 150 miles.

(3) Blantyre–Fort Jameson road :
(*a*) Blantyre–Zomba, 40 miles ;
Zomba to junction with Matope road, 80 miles (both wet season).
(*b*) Blantyre *to junction*, via Matope, 80 miles (dry season).
Blantyre–Dedza (via Zomba), 190 miles.
Blantyre–Dedza (via Matope), 150 miles.
Dedza–Fort Jameson, 135 miles.

(4) Tete–Fort Jameson, by new direct road when completed, about 200 miles.

General Remarks.—On roads where 5 ton trucks can be employed and where return-loads are available transport can be obtained for 6d.–7d. per ton-mile. On roads where 1 ton lorries only can circulate and where no return loads are available, transport costs from 1s. 6d. to 2s. per ton-mile. These figures do not give a good return to any but large and well-organized transport enterprises. (Figures apply to the Fort Jameson neighbourhood only.) Petrol costs here about 31s. 6d. per case of 8 imp. gals. (wholesale), 35s. retail in dry season ; and "whatever the traffic will bear," up to 48s. even, in the wet season. The transport costs given above are for dry-season transport only.

The importance of good road communication in a country like this, not yet linked up with a railway, cannot be over-estimated. The provision of (1) brick and steel bridges (or of the Southern Rhodesian type of low-level bridge, in concrete) over the minor rivers ; (2) of brick culverts (in place of the present "pole" bridges, eaten by ants and borers, or burnt-out by the yearly grass fires) ; (3) the raising of causeways a few feet above dambos and the intelligent application to these causeways of the ever-present "bog iron" and the protection of them by planting some kind of Bermuda grass—these few things would result in the cheap conversion of dry-weather tracks into all-weather roads for moderate traffic at least.

The natural surface of the country around here forms an excellent road for moderate traffic, even in the wet season. What holds up traffic in the wet season is one or two short stretches of dambo in a long day's run, or one or two "drifts" (over minor streams) that have not been constructed with intelligence, or one or two pole-culverts that have been squashed by the last heavy lorry to pass along the road.

It is said that the roads around the mines in the N'Dola region are very bad, owing to the heavy traffic over them. Most of the mines will, however, soon be on the railway.

Railway Construction.—It is understood that the railway is to be pushed on at once

from Blantyre to the bay at the S.W. corner of Lake Nyasa, opening up one of the most thickly populated parts of Africa to railway transport. Also that a branch from this line is contemplated to Fort Jameson via Lilongwe.

The completion of the Zambesi bridge near Sena, now under construction, should result in a great amelioration of the conditions of transport between Beira and Nyasaland, and with the new country opened up to the railway it is probable that a big increase in traffic will result with a consequent diminution of the present very heavy freight-rates. The interest on the cost of the bridge will be heavy and it will take good management to encourage traffic enough to cover this interest. It is a great pity that the railways linking Beira and Blantyre belong to four distinct companies: (*a*) presumably the Beira–Mashonaland Railway from Beira to Dondo junction; (*b*) the Trans-Zambesi Railway from Dondo to Muracca (on the Zambesi); (*c*) the Central African Railway from Chindio (opposite Muracca on the Zambesi) to the Nyasaland border; and (*d*) the Shiré Highlands Railway thence to Blantyre. The present inefficiency of this line may be in part due to this diverse ownership.

Customs Union.—The action of the Governor in delaying the break between N. Rhodesia and the Union upon Customs matters is generally regarded here as being a far-seeing action. He is reported to have said during his visit that N. Rhodesian and S. Rhodesian interests in this and other matters did not lie along the same lines.

Native Labour.—Recruiters from the "Roan," N'Kana, and N'Changa are still competing with one another for local boys and for boys entering N. Rhodesia from Nyasaland, though there is some talk of the formation of a common "recruiting bureau" to furnish labour for a pool from which all the mines in the N'Dola district would draw. Local natives, are, however, proceeding to the "Roan" in fair numbers.

BRISBANE

December 16.

Queensland Mining Legislation.—The Queensland Government has not only carried through Parliament its Petroleum Act, referred to last month, but has also secured the passage of a bill to deal with mineral land and miners' homesteads. Prior to 1925 mineral land could be bought under certain conditions and a grant in fee simple obtained which gave the purchaser the ownership of the land as freehold, in addition to an absolute right to all minerals other than gold in or upon the land. In that year, however, the Labour Government then in power passed an amending Act which took from the holder the ownership of the minerals, and put him in the position of having to make application for the land as a mineral lease instead. The Act now passed restores to the owners of mineral freeholds their rights of ownership to the full extent to which they had previously held them. Again, in 1920 the law relating to Miners' Homestead leases was so amended as to come into line with the then Government's perpetual leasehold policy, and this is now so amended as practically to bring the law back to what it was prior to 1920. Whereas the leaseholder since that year has been required to pay rent in perpetuity, under the new statute it will be optional for a miner's homestead to be applied for as a homestead lease, with rent to be paid continuously, or for thirty years.

The Coal Stoppage.—An effort, which it was thought would have brought to an end the coal stoppage in New South Wales, which has lasted just on nine months, has failed yet again. At the end of last month unbounded satisfaction was expressed at an announcement that a conference between the miners' delegates and representatives of the northern colliery owners had agreed on terms of settlement. Under these terms the miners were to accept a reduction in pay of 9d. a ton instead of 1s., which had been the amount stipulated in previous proposals. In other respects the scheme propounded was to stand. All that remained was to submit the agreement for approval to the miners themselves, as well as to the Federal and State Governments and the Northern Colliery Proprietors' Association. The miners, however, at meetings of their unions, have by large majorities refused to give their sanction, and persist in their demand that there shall be no reduction of wages.

The Mount Isa Enterprise.—The Mount Isa Company has approached the Harbour Board of Townsville, the nearest port to the Company's mines, asking for a special reduction of harbour dues on silver-lead bullion and zinc concentrates. The directors

of the company say that within a year the plant at Mount Isa will be producing about 60,000 tons of bullion and 15,000 tons of concentrates annually. The present dues on lead bullion are 3s. a ton, on blister copper, 3s., and on concentrates, 2s. 3d. It is considered that these dues are merely intended to apply to small parcels shipped intermittently, and the company asks, in view of the large regular shipments which it will make for many years, that a reduction be granted on Mount Isa products, the rates to be fixed at 8d. per ton for lead bullion and pig lead, and 4d. a ton for concentrates. The Harbour Board is now considering the request. It is estimated that the Mount Isa mine has 40 years' work in sight. Moreover, as a result of the development of the ore-bodies, which is still proceeding, it is reasonably expected that within a very few years the ore reserves, now estimated at 24,285,000 tons, having a gross value of £80,000,000, will be more than doubled. When the company decides on the location of a zinc refinery, and increases its initial output of 2,000 tons of ore a day to 5,000 tons, there will be available for shipment annually 150,000 tons of lead bullion, and the same quantity of zinc concentrates. The Mount Isa Company by this time next year will have spent upwards of £2,000,000 in opening up ore and installing plant for its treatment. Particulars supplied by the General Manager (Mr. G. J. Gray) show that, in the endeavour to obtain its plant and equipment mainly from Great Britain and other parts of the Empire, the portions to be made in Australia are the Dwight-Lloyd sintering plant, the drossing kettles, forehearth, Genter thickeners, the MacIntosh pneumatic flotation machines, and the Newman type of casting wheels. The bulk of the remaining machinery comes from Great Britain. The special concession granted to the Mount Isa Company in freights for railway carriage between the mines and Townsville, a distance of 603 miles, are as follows :—Concentrates, ordinary rate £3 11s. 1d. a ton reduced to £1 10s. 3d. ; bullion £6 7s. 3d., reduced to £1 17s. 10d. ; concentrates returned from Townsville to Mount Isa for further treatment, £3 11s. 1d., reduced to £1 0s. 2d.

No. 11A borehole at Mount Isa was at the time of the latest reports down to 438 ft., the core recovery in the last 111 ft. averaging 50%. All the other holes have been deepened for varying distances. As regards building operations, the grizzly towers for the coarse crushing plant have been finished, and the erection of steel for this plant is in progress. On the power house site 218 tons of steel has been erected to date. The foundations for the circulating water pumps for both turbines, as well as the building foundations for the Dwight-Lloyd plant, are practically complete. Of the 25 additional cottages, nine have now been furnished, while the erection of the female quarters is well advanced. The pipe-line to the Rifle Creek dam is complete for about nine miles, leaving 11 miles more to be laid.

The Lawn Hills Venture.—Mining Trust, Ltd. have lost no time in the starting of preliminary work at Lawn Hills, in north-west Queensland. The agreement with the State Government, as recently ratified by Parliament, provides, among other things, that the Trust shall, within twelve months, spend £10,000 in geological examination. The Minister for Mines has just received advice that a geological prospecting party to undertake this work left San Francisco on November 20, and is now about due to arrive in Australia. It is understood that Mr. Leslie Urquhart, when on his last visit to Mount Isa went on to Lawn Hills with one of his technical staff and made a preliminary inspection of the area covered by the agreement.

Anglo-Persian Oil Company and Papua.—A report from Sydney declares that members of the Anglo-Persian Oil Company who recently returned from New Guinea have said that the company has abandoned attempts to find oil in Papua, after a search lasting many years. The party of oil prospectors came from Popo, where five deep holes had been sunk in an effort to find oil. In every case the boring was fruitless, owing to mudstone difficulties. The Federal Government, which was working in conjunction with the Anglo-Persian Company, has also decided to cease its oil prospecting and geological survey operations in Papua, and the directors of the New Guinea Oil Company, having failed to obtain financial assistance from that Government, states that they have no option but to submit to their shareholders a proposal for liquidation.

Geophysical Prospecting.—On the historical Bendigo goldfield in Victoria, tests are being made with the Fraser-Hertzian wave ore-finder, and are said to be proceeding satisfactorily. It is stated that the instruments have demonstrated their capabilities in determining the position

of reefs on the south section of the New Red, White and Blue property, where quartz deposits have been located. Some of the ore-bodies, it is said, are of good extent and value.

VANCOUVER

January 10.

New Power Project.—Mr. Lorne A. Campbell, vice-president and general manager for the West Kootenay Power and Light Company, has announced his company's intentions with regard to power development on the Pend d'Oreille River. In December, 1928, the company was given permission by the Provincial Water Board to make surveys and to submit plans for the development of the river on or before August 31, 1930. At the time the application was made the company was contemplating a hydro-electric station of 80,000 h.p. Since then, however, the Consolidated Mining and Smelting Company of Canada has committed itself to the erection of a synthetic fertilizer plant which alone will require 70,000 to 80,000 h.p., and a considerable amount more power is needed for the electrolytic zinc plant. The West Kootenay Company has had, therefore, to revise its original plans, and has made an application for the use of the whole length of the river in British Columbia Territory, which, it is estimated, is capable of developing a minimum of 180,000 h.p. and a maximum of 370,000 h.p. during five or six months in the year. The company proposes to build a dam near the point where the Pend d'Oreille emerges into the Columbia River, and this dam will back up the water for nearly the river's full length in B.C. territory, that is—17 miles. The dam will have a maximum height of 350 ft., and three to four years will be required for its completion. It is estimated that the erection of the dam, the equipment of the power station, and the erection of transmission lines will cost approximately $18,000,000. United States interests are contemplating the development of the river to the south of the international boundary, and if this is done it will increase the maximum development on the Canadian side to 400,000 h.p. Mr. Campbell has stated that his company's engineers have examined the bedrock formation and are satisfied that it is able to carry the weight of the huge structure, but in order to make certain a shaft will be sunk 200 ft. and a tunnel driven under the site for the dam, making a base from which diamond drill-holes will be bored in directions both up and down the river, whereby a thorough knowledge of the formation on which the foundations will rest will be gained.

Reeves-McDonald Mines, which is controlled by the Victoria Syndicate, of London, also has made application for power rights on the Pend d'Oreille. The company desires to develop 9,000 h.p., and the contemplated plant is estimated to cost $1,956,000. The application was opposed by the West Kootenay Company because its own power development would flood the site for the proposed Reeves-McDonald dam. Col. H. H. Yuill, president of and general manager for Reeves-McDonald, urged his company's claim before the Provincial Water Board on the ground that a series of large deposits of low-grade zinc-lead ore already had been developed and that the power was necessary for the exploitation of these deposits. His company has made the necessary survey for the dam, plans are completed, and if permission is given the company is prepared to start work immediately and push it to conclusion. So necessary is the immediate development of the water-power to this company that it was prepared to guarantee that if its plant is flooded by the larger concern during or after 1933, and that concern was willing to sell his company power no claim for damages will be made. Mr. Campbell, in opposing this application, said his company would extend its transmission line from Ymir to the Reeves-McDonald property and provide it with power from its present sources within three months, but Col. Yuill said his company preferred to develop its own power. The Provincial Water Board has reserved its decision on the Reeves-McDonald application until August 31 next or until the West Kootenay Company files its final plans, should it do so before that date. This means, of course, that unless the West Kootenay Company modifies its preliminary plans the Reeves-McDonald application will be denied.

Portland Canal.—The Black Hill Mining Company has made a second shipment of silver-lead ore from its property on Glacier Creek to the Selby smelter, on San Francisco Bay. The company is developing a narrow vein containing three shoots of ore averaging about $100 per ton in silver and lead by means of two adits. The shipments, about

40 tons, have been taken out in the course of development. Work will be continued during the winter.

The American Boy Mining Company did some 2,000 ft. of tunnelling and driving during last year, established a camp, and erected a compressor. Its plans for the present year include 5,000 ft. of driving to open up the Highgrade and Mann veins at depth. The country along American Creek where the property is situated is precipitous and difficult, which prevents rapid development. Some 150 tons of supplies have been freighted to the camp recently, and 20 men will be employed during the winter. Recently, Montreal interests bonded the Lucky Jim group, adjoining American Boy, and the Anaconda Copper Mining Company bonded the Good Luck group, higher up the creek. It is unofficially reported that the Premier Gold Mining Company has found a body of low-grade silver-lead ore in the Silverado group, on which it has an option.

Anyox—The Granby Consolidated Mining, Smelting and Power Comyany has declared a dividend of $2 per share, covering operations for the last quarter of 1929. The disbursement will amount to $900,000, and will bring the total disbursements for the year up to $3,150,000 or $7 per share. The total earnings for the year approximated $8·75 per share. The company's copper output in round figures was 61,000,000 lb. of which about 40,000,000 came from the northern properties, Hidden Creek and Bonanza, and the remainder from Copper Mountain, but, although no official statement has been made on the subject, it is understood the general outlook for the southern property is considerably more promising than for the northern ones. The Hidden Creek mine has been operated continuously for 16 years and has produced in round figures 15,000,000 tons of ore containing 480,000,000 lb. of copper, 100,000 oz. of gold, and 4,250,000 oz. of silver, but during recent years the quantity of ore mined has exceeded the amount developed and the grade has been appreciably lower. A considerable quantity of the ore milled at Anyox this year contained less than 1% of copper. The Bonanza mine was brought to production in February, 1929, and since has sent about 400 tons daily over the aerial tramway to Anyox. The extent of the Bonanza orebody has not yet been determined. The Copper Mountain deposits, on the other hand, have improved in both size and grade at depth, and, as a consequence, Granby's total ore reserve probably was slightly greater at the end of last year than at the beginning. The company's plans for this year include the erection of another large boarding-house at Copper Mountain, which will make the fourth, each of which will accommodate 100 men, and there are a number of cottages besides for the married employees. The capacity of the coarse crushing plant at the mine has been increased and the capacity of the mill at Allenby has been increased to 2,500 tons daily. Signs point to much greater activity at Copper Mountain and Allenby in the future.

The Kootenays.—The Britannia Mining and Smelting Company has relinquished its option on the Kootenay King group after spending some $75,000 on its exploration. The early indications that the property might be developed into a large producer of lead and zinc were not corroborated by diamond drilling and therefore the property failed to interest Britannia. It seems probable, however, that it may be made into an interesting small producer, and so Kootenay King Mines will continue development as soon as weather permits in the spring.

Mr. W. A. Porter and Spokane associates have taken a lease and option on the Queen Bess mine, at Sandon, from which Mr. Clarence Cunningham cleaned up a fortune during the latter part of the war. A six-foot vein of clean galena, assaying 260 oz. of silver and 70% of lead has been opened in three places and is believed to be the downward extension of the shoot from which Mr. Cunningham took ore to the value of more than $1,000,000. The Spokane Syndicate has bonded several adjacent claims.

The Victoria Syndicate has shut down work at the Paradise mine, near Invermere, leaving only a watchman in charge. The property is owned by the Hon. R. R. Bruce, Lieutenant-Governor of British Columbia, and has been developed under lease and option by the syndicate, which erected a 75-ton mill and later moved it four miles from the mine to get better water supply and made a survey for an aerial tramway to connect mill and mine.

Weather.—A generous rainfall, varying from 5 to 10 inches in southern British Columbia during the latter part of December, has relieved the power situation which in the

beginning of the month had assumed a serious aspect. The Britannia Mining and Smelting company had to lay off 250 men, and several concerns had to reduce output owing to power shortage. This situation now has been relieved and, with rain at the coast and snow in the interior during the early part of this month, conditions have returned to normal.

TORONTO

January 18.

Gold Production of Ontario.—The Ontario Department of Mines reports that during the year 1929 the value of the crude bullion output of the gold mines of the Province amounted to $33,383,169 as compared with $32,688,824 in 1928, the figures for 1929 being subject to revision. The production of the mines of the Porcupine camp showed a decrease, being valued at $19,306,550 as against $20,417,714 in the previous year, but the output of the Kirkland Lake field increased from $12,271,110 to $14,055,244. During December the yield of the Porcupine mines was $1,766,838 as compared with $1,395,689 in November ; the production of Kirkland Lake also showed an increase amounting to $1,274,437 as against $1,159,894 in the previous month.

Porcupine.—Hollinger Consolidated continues to head the list of the producing mines, and although full details are not yet available the value of its output for 1929 is conservatively estimated at nearly $9,000,000, or approximately half the total gold produced in the Porcupine area. Officials have intimated that the ore reserves have been drawn upon to some extent during the year, but as the mine entered the year with a reserve of about $50,000,000, its strong position has not been sensibly impaired. The geological structure of the eastern part of the property is such as to afford encouragement for deeper mining.

No decision has so far been arrived at by the Dome Mines, Ltd., as to the erection of a new mill to take the place of that destroyed by fire. The present season is unfavourable for construction and the officials are believed to be awaiting the results of the test of a new process of ore-treatment, which has for some time been carried on at the McIntyre, before coming to a final determination. Another factor to be taken into account is the extent of the tonnage of ore occurring in the greenstone formation in which the company is now carrying on development at depth. The question of mill construction is also occupying the management of the McIntyre, as it has become necessary to instal an entirely new mill or to put fresh equipment in the old one. To provide for the increased output in view, development operations have been considerably expanded, and there are now 50 faces in ore.

Ventures, Ltd., which has taken an option on the Coniaurum property, is sinking a winze on the 2,000 ft. level, on which work has proved disappointing, to the 2,250 ft. horizon. The March is treating about 4,800 tons per month, with a recovery of approximately $25,000. Diamond drilling to the depth of 1,000 ft. will be undertaken. At the Vipond an ore shoot 250 ft. in length and 9 ft. in width carrying $7 to the ton has been encountered on the 400 ft. level. Crosscutting has been carried on to pick up the downward extension. Work has been resumed at the Ridgedome, situated about 5 miles W. of Timmins, where a shaft is down 125 ft. A contract has been placed for diamond drilling.

Kirkland Lake.—The output of the Lake Shore mine for December is estimated at $600,000. The 2,000 ft. level is opening up better than any so far developed, average values over the full width of the drift being over $40 to the ton. Construction of the new mill which will raise the capacity to 2,000 tons daily has been delayed, but the building has been enclosed and most of the machinery is now on the ground. Preparations are being made to sink No. 3 shaft to a depth of 4,000 ft.

Wright-Hargreaves is steadily increasing its rate of production, and the mill is treating 500 tons per day, the objective being 700 tons. At the two new levels in the easterly part of the mine particularly good results have been obtained below the 2,000 ft. level. As much as 250 tons per day of $12 ore is being obtained from development at times. In addition new ore is being found in the older sections of the mine. At the Teck-Hughes, development on the six new levels is disclosing an improvement in the grade of ore. A winze has been started from the 2,500 ft. level to a depth of 3,600 ft. and this will be connected with the south shaft at the 3,000 and 3,600 ft. levels.

Diamond drilling at the Sylvanite from the 1,750 ft. level has indicated the downward continuation of a vein encountered on the upper levels carrying good commercial ore. Stoping has been started at the 1,750 ft. level

on ore of a profitable grade. Broken ore in the stopes and on the surface amounts to about 57,000 tons. To the east, on the new vein system where diamond drilling has indicated good widths and high values, development is being actively carried on.

The Kirkland Lake gold mine has encountered rich ore in driving on the 3,875 ft. level. A crosscut has tapped the vein on the 4,000 ft. level, assays showing very high gold content. At the Bidgood recent results of development have been encouraging, a good width of vein structure having been encountered on the 1,000 ft. level.

The shaft of the Amity Copper has reached the 1,000 ft. level, and cross-cutting will be started on this level towards the sulphide zone on which important ore shoots were developed on the upper levels.

Sudbury District.—Mining activity in this area has been retarded by inadequate supply of electric power, but the Ontario Government promises that this difficulty will shortly be overcome. The matter is under consideration by the Provincial Hydro-Electric Power Commission, and an early announcement as to which of the available sources of power will be utilized is anticipated. Good progress is being made with the construction of the new refinery buildings of the Ontario Refinery Company at Copper Cliff. It will have a capacity of 120,000 tons of refined copper per annum, and the first unit is expected to be ready for operation by midsummer. The International Nickel Company is repairing the damage occasioned by fire at the Lavack Mine in December by the construction of buildings which will have a more modern equipment. The Falconbridge is rapidly approaching the producing stage. The smelter is almost completed and has an initial capacity of 250 tons a day. It is expected to go into operation next month. Diamond drilling has proved the downward continuation of the ore-body to a vertical depth of 1,500 ft.

Diamond drilling by the Sudbury Basin has located a large ore-body 1½ miles east of the main deposit. It is stated that 2,000,000 tons of ore have been indicated down to a depth of 500 ft. At the Treadwell Yukon diamond drilling has encountered good showing of ore at depth, and shaft No. 2 will be deepened to 1,500 ft. Nos. 1 and 2 shafts have been connected by a long drive at the 500 ft. level.

Rouyn.—Rapid progress has been made with the sinking of the new shaft at the Noranda which has now almost reached its objective of 1,500 ft. Exploration has resulted in a considerable increase in the ore reserves, the value of which is now estimated at $120,000,000, the supply being sufficient to keep the smelter in operation for six or seven years, at the rate of 2,000 tons per day.

The Granada is being financially reorganized in order to secure the necessary funds for the construction of a 100-ton mill, sufficient ore of good grade being in sight to keep it in operation for two years.

The Newbec is preparing to make shipments of ore to the smelter from an ore-body developed on the 125 and 250 ft. levels. The workings will be carried deeper.

The Amulet is making good headway in mill construction and will become a producer in the course of the next few months. Ore reserves of copper and zinc of the value of $5,000,000 have been indicated by diamond drilling on the F. ore-body.

The Abana has increased its capital from $3,000,000 to $3,500,000 which will enable them to build a mill, which it is hoped to have in operation by the fall.

The Stanley Siscoe Extension Mines, Ltd., which owns several claims, including a large portion of the bed of the Kenowisik Lake, has undertaken a campaign of diamond drilling which is being carried on through the ice.

Patricia District. — Mining activities in this area have been largely suspended during the winter months, and some of the companies are waiting until a supply of power becomes available before undertaking active development. The mill of the Howey has been practically completed and it is officially announced that it will go into operation by the end of January treating at first 250 tons per day, which will be gradually increased to 600 or 700 tons. Underground development has been attended with satisfactory results, the ore in the lower levels down to 1,000 ft. showing increasing widths and values.

The Central Patricia is bringing in mining equipment over the winter roads, and plans the sinking of the shaft to a depth of 500 ft. and about 3,000 ft. of lateral work. Diamond drilling has indicated 680 ft. of ore at the 250 ft. level with an average width of 6 ft. and an average grade of $15.

The Ontario Woman Lake Gold Mines, Ltd., operating in the Woman Lake area, will instal a mining plant and undertake active development. A vein discovered on the

surface has been cut by diamond drilling at the 100 ft. level, and a large body of commercial ore disclosed.

Manitoba.—Work on the construction of the smelter of the Hudson Bay Mining and Smelting Company has made satisfactory progress and is well up to schedule. At the mine the hoist and the head frame are approaching completion, and the hoist will be installed this month. The steel of the crushing plant will be erected by the end of January, and the machinery will be installed in February.

The Sherritt Gordon is making steady progress in development and will have a large tonnage of ore in readiness as soon as the Hudson Bay smelter is ready to operate.

The Consolidated Mining and Smelting Co. is steadily increasing its mineral holdings in Northern Manitoba. It has recently acquired several properties adjacent to the Don Jon group at Thompson Lake.

The Mandy mines has ceased drilling on the Baker-Patton property recently acquired under option, the results having proved disappointing.

The Yellow-Jacket group of ten claims, on which important discoveries have been made, has been taken over by Toronto and Vancouver interests who are organizing a company. The Gem Lake has put down a three compartment shaft to the 500 ft. level, and opened up four levels with ore showing on each, and a vein 11 ft. wide on the 500 ft. level carries free gold. The shaft will be continued to the 1,000 ft. level.

The Winnipeg River Tin Mines, Ltd., which owns 90 claims in southern Manitoba, has been conducting extensive exploration and has discovered promising tin showings in four places.

CAMBORNE

February 5.

Tin Restriction.—The general feeling in the county with regard to the restriction of tin production is that, after a year or more of discussion and persistent labour, it is satisfactory to realize that diverse interests have, at length, been reconciled to such an extent that control over the world's output is established on a working basis for a trial period of sufficient duration to test its general practicability. At the time of writing these notes success has been attained in securing a majority of producers to support the scheme, and to undertake to carry out its provisions in the administration of their mines and works, in all tin-producing areas except the Dutch East Indies. It is worthy of note that the last-mentioned shows a reduced output in 1928 as compared with 1927, and again in 1929 as compared with 1928, so that, apart from the general restriction scheme now adopted by a majority of the producers in all other tin-producing areas, production has been already curtailed by the Dutch interests.

Cornwall, in relation to voluntary restriction of output, stands very much the same as Bolivia and Nigeria, because the average inclusive costs in all three are very nearly equal. With very few exceptions profits cannot apparently be made in either area with tin metal at less than £180 per ton.

South Crofty and Geevor.—Six months, more or less, of restricted output of tin in South Crofty and in Geevor will cause very little inconvenience financially. The worst that can happen is a little temporary encroachment upon the cash reserves, which stand at about £45,000 and £30,000 respectively. Even that, to any appreciable extent, is unlikely. South Crofty, in resuming operations on wolfram at Castle-an-Dinas, and raising a little more wolfram than usual in recent years at South Crofty itself, will undoubtedly be able to make up, partially if not wholly, in wolfram what is lost through restricting tin output. At Geevor lessened returns will be, at least partially, counterbalanced by a lower expenditure in ordinary costs, especially in labour.

Wheal Reeth.—In some other less favourably-financed mines, where restriction is rather through necessity than by choice, the situation is more serious. In the case of Wheal Reeth, for example, it became necessary, some three months ago, to provide additional funds to carry on the mine. Although underground reserves of moderate values had been developed, the capacity of the mill and concentration plant—only one-half of which had been erected—was insufficient to permit of profits on the tonnage treated at current prices of tin. In order to instal the contemplated second unit of the mill, and so double the tonnage treated, an effort was made to raise £12,500 on debentures. The effort was only partially successful. Consequently it has been decided to suspend operations for six months.

Levant is meeting the necessities of the case by reducing labour and other costs.

Wheal Kitty and some other mines are working short time, by cutting out the week-ends, a certain number of the workmen being employed only four, or five, days instead of six in each week.

Unemployment. — Restriction renders unemployment all the more acute. This is unfortunate, but unavoidable, under existing conditions. Unemployment is steadily growing, especially in Redruth, Camborne, and St. Just. In a minor degree the Silicosis Order is a contributory factor in relation to the growth of unemployment.

Dolcoath.—Any expectations which may have existed that the Government would, in some way, grant financial assistance either to the Dolcoath company, to enable them to resume operations at Roskear, or to the scheme prepared by the joint committee of the Cornish Institute of Engineers and the Cornwall Chamber of Mines have not yet been realized and prospects of realization are not very promising.

PERSONAL

J. A'C. Bergne is home from the United States.
F. O'D. Bourke is home from Nigeria.
R. P. Brodie is home from Nigeria.
A. O. Brown has left for Morocco.
James Caldwell has left for Mexico.
G. W. Campion is home from West Africa.
George P. Chaplin has returned from Colombia.
N. Baldwin Davies is home from Nyasaland.
Dr. C. V. Drysdale has been appointed a member of the Explosives in Mines Research Committee, in place of Dr. F. E. Smith, who becomes Secretary to the Department of Scientific and Industrial Research.
G. L. Dyer has returned from Russia.
M. A. Francis is returning from Burma.
W. C. Grummett has left for Nigeria.
W. Hope Henderson is home from Egypt.
W. Hoetson is here from Tanganyika.
J. G. Lawn is home from South Africa.
H. W. Laws has left for British Columbia.
Hugh Marriott has left for the United States and Panama.
E. J. Membrey is returning from Uganda.
C. R. Miller has left for West Africa.
R. H. Mitchell has left for Venezuela.
G. D. O'Gowan has returned from Portugal.
T. H. Prisk is home from Bolivia.
John Rodger is returning from India.
G. W. Rudyerd has left for Spain.
W. H. Rundall has left for Colombia.
H. E. F. Savage is here from Malaya.
D. A. Thompson has left for West Africa.
T. H. Walmsley has left for Nigeria.
R. J. Westwood is returning from South Africa.
R. Winter is home from Queensland.

Edwin Tulley Newton, F.R.S., palæontologist to the Geological Survey from 1882 to 1905, died on January 28, aged 90.

Hugh Longbourne Callendar, F.R.S., Professor of Physics at the Imperial College of Science and Technology, died on January 21 at the age of 66. Professor Callendar's work on the measurement of heat and radiation and on the properties of steam at high pressures and temperatures has been of great value to engineers.

TRADE PARAGRAPHS

Head, Wrightson, and Co., Ltd., of Stockton-on-Tees, issue booklets devoted to chimneys and tanks, notably cyanide vats, and to cement works plant.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, in their *Edgar Allen News* for December have an article describing steel castings for bucket dredges and also for crushing machinery.

Samuel Osborn and Co., Ltd., of Sheffield, have issued a leaflet drawing attention to their S.O.B.V. cutting alloy, to which reference has been made in these columns before.

Henry Bath and Son, of London, Liverpool and Swansea, send us a copy of their annual chart showing fluctuations in the prices of copper, tin, spelter, and lead.

Daniel Adamson and Co., Ltd., of Dukinfield, Manchester, issue fully illustrated catalogues devoted to turbo compressors, Adamson turbines, and condensing plant.

Hardy Patent Pick Co., Ltd., of Heeley, Sheffield, issue a leaflet describing the new Hardy "Trojan" light drifting machine, the total weight of which without column arm or clamp is 122 lb.

The British Industries Fair is being held simultaneously in London and Birmingham, as in former years, from February 17 to 28, 1930, the heavy section, including all the engineering industries, being at Birmingham.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E. 7, send us a booklet describing steel plate and construction work, such as kilns, oil storage tanks, stills, and also a variety of hydraulic pressings.

Leyland and Birmingham Rubber Co., Ltd., of Preston, Lancs., send us the first issue of a new house journal which, as an Editorial points out, has become necessary as a result of the increasing distribution of their staff.

Mavor and Coulson, Ltd., of 47, Broad Street, Glasgow, issue a booklet describing their 16 in. gear for driving electric shaking conveyors. They also issue a pamphlet which describes the new trough belt gate-end loader.

Salermo, Ltd., of 14, Waterloo Place, London, S.W. 1, issue a booklet which describes in some detail, with both drawings and photographs, the Salermo process of coal distillation, together with a description of the new Salermo retort.

A.E.G. Electric Co., Ltd., of 131, Victoria Street, London, S.W. 1, send us the January issue of their *A.E.G. Progress*, which contains an article on the distribution of electrical energy on oil fields and also a description of a new mine locomotive.

Fry's (London), Ltd., of London, S.E. 10, issue a 102 page fully illustrated catalogue of small tools for engineers and carpenters—notably hack-saw blades, stocks and dies, reamers, twist drills, lathes, wrenches and pliers, and lubricators.

Vickers-Armstrongs, Ltd., of Barrow-in-Furness, issue leaflets descriptive of jaw crushers and of crushing rolls, the former are made in sizes having jaw openings of 24 in. by 13 in. up to 84 in. by 60 in., requiring approximate h.p. of from 30 to 300 b.h.p.; the latter in roll sizes of from 30 to 72 in. diameter for h.p. of from 15 to 100.

Mirrlees, Bickerton, and Day, Ltd., of Hazel Grove, Stockport, inform us that Shan States Silver Lead Corporation, Ltd., in Burma have ordered three 120 b.h.p. Mirrlees Diesel engines for coupling to alternators of General Electric Co. manufacture. Orders have also been received from the British Columbia Electric Railway Co., and the Alexandria Water Co., Ltd.

International Combustion, Ltd., of Africa House, Kingsway, London, W.C. 2, inform us that they have received orders for a complete boiler plant, comprising boilers, air preheaters, pulverizing plant and auxiliary machinery for the Bwana M'Kubwa Copper Mines. A complete stoker-fired plant for Ryde Pumping Station of Sydney Water Board has also been ordered.

James Gordon and Co., Ltd., of Windsor House, Kingsway, London, W.C. 2, communicate interesting particulars concerning the adoption by the Hull Corporation Electricity Dept. of the Hagan system of automatic boiler control for five Clarke Chapman boilers. The system controls both fuel and air supply in accordance with steam demand by means of a master regulator which is sensitive to minute variations in steam pressure.

Mond Nickel Co., Ltd. (Bureau of Information on Nickel), of Imperial Chemical House, London, S.W. 1, send us the November and December issues of their bulletin, the former of which contains interesting detail concerning the employment of nickel alloy steels in modern motor car manufacture, in particular the Daimler 30 h.p. double six, and in each of which there are the usual extracts from recent articles describing progress in nickel metallurgy.

British Geophysical Agency, of 20, High Holborn, London, W.C. 1, send us an illustrated catalogue prepared by Ferdinand Suss, of Budapest, describing the small original Eotvos torsion balance, some of the major characteristics of which are: Length of torsion wire 300 m.m., diameter of torsion wire 0·02 m.m., length of torsion arm or beam 100 m.m., interval of the successive readings 45 min., and total height of instrument with pedestal and tripod 1,600 m.m.

Swedish American Prospecting Corpn., of 26, Beaver Street, New York, inform us that they have acquired all the shares of Aktiebolaget Elektrisk Malmletning (The Electrical Prospecting Company), of Stockholm, Sweden. It will be recalled that these companies undertake electrical prospecting surveys of mineral land for ore and of petroleum fields for mapping structure. In the latter field, particularly, they work in co-operation with Seismos, Ltd., of Hanover, Germany, and subsidiary companies.

Westinghouse Electric International Co., of 2, Norfolk Street, Strand, London, W.C. 2 (Head Office: New York), inform us that their American associate company are constructing a central engineering laboratory and an addition to the present direct current power laboratory at East Pittsburgh. It is estimated that the building will house one of the world's best equipped electrical laboratories. Generators big enough to supply the electricity of a large town will be used for experimental purposes and artificial lighting for testing insulating materials will be produced by a high voltage surge generator. Means will also be available for reproducing different weather conditions for testing apparatus built for outdoor service. They send us also the February-March issue of their magazine which contains a review of recent progress by the firm in electrical engineering.

International Combustion, Ltd., Grinding and Pulverizing Offices, of 11, Southampton Row, London, W.C. 1, inform us that the company will in future be known as **Mining and Industrial Epuipment, Ltd.,** and they give us the following history of the circumstances which have led to the change of name: In order to comply with the British Patent requirements the first Hardinge mill was built in England in 1912. The Hardinge Company opened a London office under Mr. J. C. Farrant to deal with the manufacture and sale of Hardinge mills for the Eastern Hemisphere in January, 1913, and the business was conducted on these lines until 1925, when the rights for the Hardinge mills were acquired by International Combustion, Ltd. The principal reason for acquiring these rights was to obtain a mill which would be suitable for grinding coke, anthracite, and the lower grades of coal as an addition to the Raymond mill for bituminous coals. International Combustion, Ltd., created a grinding and pulverizing department, which included business done under the Hardinge regime, together with commercial pulverizing, for which the various types of Raymond mills were employed. From 1925 to 1930 this business expanded rapidly, the joint turnover increasing 600% over this period. The returns for last year exceeded those of 1928—the previous best year—by 65%. In addition to wet and dry grinding the licence to manufacture and sell Hum-mer screens was acquired from the W. S. Tyler Company, and last year the grinding and pulverizing department of International Combustion, Ltd., took over the existing business of the Rotary Filter Company, and the licence to manufacture the Hardinge Thickener and other Hardinge products. Towards the end of 1929 it was decided that the activities of this department had so increased that they would be better conducted by a separate company, duly incorporated on December 23 last, which would take full responsibility and control of all problems in connection with grinding, screening, thickening, and filtering, including those applying to power plants. So far as the policy of the new company is concerned, this will be as heretofore, namely, to specialize in grinding and screening and dry and wet separation. For the progressive development of this business plant facilities have been extended and the personnel and office accommodation have been considerably increased. A complete up-to-date test plant, incorporating commercial sized machines covering the whole range of their products, has been erected at Derby and is in daily operation as described in these columns in our issues of January and October, 1929. The three original members of the Hardinge Company (1913) are still with the organization, occupying the following positions: J. C. Farrant, Managing Director; C. R. C. Burton, Sales Manager; S. Longhurst, Office Manager. The board of the new company consists of G. C. Usher,

(General Manager and Director International Combustion, Ltd.), chairman ; V. Young (Secretary, International Combustion, Ltd.), secretary ; and J. C. Farrant, managing director. They also report that new orders have been received for the following equipment :—For England : One 3ft. by 8 in. ball mill (Hardinge) for aluminium skimmings ; one 5 ft. by 36 in. ball mill (Hardinge) for coal ; one 4½ ft. by 16 in. ball mill (Hardinge) for metal matte ; one No. 00 Raymond pulverizer for carbonate of magnesia ; one 4 ft. by 5 ft. Hum-mer screen for blast furnace slag ; one 4 ft. by 5 ft. Hum-mer screen for sand. For Cyprus : One 4 ft. by 5 ft. Hum-mer screen for pyrites ore. For Burma : One 7 ft. by 48 in. Hardinge ball mill for copper ore. For India : Two 5-roller Raymond mills for barytes

METAL MARKETS

Copper.—The copper market was fairly firm during January. In America, despite the burden of big surplus stocks, producers maintained their quotation at 18 cents per lb., and the cheaper sellers at slightly under this figure seem to have disappeared. In London, standard values have been advanced, but this movement, it is suspected, has some connexion with American manipulation. Consumers everywhere are frankly distrustful of the market and feel that prices ought to be reduced. Producers, however, are cutting down their output and apparently do not propose to make price concessions until they are absolutely forced to do so.

Average price of cash standard copper : January, 1930, £71 11s. 1d. ; December, 1929, £68 7s. 3d. ; January, 1929, £75 11s. 11d. ; December, 1928, £69 7s. 7d.

Tin.—Conditions on the tin market last month were somewhat erratic, a decline being succeeded by a recovery, so that values, on balance, showed very little alteration. Sentiment fluctuated according to the varying nature of the news regarding the efforts being made to curtail production. The reported adhesion of the Patiño interests to the scheme was of course a " bull " point for tin and there are also favourable indications regarding possible future co-operation in other quarters. On the other hand, the outlook as regards world consumption is somewhat doubtful, as no one can yet tell how the American business setback is going to react on the transatlantic demand for tin. However, the slowing-down of operations at the mines and smelters should soon begin to have its effect on the statistical position, and world " visible supplies " should, sooner or later, commence to shrink.

Average price of cash standard tin : January, 1930, £175 10s. 10d. ; December, 1929, £179 10s. 2d. ; January, 1929, £222 16s. 3d. ; December, 1928, £227 13s. 11d.

Lead.—This market was very steady during January, but in view of the quietude of demand throughout Europe, this result was only attained by means of considerable artificial support on the part of the Lead Producers' Association. Supplies are superabundant and yet towards the close of the month, sellers were even able to exact a premium for spot metal. How long they can continue these tactics if industrial demand fails to improve is, of course, a problem that only time can solve, but the situation is obviously highly artificial. The price looks cheap, but it would undoubtedly be cheaper still but for the control above referred to.

Average mean price of soft foreign lead : January, 1930, £21 11s. 1d. ; December, 1929, £21 9s. 6d. ; January, 1929, £22 4s. 6d. ; December, 1928, £21 6s. 8d.

Spelter.—The tendency of values was rather easier until the middle of the month, supplies being in excess of demand, but towards the close more consuming and speculative interest manifested itself and values recovered. The outlook remains obscure as it is rather doubtful whether the recent industrial purchasing will be continued to any extent, while nothing further has transpired as regards the attempt to rehabilitate the International Cartel.

Average mean price of spelter : January, 1930, £19 18s. 9d. ; December, 1929, £20 7s. 5d. ; January, 1929, £26 4s. 3d. ; December, 1928, £26 12s. 2d.

Iron and Steel.—The Cleveland pig-iron market exhibited a rather mediocre aspect during January, demand being slow to develop as consumers were rather reckoning on cheaper quotations as a result of the lowering of fuel and ore prices. Makers, however, are not yet prepared to make concessions for very good reasons of their own, and have consequently maintained their minimum prices as follows : No. 1 Cleveland foundry, 75s. ; No. 3 G.M.B., 72s. 6d. ; No. 4 foundry, 71s. 6d. ; and No. 4 forge, 71s. Hematite eased somewhat owing to a falling-off in demand and East Coast Mixed Nos. were obtainable towards the close of January at 78s. to 80s. per ton. In the steel industry, various further measures of " rationalization " were reported, and it looks as if the British works are going to be put gradually on a more efficient basis. Demand for finished steel, however, was rather disappointing during the month, although a fair amount of home business was secured. The Continental steelworks are busy reorganizing their system of sales and of order-distribution.

Antimony.—At the close of January, English regulus was quoted between £42 10s. and £50 per ton. Chinese regulus exhibited a fairly firm tone, thanks in part to American buying, and spot material was priced at about £31 5s. to £31 10s. per ton ex warehouse, while for shipment from the East £27 12s. 6d. c.i.f. was asked.

Iron Ore.—Distinctly dull conditions prevailed in this market in January so far as new business was concerned, most works having covered fully their requirements for some little time to come. The closing down of the Ebbw Vale Co. threw some surplus ore on the market, and this, coupled with easier freight rates and the weakening peseta, brought the price of best Bilbao rubio down to its present level of about 22s. 6d. per ton c.i.f.

Arsenic.—Cornish high grade white arsenic remains steady at about £15 17s. 6d. to £16 per ton f.o.r. mines, while Mexican is held for about £17 c.i.f. Liverpool.

Bismuth.—A very fair business is still passing at the official price of 7s. 6d. per lb. for merchant quantities.

Cadmium.—The better tone noticeable towards the end of last year continued in January, and prices are firm at 3s. 11d. to 4s. per lb.

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.	For-ward.		
	Cash.			3 Months					Cash.			3 Months.												
Jan.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	d.	d.	s.	d.
10	71	11	3	69	16	3	83	10	0	76	15	0	176	17	6	180	2	6	19	8	9	21	8	9	23	0	0	20 3/4	20 7/16	84	11 1/2
13	71	16	3	69	6	3	83	10	0		—		174	18	9	178	3	9	19	7	6	21	12	6	23	0	0	21 1/16	21 1/16	84	11 1/2
14	71	18	9	69	11	3	83	10	0	77	0	0	174	10	0	177	15	0	19	5	0	21	12	6	23	0	0	21 1/8	20 15/16	84	11 1/2
15	72	2	6	69	6	3	83	10	0		—		175	0	0	178	10	0	19	5	0	21	11	3	23	0	0	21 1/8	20 15/16	84	11 3/8
16	70	16	3	68	18	9	83	10	0		—		176	6	3	179	11	3	19	7	6	21	10	0	23	0	0	21 1/16	21 1/16	84	11 3/8
17	71	3	9	68	13	9	83	10	0	76	10	0	174	3	9	177	6	3	19	7	6	21	10	0	23	0	0	21	20 15/16	84	11 3/8
20	72	3	9	68	11	3	83	10	0		—		173	17	6	176	17	6	19	8	9	21	10	0	23	0	0	21 1/16	20 15/16	84	11 3/8
21	71	18	9	68	13	9	83	10	0	76	10	0	172	6	3	175	7	6	19	12	6	21	10	0	23	0	0	21	20 13/16	84	11
22	72	1	3	68	12	6	83	10	0		—		170	18	9	174	2	6	19	13	9	21	11	3	23	0	0	20 13/16	20 13/16	84	11 3/8
23	71	11	3	68	11	3	83	10	0		—		172	1	3	175	7	6	19	15	0	21	12	6	23	0	0	20 13/16	20 7/16	84	10
24	71	15	0	68	6	3	83	10	0	76	10	0	172	12	6	175	13	9	19	16	3	21	11	3	23	0	0	20 15/16	20 13/16	84	10 1/2
27	71	11	3	68	3	9	83	10	0		—		174	12	6	177	17	6	19	17	6	21	12	6	23	0	0	20 7/8	20 7/16	84	10 3/4
28	71	11	3	68	9	4½	83	12	6	76	10	0	176	8	9	179	11	3	19	16	3	21	11	3	23	0	0	20 3/4	20 15/16	84	11 1/4
29	71	18	1½	68	18	9	83	17	6		—		180	11	3	183	16	3	20	1	3	21	11	3	23	0	0	20 15/16	20 7/16	84	11 1/2
30	72	1	3	68	16	3	83	17	6		—		178	2	6	181	5	0	20	1	3	21	13	9	23	0	0	20 7/8	20 1/4	84	11 1/2
31	72	0	0	68	13	9	83	17	6	77	0	0	176	13	9	179	13	9	19	18	9	21	15	0	23	0	0	20	19 7/8	84	11 1/2
Feb.																															
3	72	6	3	69	1	3	83	17	6		—		174	17	6	177	18	9	19	16	3	21	12	6	23	0	0	20 3/8	20 1/16	84	11 1/2
4	72	17	6	69	1	3	83	17	6	77	10	0	176	17	6	179	17	6	19	12	6	21	11	3	23	0	0	19 15/16	19 15/16	84	10 5/8
5	72	18	9	69	6	3	83	17	6		—		176	18	9	179	18	9	19	11	3	21	10	0	23	0	0	20	19 7/8	84	11
6	74	7	6	69	8	9	83	17	6		—		176	11	3	179	11	3	19	11	3	21	11	3	23	0	0	20 1/8	19 15/16	84	10 1/2
7	74	12	6	69	13	9	83	17	6	78	10	0	176	1	3	178	18	9	19	12	6	21	10	0	23	0	0	20 1/16	19 15/16	84	11 1/2
10	74	17	6	69	18	9	83	17	6		—		175	6	3	178	3	9	19	13	9	21	10	0	23	0	0	20 5/16	20 1/8	84	11 1/2

COBALT METAL.—Business has been only moderate recently and the official price of 10s. per lb. is shaded for good business.

COBALT OXIDES.—A fairly good turnover is reported at 8s. per lb. for black and 8s. 10d. for grey.

PLATINUM.—Demand has continued slack and with supplies plentiful prices have eased, the official price of refined metal now standing at £12 5s. per oz., while in the outside market down to £12 is quoted.

PALLADIUM.—In sympathy with platinum, this metal is easier at about £6 to £6 5s. per oz.

IRIDIUM.—Little interest has been shown by buyers and quotations have declined to about £36 to £39 per oz. for sponge and powder.

TELLURIUM.—Prices can only be called nominal in the neighbourhood of 12s. 6d. to 15s. per lb.

SELENIUM.—There is a steady demand and the price is pegged at 7s. 8d. to 7s. 9d. per lb. ex warehouse.

MANGANESE ORE.—It cannot be said that the year has opened very auspiciously for the manganese ore trade for there has been an almost total absence of business during January, the only sales being odd cargoes sold by weak holders at low prices. Generally speaking consumers are well covered for months ahead, and supplies are plentiful despite the fact that some of the smaller Indian mines are having to close down owing to the unremunerative prices now ruling. Best Indian is nominally about 1s. 1½d. per unit c.i.f. and washed Caucasian about 1s. 1d.

ALUMINIUM.—The undertone of the market is pretty firm owing to the strong control of the producing interests, but the volume of forward buying done over the turn of the year was rather below normal, particularly on the Continent, and it is estimated that some reduction in consumption may be seen during 1930 compared with 1929. Prices, however, remain at £95 less 2% delivered for ingots and bars.

SULPHATE OF COPPER.—There is no change in the price of English material which is quoted at £27 to £27 10s. delivered, less 5%.

NICKEL.—A steady demand is maintained on quite a brisk scale, with prices unaltered at £170 to £175 per ton.

CHROME ORE.—Supplies seem fairly plentiful but prices are upheld at £4 to £4 5s. per ton c.i.f. for good average 48% material.

QUICKSILVER.—Business during January has been on a rather restricted scale but the price keeps steady at about £23 2s. 6d. per bottle for spot material.

TUNGSTEN ORE.—With very little demand for ferro-tungsten, manufacturers have abstained from making fresh purchases of ore, and very little business has been done in the past month or so. Spot is still fairly scarce and commands up to 36s. per unit ex warehouse, but for February-March shipment from China, sellers are not willing to accept about 33s., while buyers are not bidding more than about 31s. per unit c.i.f.

MOLYBDENUM.—American 80% concentrates are steady at 37s. 6d. to 38s. per unit c.i.f., but Australian 85% material is held for about 39s.

GRAPHITE.—The position of this commodity has not altered much, although the graphite industry in Ceylon does not seem to be able to stand up to Madagascan competition very successfully. Prices are without change at £25 to £28 per ton c.i.f. for 85 to 90% raw Madagascar flake and £25 to £26 c.i.f. for 90% Ceylon lumps.

SILVER.—On January 1 spot bars stood at 21⅛d., but although subsequently India bought a little, America was a seller and with China offering no support prices declined. At the lower level India took larger quantities and China worked both ways, spot bars recovering to 21⅜d. on January 15 after having touched 20 5/16d. on January 8. During the latter half of January in the absence of any prolonged support quotations again collapsed and on January 31 spot bars closed at 20d., which was a fresh low record.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
January, 1929	840,344	36,108	876,452
February	778,559	36,725	815,284
March	830,829	35,700	866,529
April	836,474	35,649	872,123
May	858,991	38,607	897,598
June	821,352	34,677	856,029
July	853,370	36,110	889,480
August	850,952	38,649	889,601
September	814,707	34,846	849,553
October	853,609	35,081	888,690
November	827,952	33,641	861,593
December	813,574	37,560	851,134
January, 1930	848,245	34,556	882,801

TRANSVAAL GOLD OUTPUTS.

	December.		January.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	76,500	£127,085	82,000	£134,153
City Deep	96,000	24,074	99,000	24,760
Cons. Main Reef	57,000	20,894	59,300	21,077
Crown Mines	215,000	68,642	228,000	72,669
D'rb'n Roodepoort Deep	40,300	13,382	41,700	13,939
East Rand P.M.	143,000	38,239	147,000	39,620
Geduld	83,500	26,741	85,000	27,114
Geldenhuis Deep	63,000	14,636	66,000	15,588
Glynn's Lydenburg	6,100	1,946	6,200	2,100
Government G.M. Areas	196,000	£373,033	210,000	£400,792
Kleinfontein	51,700	£51,601	52,200	11,956
Langlaagte Estate	72,500	£110,103	81,500	£116,790
Luipaard's Vlei	23,000	6,001	23,000	5,851
Meyer and Charlton	17,200	£19,149	17,500	£19,150
Modderfontein New	147,000	72,388	155,000	74,574
Modderfontein B	69,500	24,845	71,500	25,562
Modderfontein Deep	42,800	22,638	45,900	23,670
Modderfontein East	66,500	19,484	70,000	20,622
New State Areas	74,000	£142,539	78,000	£148,185
Nourse	56,400	16,740	54,500	16,587
Randfontein	208,000	£212,692	204,000	£216,679
Robinson Deep	76,000	19,641	80,500	20,840
Rose Deep	58,000	12,044	58,500	12,205
Simmer and Jack	77,800	19,750	73,800	19,528
Springs	65,500	£130,913	70,000	£143,387
Sub Nigel	25,700	20,956	27,400	21,430
Transvaal G.M. Estates	13,700	4,583	15,000	4,700
Van Ryn	41,500	£39,984	42,000	£41,185
Van Ryn Deep	58,000	£105,366	62,000	£105,948
Village Deep	58,000	15,066	57,000	15,381
West Rand Consolidated	90,000	£98,277	90,000	£98,342
West Springs	63,500	£75,914	66,800	£76,994
Witw'tersr'nd (Knights')	53,000	£50,655	56,000	£53,405
Witwatersrand Deep	42,300	9,635	42,300	9,370

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.	£
Nov., 1928	2,539,700	27 9	19 7	8 2	1,041,713
December	2,505,500	27 10	19 8	8 2	1,024,654
January, 1929	2,627,320	28 1	19 9	8 4	1,095,070
February	2,403,720	28 6	20 3	8 3	990,942
March	2,581,600	28 3	20 0	8 3	1,062,331
April	2,606,420	28 1	19 11	8 2	1,068,103
May	2,694,610	28 0	19 10	8 2	1,100,461
June	2,543,550	28 3	19 10	8 5	1,065,191
July	2,649,560	28 1	19 8	8 5	1,112,246
August	2,661,800	28 1	19 9	8 4	1,111,834
September	2,530 370	28 2	19 10	8 4	1,056,839
October	2,658,100	28 1	19 8	8 5	1,115,744
November	2,559,450	28 3	19 11	8 4	1,071,199
December	—	—	—	—	1,058,231

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
January 31, 1929	192,526	15,845	50,56	213,427
February 28	196,150	15,940	5,635	217,725
March 30	197,646	16,065	5,787	219,498
April 30	197,412	15,900	5,554	218,866
May 31	195,733	15,852	5,473	217,058
June 30	192,595	15,928	5,029	213,552
July 31	190,031	15,914	4,845	210,790
August 31	190,062	15,867	5,071	211,000
September 30	190,567	15,733	4,814	211.114
October 31	189,739	15,533	4,555	209,827
November 30	186,941	15,320	4,561	206,822
December 31	184,280	15,326	4,811	204,417
January 31, 1930	190,663	15,288	5,889	211,840

PRODUCTION OF GOLD IN RHODESIA.

	1926	1927	1928	1929
	oz.	oz.	oz.	oz.
January	48,967	48,731	51,356	46,231
February	46,026	46,461	46,286	44,551
March	46,902	50,407	48,017	47,388
April	51,928	48,290	48,549	48,210
May	49,392	48,992	47,323	48,189
June	52,381	52,910	51,762	48,406
July	50,460	49,116	48,960	46,369
August	49,735	47,288	50,611	46,473
September	48,350	45,838	47,716	45,025
October	50,132	46,752	43,056	46,923
November	51,090	47,435	47,705	46,219
December	48,063	49,208	44,772	46,829

RHODESIAN GOLD OUTPUTS.

	December.		January.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,000	10,667	24,000	10,986
Globe and Phœnix	6,079	5,278	6,022	5,797
Lonely Reef	5,800	4,153	6,000	4,140
Mayfair	1,000	470	—	—
Rezende	6,400	2,844	6,400	2,722
Shamva	—	—	—	—
Sherwood Starr	4,400	£9,880	4,800	£11,184
Wanderer Consolidated	10,100	2,081	12,040	3,017

WEST AFRICAN GOLD OUTPUTS.

	December.		January.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	7,084	£12,044	—	—
Ashanti Goldfields	10,034	11,298	10,367	11,458
Taquah and Abosso	8,765	£14,566	8,810	£14,633

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.	New South Wales.
	Oz.	Oz.	Oz.	Oz.
January, 1929	27,384	—	260	445
February	28,177	1,997	117	474
March	25,848	2,974	816	—
April	39,166	—	617	—
May	28,026	3,018	493	467
June	33,139	2,368	465	8
July	28,086	1,421	1,203	—
August	37,032	2,178	567	—
September	32,751	1,739	381	—
October	35,445	—	789	—
November	28.460	—	—	—
December	33,650	2,736	473	—
January, 1930	25,472	—	—	—

AUSTRALASIAN GOLD OUTPUTS.

	December.		January.	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	3,674	6,033	4,353	7,570
Blackwater (N.Z.)	2,559	4,850	1,364	5,790
Boulder Persev'ce (W.A.)	4,848	12,679	5,262	12,019
Grt. Boulder Pro. (W.A.)	5,395	17,349	—	—
Lake View & Star (W.A.)	—	—	12,230‡	31,132‡
Sons of Gwalia (W.A.)	8,724	8,978	12,554	11,119
South Kalgurli (W.A.)	6,140	12,653	7,316	15,029
Waihi (N.Z.)	21,476	7,272* / 54,452†	—	— / —

* Oz. gold. † Oz. silver. ‡ Dec. and Jan.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	December.		January.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	4,550	2,587	3,250	2,303
Champion Reef	8,410	6,938	7,700	5,591
Mysore	17,019	9,961	17,205	8,356
Nundydroog	11,072	6,931	11,500	6,953
Ooregum	13,544	6,237	13,544	6,231

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	December.		January.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	9,900	11,265	—	—
Frontino& Bolivia (C'lbia)	2,400	6,960	1,480	6,653
Lena (Siberia)	—	11,978	—	12,469
Lydenburg Plat. (Trans.)	3,360	699*p*	—	—
Marmajito (Colombia)	910	4,498	862	3,274
Fresnillo	92,742	89,513*d*	—	—
Onverwacht Platinum	2,615	450*p*	2,850	452*p*
Oriental Cons. (Korea)	—	103,600*d*	—	97,635*d*
St. John del Rey (Brazil)	—	42,000	—	44,300
Santa Gertrudis (Mexico)	50,816	103,802*d*	—	—

d Dollars. *p* Oz. platinoids.

PRODUCTION OF TIN IN FEDERATED MALAY STATES

Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

July, 1929	5,802	January, 1930	6,128
August	5,610	February	—
September	5,332	March	—
October	5,966	April	—
November	6,135	May	—
December	5,849	June	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Nov.	Dec.	Jan.
Ayer Hitam	—	—	50½
Batu Caves	28	31	26
Changkat	65	95	55
Chenderiang	28	29¼	27¾
Gopeng	83	86	77½
Hongkong Tin	50½	184½	137
Idris Hydraulic	38¾	38¾	—
Ipoh	45	51¾	31
Jelapang	21¾	34	34
Kampar Malaya	80	70	55
Kampong Lanjut	60	70	60
Kamunting	72	73½	89½
Kent (F.M.S.)	45	45	33
Kepong	38	37	40
Kinta	33	38¾	30
Kinta Kellas	31	65½	53½
Kuala Kampar	80	90	75
Kundang	25	20	23
Lahat	15	16⅝	14¼
Larut Tinfields	82	75	42
Malaya Consolidated	89¼	73	59
Malayan Tin	119	142¾	148¾
Meru	30½	24½	—
Pahang	222¾	222	222
Penawat	68¼	82½	77
Pengkalen	71	65½	51
Petaling	178	178	202½
Rahman	59½	65½	65½
Rambutan	10	11	10½
Rantau	58	50	31
Rawang	30	90	100
Rawang Concessions	200	90	70
Renong	104¾	108	93
Selayang	23	25	31
Southern Malayan	172¾	178½	172½
Southern Perak	50½	59¼	68¼
Southern Tronoh	45	48	54
Sungei Besi	48	53	48
Sungei Kinta	49	49½	33¼
Sungei Way	77¼	77¼	83¼
Taiping	38	33	24
Tanjong	41¾	44½	38¾
Teja Malaya	—	35	15¾
Tekka	46	45	42
Tekka-Taiping	26	31	31
Temoh	44	51¾	37½
Tronoh	118	122	107

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Nov.	Dec.	Jan.
Amari	9	7	—
Anglo-Nigerian	43¾	67	—
Associated Tin Mines	250	274	200
Baba River	3	2½	—
Batura Monguna	2	2	—
Bisichi	100	112	122
Daffo	10	9	—
Ex-Lands	63	65	—
Filani	5¾	5½	4½
Jantar	37	42	35
Jos	29	26¾	21¾
Juga Valley	25	24	20
Junction	3	4½	6
Kaduna	59	40½	—
Kaduna Prospectors	32½	24	—
Kassa	22½	19	—
London Tin	255	251	270
Lower Bisichi	8¼	6¾	6¼
Mongu	70	60	—
Naraguta	41	18½	21
Naraguta Durumi	19	18½	21
Naraguta Extended	20	15	10
Naraguta Karama	27½	27½	29½
Naraguta Korot	20	20	13
Nigerian Base Metals	44	—	—
Nigerian Consolidated	20	20	18
Offin River	8¼	7¼	8½
Ribon Valley	18	15	—
South Bukeru	8¼	13	13
Tin Fields	3¾	2¾	2¾
Tin Properties	25	23	17
United Tin Areas	28	20	—
Yarde Kerri	5	5	8

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Nov.	Dec.	Jan.
Anglo-Burma (Burma)	21	19½	—
Aramayo Mines (Bolivia)	435	365	240
Bangrin (Siam)	44½	48	59½
Berenguela (Bolivia)	38	35	33
C'nsolidated Tin Mines (Burma)	100	100	100
East Pool (Cornwall)	87½	87½	—
Fabulosa (Bolivia)	197	290	177
Geevor (Cornwall)	67	65	65
Jantar (Cornwall)	22	24¼	—
Kagera (Uganda)	28	30	25
Northern Tavoy	55	40	40
Polhigey (Cornwall)	35	34	31
San Finx (Spain)	30½*	16½*	—
Siamese Tin (Siam)	134½	145½	138
South Crofty (Cornwall)	68	67½	55½
Tavoy Tin (Burma)	40	47	25
Theindaw (Burma)	3	6	4
Tongkah Harbour (Siam)	73	67	50
Toyo (Japan)	30	30½	27½
Wheal Kitty (Cornwall)	45	45⅝	40
Wheal Reeth (Cornwall)	—	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		Dec.	Jan.
Broken Hill South	Tons lead conc.	4,384	—
	Tons zinc conc.	4,389	—
Burma Corporation	Tons refined lead	6,750	6,750
	Oz. refined silver	607,000	608,741
Bwana M'Kubwa	Tons copper oxide	598	612
Electrolytic Zinc	Tons zinc	4,212†	4,251‡
Indian Copper	Tons copper	233	243
Messina	Tons copper	588	641
Mount Lyell	Tons concentrates	3,122	3,671
Namaqua	Tons copper	164	—
North Broken Hill	Tons lead conc.	6,950	—
	Tons zinc conc.	5,250	—
Poderosa	Tons copper ore	1,815	990
Rhodesia Broken Hill	Tons lead	—	—
	Tons slab zinc	910	1,502
San Francisco Mexico	Tons lead conc.	3,477	3,716
	Tons zinc conc.	4,083	3,699
Sulphide Corporation	Tons lead conc.	2,671*	—
	Tons zinc conc.	3,340*	—
Tetiube	Tons lead conc.	993	—
	Tons zinc conc.	2,091	—
Union Minière	Tons copper	—	—
Zinc Corporation	Tons lead conc.	5,054	—
	Tons zinc conc.	4,166	—

* Six weeks to Dec. 28. † Four weeks to Dec. 11.
‡ Four weeks to Jan. 8.

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

		Nov.	Dec.
Iron Ore	Tons	415,843	491,630
Manganese Ore	Tons	12,389	25,923
Iron and Steel	Tons	250,430	256,429
Copper and Iron Pyrites	Tons	38,306	21,456
Copper Ore, Matte, and Prec.	Tons	3,553	4,254
Copper Metal	Tons	11,430	15,985
Tin Concentrate	Tons	7,350	8,340
Tin Metal	Tons	1,639	2,440
Lead Pig and Sheet	Tons	30,596	29,606
Zinc (Spelter)	Tons	9,177	14,437
Zinc Sheets, etc.	Tons	2,142	3,005
Aluminium	Tons	1,144	3,911
Quicksilver	Lb.	145,142	177,799
Zinc Oxide	Tons	919	983
White Lead	Cwt.	18,427	17,141
Red and Orange Lead	Cwt.	2,561	3,559
Barytes, ground	Cwt.	51,994	58,525
Asbestos	Tons	3,342	2,281
Boron Minerals	Tons	1,907	295
Borax	Cwt.	25,293	39,787
Basic Slag	Tons	5,360	2,454
Superphosphates	Tons	10,181	6,876
Phosphate of Lime	Tons	28,932	50,124
Mica	Tons	334	221
Sulphur	Tons	10,733	5,134
Nitrate of Soda	Cwt.	133,149	79,822
Potash Salts	Cwt.	214,466	268,853
Petroleum: Crude	Gallons	34,147,507	34,186,141
Lamp Oil	Gallons	24,840,206	17,232,033
Motor Spirit	Gallons	50,232,378	58,904,030
Lubricating Oil	Gallons	6,322,370	4,663,394
Gas Oil	Gallons	12,946,544	8,829,531
Fuel Oil	Gallons	25,079,963	27,528,866
Asphalt and Bitumen	Tons	22,412	13,166
Paraffin Wax	Cwt.	161,792	141,202
Turpentine	Cwt.	32,486	46,390

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES

In Tons.

	Nov.	Dec.	Jan.
Anglo-Ecuadorian	14,427	14,338	14,805
Apex Trinidad	34,140	33,530	34,760
Attock	3,730	3,238	3,111
British Burmah	5,411	5,518	5,359
British Controlled	31,206	30,487	32,220
Kern Mex	770	765	753
Kern River (Cal.)	1,739	1,118	932
Kern Romana	2,592	3,194	2,768
Kern Trinidad	4,336	5,030	4,726
Lobitos	28,669	29,847	28,815
Phœnix	48,442	48,618	50,110
St. Helen's Petroleum	7,802	8,372	6,107
Steaua Romana	70,640	70,150	71,890
Tampico	2,927	2,989	2,936
Trinidad Leaseholds	30,400	39,700	32,100
Venezuelan Consolidated	5,054	7,595	7,288

QUOTATIONS OF OIL COMPANIES SHARES.

Denomination of Shares £1 unless otherwise noted.

	Jan. 10, 1930	Feb. 10, 1930
	£ s. d	£ s. d.
Anglo-American	3 9 3	3 2 6
Anglo-Ecuadorian	17 0	16 3
Anglo-Egyptian B	2 7 0	2 10 6
Anglo-Persian 1st Pref.	1 6 9	1 6 3
" " Ord.	3 13 9	4 1 9
Apex Trinidad (5s.)	1 8 0	1 5 0
Attock	1 3 9	1 18 9
British Burmah (8s.)	6 9	6 6
British Controlled ($5)	4 0	4 0
Burmah Oil	3 15 0	4 3 0
Kern River, Cal. (10s.)	6 4	5 9
Lobitos, Peru	1 18 3	2 0 0
Mexican Eagle, Ord. (4 pesos)	14 9	13 6
" " 8% Pref. (4 pesos)	14 6	13 3
Phœnix, Roumania	9 9	13 0
Royal Dutch (100 fl.)	33 0 0	32 15 0
Shell Transport, Ord.	4 15 9	4 15 6
" " 5% Pref. (£10)	9 12 6	9 15 0
Steaua Romana	9 0	9 0
Trinidad Leaseholds	3 16 3	3 17 6
United British of Trinidad (6s. 8d.)	7 3	7 0
V.O.C. Holding	2 18 9	3 0 0

PRICES OF CHEMICALS. February 7.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		16	6
" 80%	"	1	16	6
" Glacial	per ton	66	0	0
Alum	"	8	10	0
Alumina, Sulphate, 17 to 18%	"	6	15	0
Ammonia, Anhydrous	per lb.			10
" 0·880 solution	per ton	15	10	0
" Carbonate	"	27	10	0
" Nitrate	"	24	0	0
" Phosphate	"	40	0	0
" Sulphate, 20·6% N.	"	10	2	0
Antimony, Tartar Emetic	per lb.			10¾
" Sulphide, Golden	"			7
Arsenic, White	per ton	16	0	0
Barium Carbonate, 94%	"	5	10	0
" Chloride	per ton	10	12	6
" Sulphate, 94%	"	5	0	0
Benzol, standard motor	per gal.		1	7½
Bleaching Powder, 35% Cl.	per ton	6	15	0
Borax	"	13	10	0
Boric Acid	"	22	0	0
Calcium Chloride	"	5	5	0
Carbolic Acid, crude 60%	per gal.		2	5
" " crystallized, 40°	per lb.			7½
Carbon Disulphide	per ton	24	0	0
Citric Acid	per lb.		1	11
Copper Sulphate	per ton	26	5	0
Hydrofluoric Acid	"			6
Iodine	per oz.		1	0
Iron, Nitrate	per ton	6	0	0
" Sulphate	"	1	15	0
Lead, Acetate, white	"	39	0	0
" Nitrate	"	33	5	0
" Oxide, Litharge	"	37	10	0
" White	"	38	0	0
Lime, Acetate, brown	"	7	5	0
" " grey, 80%	"	16	0	0
Magnesite, Calcined	"	9	10	0
Magnesium, Chloride	"	6	15	0
" Sulphate, comml.	"	3	5	0
Methylated Spirit 64° Industrial	per gal.		1	5
Nitric Acid, 80° Tw.	per ton	21	0	0
Oxalic Acid	per cwt.	1	13	0
Phosphoric Acid	per ton	29	15	0
Potassium Bichromate	per lb.			4½
" Carbonate	per ton	26	2	6
" Chlorate	per ton	26	15	0
" Chloride 80%	per ton	9	15	0
" Hydrate (Caustic) 90%	"	31	0	0
" Nitrate, refined	"	20	10	0
" Permanganate	per lb.			5⅝
" Prussiate, Yellow	"			6½
" " Red	"		1	9
" Sulphate, 90%	per ton	11	0	0
Sodium Acetate	per ton	20	10	0
" Arsenate, 45%	"	26	0	0
" Bicarbonate	"	10	10	0
" Bichromate	per lb.			3⅜
" Carbonate (Soda Ash)	per ton	6	0	0
" " (Crystals)	"	5	5	0
" Chlorate	per ton	25	15	0
" Cyanide, 100% KCN basis	per lb.			7
" Hydrate, 76%	per ton	14	10	0
" Hyposulphite	"	9	0	0
" Nitrate, 96%	"	10	2	0
" Phosphate, comml.	per cwt.		11	0
" Prussiate	per lb.			4¾
" Silicate	per ton	9	10	0
" Sulphate (Salt-cake)	"	2	15	0
" " (Glauber's Salt)	"	2	12	6
" Sulphide	"	9	5	0
Sulphur, Roll	"	10	0	0
" Flowers	"	12	0	0
Sulphuric Acid, 168°	"	5	7	6
" " free from Arsenic, 144°	"	4	0	0
Superphosphate of Lime, 33%	"	3	9	0
Tartaric Acid	per lb.		1	3
Turpentine	per ton	44	15	0
Tin Crystals	per lb.		1	6½
Titanous Chloride	"			10
Zinc Chloride	per ton	12	0	0
Zinc Dust	"	27	10	0
Zinc Oxide	"	39	0	0
Zinc Sulphate	"	10	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted

GOLD AND SILVER:	Jan. 9, 1930. £ s. d.	Feb. 10, 1930. £ s. d.
SOUTH AFRICA:		
Brakpan	3 15 6	2 17 6
City Deep	8 0	7 6
Consolidated Main Reef	17 9	15 6
Crown Mines (10s.)	3 8 9	3 3 0
Daggafontein	1 2 6	1 3 0
Durban Roodepoort Deep	11 3	10 6
East Geduld	1 19 6	1 17 6
East Rand Proprietary (10s.)	13 3	11 0
Geduld	3 11 3	3 6 3
Geldenhuis Deep	6 0	5 6
Glynn's Lydenburg	2 6	2 6
Government Gold Mining Areas (5s.	1 17 0	1 18 9
Langlaagte Estate	1 3 6	1 1 0
Meyer & Charlton	10 0	10 0
Modderfontein New (10s.)	4 12 6	4 3 9
Modderfontein B (5s.)	17 6	15 0
Modderfontein Deep (5s.)	1 10 0	1 5 0
Modderfontein East	1 8 9	1 5 0
New State Areas	1 12 6	1 11 3
Nourse	9 0	8 3
Randfontein	6 3	6 0
Robinson Deep A (1s.)	15 0	15 0
„ „ B	8 6	7 9
Rose Deep	5 0	4 3
Simmer & Jack (2s. 6d.)	3 3	3 3
Springs	3 9 6	3 5 6
Sub Nigel (10s.)	1 17 6	1 18 9
Van Ryn	7 0	6 6
Van Ryn Deep	1 17 6	1 18 9
Village Deep	7 6	7 3
West Rand Consolidated (10s.)	7 3	6 3
West Springs	19 0	15 3
Witwatersrand (Knight's)	8 0	9 0
Witwatersrand Deep	4 0	3 9
RHODESIA:		
Cam and Motor	1 5 0	1 0 6
Gaika	4 0	4 0
Globe and Phœnix (5s.)	10 9	14 3
Lonely Reef	17 6	16 3
Mayfair	15 0	12 6
Rezende	17 6	1 2 6
Shamva	1 6	2 0
Sherwood Starr	1 2 6	1 0 6
GOLD COAST:		
Ashanti (4s.)	1 7 3	1 6 6
Taquah and Abosso (5s.)	1 6	1 9
AUSTRALASIA:		
Golden Horseshoe (4s.), W.A.	1 9	2 9
Great Boulder Proprietary (2s.), W.A	1 6	1 6
Lake View and Star (4s.), W.A.	13 6	13 0
Sons of Gwalia, W.A.	1 3	1 6
South Kalgurli (10s.), W.A.	13 9	13 0
Waihi (5s.), N.Z.	12 9	13 0
Wiluna Gold, W.A.	16 9	17 0
INDIA:		
Balaghat (10s.)	4 3	4 0
Champion Reef (10s).	8 9	9 0
Mysore (10s.)	11 9	13 0
Nundydroog (10s.)	15 0	16 0
Ooregum (10s.)	6 3	6 3
AMERICA:		
Camp Bird (2s.), Colorado	1 3	1 0
Exploration (10s.)	7 6	7 6
Frontino and Bolivia, Colombia	7 6	7 6
Mexican Corporation, Mexico	9 0	9 0
Mexico Mines of El Oro, Mexico	3 9	3 9
Panama Corporation	1 0 0	1 0 0
St. John del Rey, Brazil	17 9	18 6
Santa Gertrudis, Mexico	8 9	8 3
Selukwe (2s. 6d.), British Columbia	4 3	4 0
MISCELLANEOUS:		
Chosen, Korea	10 0	8 9
Edie (5s.), New Guinea	15 0	15 0
Lena Goldfields, Russia	9	6
COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	1 3 6	1 2 0
Esperanza Copper, Spain	1 1 3	1 1 6
Indian (2s.)	2 0	1 9
Loangwa (5s.), Rhodesia	6 9	6 3
Luiri (5s.), Rhodesia	4 6	5 0
Messina (5s.), Transvaal	18 0	16 6
Mount Lyell, Tasmania	1 16 6	1 13 9
Namaqua (£2), Cape Province	16 3	16 3
N'Changa, Rhodesia	2 5 0	3 0 0
Rhodesia-Katanga	1 14 6	1 15 0
Rio Tinto (£5), Spain	46 0 0	46 5 0
Roan Antelope (5s.), Rhodesia	1 13 0	1 10 0
Tanganyika, Congo and Rhodesia	2 2 6	1 18 9
Tharsis (£2), Spain	5 1 3	4 18 9

LEAD-ZINC:	Jan. 9, 1930 £ s. d.	Feb. 10, 1930. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	10 9	10 6
Broken Hill Proprietary, N.S.W.	1 4 3	1 3 0
Broken Hill North, N.S.W.	4 12 6	4 5 0
Broken Hill South, N.S.W.	3 1 3	2 17 6
Burma Corporation (10 rupees)	14 6	15 0
Electrolytic Zinc Pref., Tasmania	1 10 0	1 8 9
Mount Isa, Queensland	1 7 6	1 6 3
Rhodesia Broken Hill (5s.)	3 6	2 3
San Francisco (10s.), Mexico	1 6 0	1 3 6
Sulphide Corporation (15s.), N.S.W	18 9	15 9
ditto, Pref.	1 5 9	1 1 6
Zinc Corporation (10s.), N.S.W.	1 16 3	1 13 9
ditto, Pref.	3 15 0	3 12 6
TIN:		
Aramayo Mines (25 fr.), Bolivia	1 16 3	1 13 9
Associated Tin (5s.), Nigeria	6 6	6 6
Ayer Hitam	14 9	14 3
Bangrin, Siam	1 6 3	1 2 6
Bisichi (10s.), Nigeria	8 0	8 0
Chenderiang, Malay	9 0	1 6
Consolidated Tin Mines of Burma	6 9	6 0
East Pool (5s.), Cornwall	1 0	1 3
Ex-Lands Nigeria (2s.), Nigeria	2 3	2 0
Geevor (10s.), Cornwall	5 9	5 3
Gopeng, Malaya	2 2 6	2 3 9
Hongkong	1 1 0	19 0
Idris (5s.), Malaya	10 9	9 9
Ipoh Dredging (16s.), Malay	1 2 6	1 0 0
Kaduna Prospectors (5s.), Nigeria	8 9	7 6
Kaduna Syndicate (5s.), Nigeria	15 0	15 0
Kamunting (5s.), Malay	10 3	8 0
Kepong, Malay	18 9	18 0
Kinta, Malay	12 6	12 6
Kinta Kellas, Malay	8 6	8 3
Kramat Pulai, Malay	2 1 3	1 17 6
Lahat, Malay	10 3	10 0
Malayan Tin Dredging (5s.)	1 5 3	1 5 3
Naraguta, Nigeria	11 3	11 3
Nigerian Base Metals (5s.)	1 9	1 3
Pahang Consolidated (5s.), Malay	9 9	10 3
Penawat ($1), Malay	2 0	1 9
Pengkalen (5s.), Malay	19 0	17 0
Petaling (2s. 4d.), Malay	12 3	12 6
Rambutan, Malay	13 9	13 9
Renong Dredging, Malay	1 6 3	1 4 3
Siamese Tin (5s.), Siam	12 3	12 0
South Crofty (5s.), Cornwall	3 6	3 3
Southern Malayan	16 3	16 0
Southern Perak, Malay	2 5 0	2 1 9
Southern Tronoh (5s.), Malay	11 6	9 9
Sungei Besi (5s.), Malay	11 6	12 0
Sungei Kinta, Malay	1 1 0	19 6
Tanjong (5s.), Malay	14 6	13 3
Tavoy (4s.), Burma	6 3	7 6
Tekka, Malay	1 1 0	1 0 6
Tekka Taiping, Malay	1 2 6	19 9
Temengor, Malay	1 5 0	1 6 3
Toyo (10s.), Japan	7 6	7 0
Tronoh (5s.), Malay	1 0 6	1 0 0
DIAMONDS:		
Consol. African Selection Trust (5s.)	1 5 0	1 5 0
Consolidated of S.W.A.	12 6	11 3
De Beers Deferred (£2 10s.)	10 1 3	10 0 0
Jagersfontein	2 1 3	2 1 3
Premier Preferred (5s.)	5 0 0	5 0 0
FINANCE, ETC.:		
Anglo-American Corporation	1 12 6	1 11 3
Anglo-French Exploration	1 1 3	1 1 3
Anglo-Continental (10s.)	10 9	10 9
Anglo-Oriental (Ord., 5s.)	6 6	6 3
ditto, Pref.	13 3	14 9
British South Africa (15s.)	2 1 0	2 2 0
Central Mining (£8)	18 15 0	18 5 0
Consolidated Gold Fields	2 6 3	2 1 3
Consolidated Mines Selection (10s.)	18 3	18 3
Fanti Consols (8s.)	14 0	13 0
General Mining and Finance	17 6	15 6
Gold Fields Rhodesian (10s.)	10 0	9 9
Johannesburg Consolidated	2 6 3	2 5 0
London Tin Syndicate	1 16 3	1 18 9
Minerals Separation	4 15 0	7 2 6
National Mining (8s.)	1 9	1 0
Rand Mines (5s.)	3 4 6	3 1 3
Rand Selection (5s.)	15 0	14 0
Rhodesian Anglo-American (10s.)	1 13 9	1 16 3
Rhodesian Congo Border	7 17 6	14 5 0
Rhodesian Selection Trust (5s.)	2 11 3	2 8 9
South African Gold Trust	1 7 0	1 6 3
Southern Rhodesia Base Metals	12 6	15 0
Tigon (5s.)	1 8 9	1 7 6
Union Corporation (12s. 6d.)	3 14 6	3 12 6
Venture Trust (10s.)	5 6	6 0

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.

DEVELOPMENTS IN MILLING PRACTICE ON THE FAR EAST RAND

In the *Journal* of the Chemical Metallurgical and Mining Society of South Africa for October last further developments in tube-milling and classification practice at West Springs are described by J. L. Willey and S. E. T. Ewing. The writers in previous papers have dealt with the economic and metallurgical aspects of single stage crushing followed by tube-milling as applied to mines situated on the Far East Rand. Full extracts are here given from their latest paper.

In the first place it should be stated that ores drawn from different areas and horizons of the Rand goldfield, when reduced to identical final pulp gradings and submitted to identical cyanide treatments yield quite different extraction results. Broadly speaking, ores from the deeper workings of the Far East Rand basin will show residual values double those obtained from the West and Central Rand when submitted to identical treatment. Much investigation and experiment has been carried out by workers in this field with a view to determining the underlying reason for this comparative intractability. Whatever the cause or causes, all the research that has been carried out on mines of the Group associated with West Springs leads to the conclusion that the so-called refractory gold content is so encased in the pyritic portion of the ore as to necessitate very fine grinding for its release.

When the first Dorr Classifier to be installed on these fields was put into operation at Springs Mines in 1920, it was at once noticed that the small proportion of — 200 mesh product contained in the rake oversize product carried abnormally high gold values, thus showing that the classifier had a distinct concentrating effect. This effect was further confirmed a short time later on the installation of two bowl classifiers on the same mine, and it then became the subject of closer investigation. It was found that a surprisingly large proportion of the total residual gold was contained in this particular product. Laboratory treatment of these values indicated that the gold was still mainly locked up or encased in its pyritic envelope, and that the product would require considerable further comminution to release the bulk of its gold values. At the same time it was clear that under existing conditions of cost of tube-milling the economic limit of comminution of the total ore had already been reached. The question, therefore, resolved itself into the possibilities of economical separation and further comminution of this product and this product only.

The separation of the pyritic content of Rand ores by mechanical concentration or flotation, and its subsequent regrinding and treatment, has been the subject of experiment and discussion for many years, and is, in fact, in operation to-day on several mines. Owing, however, to the high percentage of pyritic matter contained in the ores of the mines dealt with here, and the correspondingly large plant required, the overall gain that could be foreseen was not sufficient to warrant the adoption of any of these known methods, all of which really entail the bodily removal of the material it is desired to submit to special treatment from the main body of pulp and its further handling in a separate plant. The matter, therefore, lay in abeyance some time until a new

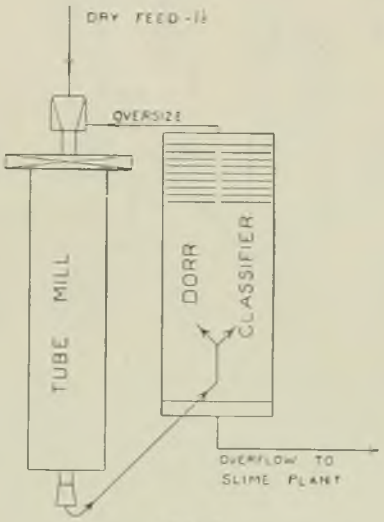


FIG. 1.

possibility was opened up by the information which began to come in from various sources as to the practicability and gain in overall grinding efficiency to be secured by carrying out the operation of tube-milling by stages instead of in only one stage as now commonly practised on the Rand.

Tube-milling in two stages, combined with the known concentrating effect of the Dorr Bowl Classifier, offered a simple means of submitting a selected portion of the total pulp from the primary mills to a further stage of grinding without incurring the heavy expense of bodily abstracting the selected portion from the main pulp stream. A plant designed on these lines which would involve little or no additional capital or running costs might therefore, be expected to yield a higher output of finished product per tube mill due to the staging effect, and allow of additional fine grinding of the selected product, without increasing the fineness of the total product beyond the economic limit.

The opportunity for putting these ideas into effect did not occur until an increase of the tonnage capacity of the West Springs plant was decided on in 1927. At this date the tube-mill plant consisted of ten 6 ft. 6 in. × 20 ft. 0 in. tube mills producing an average daily tonnage of 2,000 tons of finished product. It having been decided to increase the capacity of the milling plant to enable it to deal with a nominal monthly tonnage of 60,000, an increase of 10,000 tons, steps were taken to alter the operation of the plant to stage

As regards grinding media in the secondary or regrinding mills, large pebble as used in the primary mills is, of course, quite unsuitable. Steel balls or cylinders, etc., give satisfactory grinding results but are naturally expensive. At West Springs the size of the pebble reject from the primary tubes is determined by the authors' previous experience, and is a $-1\frac{1}{2}$ in. pebble. Plenty of suitable material is available from this reject which is trommelled to discard pebble below 1 in. approximately. A composite grinding media

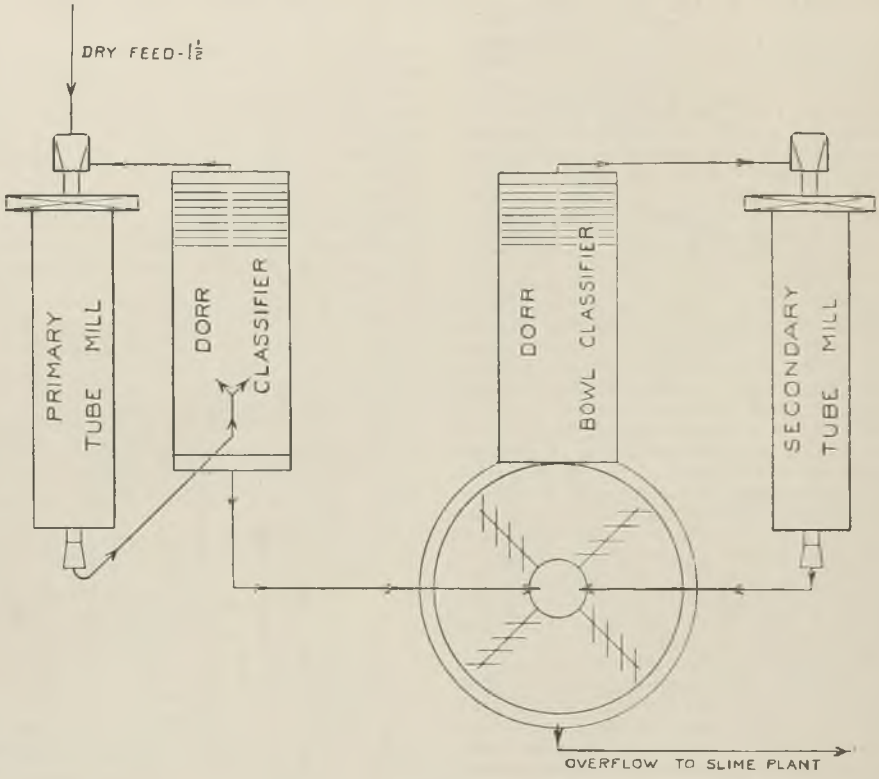


FIG. 2.

milling and "selective" grinding, at the same time adding two additional 6 ft. 6 in. × 20 ft. 0 in. tube mills. The increased and modified plant came into full operation in August, 1928. Fig. 1 shows the original flow sheet, and Fig. 2 the amended flow sheet. The effect on the residue values was immediate, a fall of 0·10 dwt. showing up in the first few days. The determination of the best ratio of primary to secondary mills is, however, a slow process. A start was made with a ratio of 10–2, and this was maintained until the conditions for obtaining the best results in the regrinding circuit had been determined. At present the plant is operating on a 9–3 ratio, and still higher ratios of secondary to primary mills will be experimented with when opportunity presents itself.

Tonnage production has been increased by this double stage grinding, and although nominally of 60,000 tons monthly capacity in a 26 working day month, the plant has handled 65,000 tons in a 27 working day month with ease.

consisting mainly of reject pebbles from the primary tube mills, together with scrap steel, is being used at the present time; (the scrap steel is mainly obtained from old drill steel and worn out tube mill bars cut down to a length of from 3 in. to 4 in). The tendency at the present time is gradually to reduce the amount of steel used, and the indications are that it will be possible to obtain the required results by the use of reject pebbles alone. If this should prove to be the case, a further appreciable saving in costs will result.

Mention has previously been made of the concentrating effect obtained by the use of the type of classifier installed; in this connection it is interesting to note that the pyritic content of the ore milled is from 4·4% to 4·5%; in the rake product from the primary duplex Dorr Classifiers the percentage of pyrite rises to between 7·3% and 7·5%; in the — 200 mesh portion of this product the pyritic content is of the order of 17·5%. In

the rake product from the bowl or final classifiers the percentage of pyrite varies from 8·5% to 9·0%, and in the — 200 mesh portion of this product it has risen to approximately 36%.

With the original flow sheet (Fig. 1) in operation, the tube mills were run at a speed of 25·6 r.p.m. It was felt that a lower speed might give better results in the regrinding section, and therefore, arrangements were made to run the two secondary mills at 24·25 r.p.m. and 23·5 r.p.m. respectively. A certain amount of experimental work was also carried out with different speeds varying from 19 r.p.m. up to 25·6 r.p.m. This work clearly indicated that, under the conditions pertaining at the plant, the higher speed gave the best results expressed in terms of — 200 mesh material produced. It is realized that these tests were not so exhaustive as could have been desired, but the carrying out of large scale experiments in an operating plant is frequently a matter of great difficulty. In the tests carried out, the general conditions on each mill, i.e. as regards feed, grinding media, moisture, etc., were maintained as similar as possible, the speed of the mills being the only variable.

Briefly, the results obtained were as follows:—

(1) With one mill running at 21 r.p.m., as compared with the other running at 24·25 r.p.m., the latter mill showed an increase of 3·2% in the quantity of — 200 mesh material produced based on the total tonnage crushed.

(2) With a speed of 22 r.p.m., as compared with a speed of 24·25 r.p.m., the latter speed gave an increase of 1·5% in the — 200 mesh material produced.

(3) With a speed of 23·5 r.p.m., as compared with a speed of 24·25 r.p.m., the increase in favour of the higher speed was 0·6%.

(4) With a speed of 24·25 r.p.m., as compared with a speed of 25·6 r.p.m., the increase in favour of the higher speed was 1·7%.

(5) A repetition of No. 4 gave an increase of 1·9% in favour of the higher speed.

(6) With a speed of 19 r.p.m., the results obtained were so poor that this test was abandoned after a three days' run.

As a result of the above tests, the regrinding mills are now run at a speed of 25·6 r.p.m., which is the same speed at which the primary mills are operated.

For effective stage tube-milling, certain modifications in the operation of the primary tube mill circuit, as compared with the original conditions, have been found necessary. In order to handle the larger circulating load necessitated by the new conditions and also to overflow the increased tonnage of appreciably coarser pulp, it was necessary to make the following alterations:—

(1) Increase the speed of the classifier rakes from 15 strokes per minute to 20 strokes, and finally to 22½ strokes, which is the present speed.

(2) Increase the pressure in the jet elevators from 60 lb. to 100 lb., simultaneously reducing the size of the jets from 13/16 in. to 11/16 in., which enables a moisture content of 76% to be maintained in the primary classifier overflow.

(3) Cut down the level of the primary classifier overflow by approximately 5 in.; the overflow plate at the end of the classifier has been actually cut down 10 in. and this plate replaced by renewable wooden slats, each of a thickness of 1 in. This arrangement enables a rapid alteration in classification conditions to be made, and has been found extremely useful in operation.

Bar liners of the Osborne type are used in the primary mills; these are installed in two sections, and the average life of the inlet end section is 125 days, whilst an average life of 165 days is obtained from the outlet end section.

The diameter of the screen in the primary mills is 4 ft. 4½ in.; the apertures are slotted, the slots being 4 in. long and 1¼ in. wide tapering to 1½ in. A 6-arm discharge scoop is used.

The liners in use in the regrinding mills are of the solid cast type, and up to the present it has not been necessary to replace either of these liners, and it is estimated that an approximate life of 16 months will be obtained from them.

The diameter of the screen is the same as in the primary mills; the apertures are round, tapering from 1 in. in diameter to $1\frac{3}{16}$ in. A 3-arm discharge scoop is used.

TABLE A: SINGLE STAGE TUBE MILLING.

Date.	*Running time hrs.*	*Total tons milled.*	*Tons milled per tube per 24 hours.*	*Tons —90 Product per mill per 24 hours.*	*Tons—200 Product per mill per 24 hours.*	*Total K.W. hours*	*K.W. hours per ton milled.*	*K.W. hours per ton —90 product*	*K.W. hours per ton —200 product*
1928.									
May	6460·67	53,600	199·11	189·95	154·11	1,072,281	20·0	21·0	25·9
June	6215·00	52,200	201·58	192·10	154·81	1,078,097	20·7	21·7	26·9
July	6202·92	52,000	201·20	191·54	155·12	1,103,885	21·2	22·3	27·8
Totals and Averages	18878·59	157,800	200·61	191·18	154·67	3,254,263	20·6	21·65	26·8

DOUBLE STAGE TUBE MILLING AND SELECTIVE GRINDING.

Ratio 10 Primary Tube Mills and 2 Secondary Tube Mills.

1929.									
January	7215·00	63,000	209·56	204·95	167·44	1,212,069	19·2	19·7	24·1
February	6500·58	57,000	210·44	205·39	167·51	1,143,306	20·0	20·5	25·2
March	6812·25	60,000	211·38	205·47	165·94	1,300,414	21·7	22·3	27·6
Totals and Averages	20527·83	180,000	210·45	205·26	166·96	3,655,789	20·3	20·8	25·6

DOUBLE STAGE TUBE MILLING AND SELECTIVE GRINDING.

Ratio 9 Primary Tube Mills and 3 Secondary Tube Mills.

1929.									
April	7127·14	62,600	210·80	206·37	169·91	1,233,462	19·7	20·1	24·4
May	7694·78	65,100	203·05	200·41	169·34	1,336,418	20·5	20·8	24·6
June	6967·01	60,100	207·03	203·51	168·52	1,279,495	21·3	21·7	26·2
Totals and Averages	21788·93	187,800	206·96	203·43	169·26	3,849,375	20·5	20·9	25·1

TABLE B: SINGLE STAGE TUBE MILLING.

Date.	Gradings of Final Product. + 60	+ 90	+ 200	− 200	Original Value Dwts.	Residue Value Dwts.	Theoretical Ext'tion %	Original Grading Assays Dwts. per ton. + 60	+ 90	+ 200	− 200	Residue Gradings Assays. Dwts. per ton. + 60	+ 90	+ 200	− 200
1928.															
May	—	—	—	77·4	6·916	·491	92·90	—	3·87	2·50	8·60	—	·99	·73	·46
June	—	—	—	76·8	6·836	·481	92·96	—	3·73	2·87	8·90	—	·74	·80	·48
July	—	—	—	77·1	6·919	·512	92·60	—	3·15	2·65	8·82	—	·81	·73	·49
Averages	—	—	—	77·1	6·891	·495	92·82	—	3·58	2·67	8·77	—	·85	·75	·48
DOUBLE STAGE TUBE MILLING AND SELECTIVE GRINDING. Ratio 10 Primary Tube Mills and 2 Secondary Tube Mills.															
1929.															
January	—	—	—	79·9	5·868	·391	93·34	—	12·40	1·68	6·45	—	·81	·45	·37
February	—	—	—	79·6	6·277	·383	93·90	—	11·45	2·03	7·13	—	·92	·55	·35
March	—	—	—	78·5	6·300	·383	93·92	—	13·71	2·77	6·63	—	·81	·37	·34
Averages	—	—	—	79·3	6·140	·386	93·72	—	12·52	2·16	6·74	—	·85	·46	·35
DOUBLE STAGE TUBE MILLING AND SELECTIVE GRINDING. Ratio 9 Primary Tube Mills and 3 Secondary Tube Mills.															
1929.															
April	—	—	—	80·6	6·340	·368	94·24	—	12·35	2·00	5·95	—	·70	·35	·34
May	—	—	—	83·4	5·265	·335	93·64	—	18·38	2·07	6·55	—	·95	·42	·28
June	—	—	—	81·4	6·341	·335	94·72	—	16·75	2·30	6·52	—	·68	·36	·28
Averages	—	—	—	81·5	5·968	·346	94·20	—	15·83	2·12	6·34	—	·78	·38	·30

TABLE C: GRADINGS.

Date.	Overflow from Primary Classifiers. + 60	+ 90	+ 200	− 200	Feed to Secondary Tube Mills. + 60	+ 90	+ 200	− 200	Discharge from Secondary Tube Mills. + 60	+ 90	+ 200	− 200
1929.												
January	2·8	18·8	20·0	58·4	3·7	41·8	42·9	11·6	·7	22·4	40·0	36·9
February	3·0	19·1	20·5	57·4	3·7	42·5	42·6	11·2	·8	23·4	40·0	35·8
March	3·2	19·8	20·7	56·3	4·0	42·9	41·3	11·8	1·0	24·1	38·9	36·0
April	4·5	19·7	22·2	53·6	5·9	37·6	43·5	13·0	·7	14·0	35·6	49·7
May	4·7	19·3	22·9	53·1	6·7	34·4	45·1	13·8	0·4	7·1	31·8	60·7
June	6·4	20·0	22·9	50·7	8·7	36·7	42·5	12·1	0·5	9·1	33·9	56·5

TABLE D.

Date.	Rock fed to Primary Tube Mills. Single Stage Tube Milling Tons per mill per 24 hours.	Rock fed to Primary Tube Mills. Double Stage Tube Milling Ratio 10 : 2. Tons per mill per 24 hours.	Grinding Media fed to Secondary Tube Mills. Double Stage Tube Milling Ratio 9 : 3 Tons per mill per 24 hours.	Grinding Media fed to Secondary Tube Mills. Reject Pebbles Tons per mill per 24 hours.	Grinding Media fed to Secondary Tube Mills. Scrap Steel Lb per mill per 24 hours.
1928.					
May	38·8	—	—	—	—
June	37·5	—	—	—	—
July	39·6	—	—	—	—
1929.					
January	—	35·2	—	7·2	1149
February	—	36·4	—	6·7	936
March	—	39·2	—	7·8	1013
April	—	—	34·4	11·7	764
May	—	—	31·7	9·0	512
June	—	—	32·3	8·8	621

TABLE E: COSTS.

Date.	Sorting and Crushing.	Tube Milling. Shillings per ton.	Combined Sorting and Crushing and Tube Milling. Shillings per ton.	Total Reduction Costs. Shillings per ton.
1928				
May	0·473	1·371	1·844	3·020
June	0·583	1·430	2·013	3·184
July	0·570	1·567	2·137	3·274
Averages	0·542	1·456	1·998	3·159
1929.				
January	0·400	1·434	1·834	3·101
February	0·466	1·459	1·925	3·137
March	0·398	1·424	1·822	3·010
Averages	0·421	1·439	1·860	3·082
1929.				
April	0·405	1·441	1·846	3·031
May	0·387	1·390	1·777	2·944
June	0·402	1·442	1·844	2·822
Averages	0·398	1·424	1·822	2·934

Tabulated statements of comparative results are given. It will be noted that a period of three months is dealt with in each case. The figures relating to the single stage tube milling are for the last three months that this particular flow sheet was in operation. Those relating to the flow sheet when 10 primary and 2 secondary tube mills were operated are also for the last three months that this flow sheet was in operation, whilst the last set of figures cover the period of the first three months that 9 primary and 3 secondary tube mills were used.

Table "A" gives the details of running time, tonnage crushed, production of — 90 mesh and — 200 mesh product, and power consumed. It is interesting to note the appreciable increase of tons of — 200 mesh product per tube mill per 24 hours under double stage tube milling conditions, as compared with single stage tube milling, and the slight but definite improvement in power consumption per ton of — 200 product. As the production of — 200 material is to a great extent the most important factor in determining the extraction of the gold content of the ores in the mines dealt with in this paper, only the percentage of — 200 mesh produced is given in the grading of the final pulp. The power consumed is given in kilowatt hours per ton of ore crushed, per ton of — 90 mesh material produced, and also per ton of — 200 mesh material produced. The kilowatt hours thus recorded are the power input to the tube mill motors. As they are metered at the distribution sub-station, they therefore include the cable transmission losses, and also the motor and tube mill gearing losses.

Table "B" deals with assay values of heads and tails. In this connexion the increase in the theoretical extraction in spite of the drop in the original value is noteworthy. Further, the very considerable increase in the gold content of the + 90 mesh material under double stage tube milling, and the fact that the residual value of this product is slightly lower in spite of the higher value is also of interest. The decrease in the residual values of the + 200 and — 200 products is also appreciable.

Table "C" deals with the gradings of overflow from the primary classifiers; the feed to the regrinding tube mills, and the discharge from these mills.

Table "D" gives details of grinding media fed to both the primary and regrinding mills.

Table "E" gives the costs for sorting and crushing, tube milling, and the total reduction costs.

The outcome of the application of the methods of stage tube milling and "selective" grinding as described in the foregoing paper may be briefly summarized as follows:—

(1) An increased milling capacity at a proportionately lower cost due to a 5% increased output per tube at slightly reduced power consumption.

(2) An increased recovery of 7·45 pence per ton of ore treated.

THE GEOLOGY OF NORTHERN RHODESIA

(*Continued from the January issue, p.* 47.)

Geology of the Bwana M'Kubwa Mine.—The mine that bears this name is situated on the railway, 116 miles north of Broken Hill in latitude 13°S., with longitude 28° 45'E., and at an elevation of 4,395 ft. above sea-level. It was worked prior to the advent of the white man in Northern Rhodesia. When discovered, the richest central portion of the deposit was pitted with ancient excavations, and since then fragments of pottery and two round, flat stones, each pierced with a central hole, have been found buried in the detritus. These ancient workings were directed towards the removal of the rich malachite that occupied the upper portion of what is now known as the "Central Lode." In 1902 the mine was pegged in the name of the Rhodesia Copper Co., and work was started in 1903. By the end of 1903 four shafts had been sunk along the line of outcrop. The 250 ft. level was reached without encountering water. In 1905 the property was shut down to await the coming of the railway which, at that time, had only reached Broken Hill. Work was resumed in 1909, at the end of which year the railway arrived.

Until 1910, when the Bwana M'Kubwa Copper Mining Co. was formed to take over the property, only development work had been done, No. 3 Shaft having reached a depth of 350 ft. At the end of 1911 this shaft had reached its present depth of 520 ft. In 1912 a 90-ton concentrator was erected to treat high-grade ore stoped from the Central Lode. This mill was operated from January, 1913, until September, 1914, when operations were suspended because of the sudden drop in the price of copper at the outbreak of the Great War. Operations were resumed from June, 1916, to the end of March, 1918. During these two periods of activity the mill treated 69,374 long tons of crude ore assaying 10% copper as hoisted and before waste was sorted out. The concentrates were usually sent to the Falcon smelter in Southern Rhodesia, but during the war a certain tonnage was shipped to England.

By the above methods copper could only be produced with profit when the market price was abnormally high. It was early in February, 1922, that a new company was formed to acquire the assets of its predecessor, whose name is retained. The present open-cut method of mining by steam shovels was initiated by P. K. Horner in 1924, coincident with the beginning of the construction of the present plant for treating the ores. Since completion in April, 1926, the plant has undergone several important modifications, and is now treating about 1,000 tons of ore per day carrying an average of from 3 to 4% copper. The shovel pit is approximately in the centre of the area of 64 square miles within which the mining rights are owned by the company. According to present plan, this open-cut is to be carried down to water level, a depth of 270 ft.

General Geology.—The mineral area of 64 square miles lies on the south-western limb of a broad synclinal basin which is occupied by the Bwana M'Kubwa Series of copper-bearing rocks. Striking from south-east to north-west, this basin has been proved to have a length of over 75 miles, and has recently come to be known as the Mufulira syncline. At Bwana M'Kubwa the rocks within the broad basin have been folded, and the mine is situated on the south-western and vertical limb of a subsidiary

syncline which is known to have a width of at least a mile. The nose of this syncline lies about 2·7 miles south-east of the open pit.

The kopje, about 2,000 ft. in length, on which the mine is situated owes its existence to a group of dense white quartzite beds which are locally known as "the foot-wall quartzite." In part, for a thickness of 45 ft., they average 98% SiO_2. These quartzites and the overlying beds, including those containing the ore, strike N.70°W, parallel to the length of the pit, and dip vertically. Towards the south-eastern end of the pit, their dip is slightly overturned. At depths of 300 to 700 ft., however, these strata are dipping steeply toward the north-east, thus forming the steep and slightly overturned south-western limb of the syncline already referred to.

When facing the pit in front of the mine office, the vertical beds of the foot-wall quartzite, traversed by many joints, form an abrupt wall on the opposite side, while at depth they are dipping steeply towards the observer. Below the foot-wall quartzites is an at present unknown thickness of felspathic sandstones and quartzites, including two, and possibly three, beds of conglomerate and a few thin layers of shale which together comprise the basal beds of the Bwana M'Kubwa Series in this locality.

Above the foot-wall quartzites there follow in sequence :

(1) Sandstones or quartzites, 15 ft. thick, which at depth are slightly dolomitic, but from the surface downwards for a few hundred feet have weathered into loose sand.

(2) Dark grey felspathic quartzites exhibiting characteristic scattered grains of glassy quartz. These mineralized beds, up to about 60 ft. in width, comprise what is known as the "foot-wall ore-body." The dark colour of the rock is due to the presence of carbonaceous matter. The uppermost 10 to 15 ft. in thickness of these beds are somewhat lighter in colour, and either carry only low copper values or are barren.

(3) An impure banded dolomite, averaging 10 to 15 ft. in thickness, and much decomposed to a depth in excess of 500 ft. These beds are known as the "central lode," and they yielded the high-grade ore which was stoped out during the early history of the mine. Because of their relative solubility, which rendered them porous and open, they formed a very ready channel for the descent of oxygen-bearing waters from the surface, which played an important part in the re-arrangement of primary copper values to the development of the ore-bodies as they are now known. To the west of the shovel pit, this dolomite apparently becomes more sandy and grades into a sandstone.

(4) Quartzites of light to intermediate grey colour, which for a true thickness that varies from about 25 to 50 ft., are mineralized and are known as the "hanging wall ore-body." At depth the lower 8 or 10 ft. of these quartzites, resting on the central lode dolomite, are quite barren.

(5) Light to dark grey felspathic quartzites, including a few beds of argillaceous sandstones, which have a total true thickness of about 160 ft. In places these include two other hanging wall ore-bodies more or less lenticular and irregular in width. The foot-walls of these bodies are about 45 ft. and 100 ft. respectively above the top of the hanging wall ore-body. Locally, the lower attains 25 ft. in true width, and the upper about 10 ft.

(6) An at present unknown thickness of micaceous and talcose schists (originally shales) with some intercalated beds of felspathic quartzite. These soft micaceous schists or shales occupy the north-eastern part of the shovel pit.

As the south-eastern end of the open-cut is approached, the strike of the beds turns quite sharply towards the south-east. The underground workings have not been accessible for some years, but those in charge when the work was done were of the opinion that faulting had taken place at this bend of the strata. Whether a fault or merely a kink in the strike, or possibly both, there seems no doubt that this structure was developed prior to mineralization and has played an important part in admitting the mineralizing solutions which developed the ore-bodies. Adjacent to this bend the ore-bodies are relatively wide and high-grade, while towards and beyond the western end of the open-cut they terminate by fraying out and tapering.

From the surface to the present ground-water level, at a depth of 270 ft., the ore-bodies carry their copper values chiefly in the form of malachite, with valuable proportions of chrysocolla, cuprite, and tenorite. Grains of dioptase are of rare occurrence. Occasionally on joints, bedding places, and within drusy cavities small crystals of the dark blue copper phosphate, cornetite, have been found. This mineral is said to have been first recognized as a distinct species by M. J. Cornet in the "Etoile du Congo" copper mine in the Belgian Congo. Oxides of iron and of manganese, chiefly as hematite, limonite, pyrolusite, and psilomelane, are of common occurrence and blend in very intimate mixtures, especially with the copper oxides, cuprite and tenorite.

How far oxide copper minerals extend below the present water-table is, as yet, unknown. Some of the strata within these ore-bodies have been much more porous than others, while some, because of their fine-grained texture and mineralogical composition, have been relatively resistant to weathering processes. Moreover, there is no doubt that in the recent past this country was considerably more arid than now, and the water-table then stood at a lower level. It is no wonder, therefore, that there is no sharp line of demarcation between the zone in which the copper values are in the form of oxides, carbonate, silicate, and phosphate, and the underlying zone where they occur as sulphides.

The sulphides here present are chalcocite, bornite, covellite, chalcopyrite, and pyrite. In the foot-wall quartzites, the densest, hardest strata exposed in the pit, a few widely scattered grains of chalcopyrite may be found within a few feet of the surface. In some of the denser strata within the ore-bodies themselves, nests of irregular patches of chalcocite, bornite, and covellite are quite frequently encountered in the shovel pit. On the other hand, within the more porous and easily decomposed beds, malachite and other oxide copper minerals are known to predominate to depths in excess of 500 ft. The result of a recent diamond-drill hole which passed successively through four ore-bodies will suffice to illustrate the character of the mineralization. At depths of 250 to 290 ft. this hole passed through one of the subordinate hanging wall ore-bodies which occurs in fairly dense quartzite; with a true width 25 ft., this ore-body averaged 5·21% copper, of which 4·04% is present in the form of chalcocite and bornite and the other 1·17% as oxide copper minerals. From 405 to

483 ft. in depth, this hole passed through the hanging wall ore-body, which occurs within rocks less dense and more readily weathered; with a true width of 33 ft. this ore-body averaged 3·58% copper, of which only 1·32% occurs as disseminated chalcocite and the other 2·36% as oxide copper minerals. From 518 ft. to 529 ft. the much decomposed dolomite of the central lode was encountered, which, with a true width of 5 ft., averaged 4·52% copper, of which 4·11% is in the form of malachite and copper oxides. From 549 to 569 ft., the foot-wall ore-body was traversed, which, with a true width of only 8 ft., carried 2·56% copper, of which 2·46% occurs as bornite, chalcopyrite, and chalcocite, and 0·10% as malachite. From a width of 60 ft. in the shovel pit, this foot-wall ore-body has decreased with depth to 8 ft. in width, not because the width of the mineralized beds has diminished, but because disseminated secondary bornite and chalcocite have given way to scattered grains of primary chalcopyrite and pyrite.

The N'Changa Mine.—About 4,300 ft. above sea-level, N'Changa is 94 miles by motor road north-west from N'Dola or 17 miles south by road from Tchinsenda, the nearest railway station, which lies a few hundred yards within the Belgian Congo. The N'Changa Copper Mines, Ltd., here own a rectangular area, 3 miles in length and 1½ miles in width, with its longer axis trending approximately east and west. A small stream, 6 ft. or less in width and bordered by a grassy savannah or "dambo" up to 2,000 ft. wide, crosses the central portion of the area in a north-easterly direction.

General Geology.—More than three-fourths of this area of 4·5 square miles is occupied by a synclinal basin of sedimentary rocks belonging to the Bwana M'Kubwa Copper-bearing Series. The nose of this syncline lies in the vicinity of Luano, a few miles to the eastward. Varying from 6,000 to 8,000 ft. in width, the synclinal structure is in reality a lobe which protrudes toward the east from an extensive basin underlain by these rocks, which lies to the west of the N'Changa area and the boundaries of which are now being delimited for the first time. For example, recent mapping has shown that from the vicinity of the north-western corner of the N'Changa mineral area, the northerly limb of the "N'Changa syncline," turning first north-west and thence north, has been traced for over 4·5 miles. Within this distance low copper values have been found at the surface at several points within favourable beds.

In the north-eastern corner of the N'Changa mineral area, the sedimentary rocks of the Bwana M'Kubwa Series are resting unconformably on para-gneisses which, presumably, belong to the Basement Schists. To the southward, the country rises gradually to an area of several hundred square miles, which is underlain by a batholith of massive, pink to reddish, granite. The northern periphery of this body of granite, which is believed to be intrusive into the Bwana M'Kubwa Copper-bearing Series of rocks, transgresses the southern boundary of the N'Changa area. In places, a few scattered grains of chalcopyrite have been observed on fresh fractures of the granite within a few inches of the surface. Small dykes and stringers of pegmatite and veins of quartz, similar to those which locally cut this granite, frequently traverse the best mineralized portions of the ore-bearing beds within the N'Changa syncline.

The northern and southern limbs of the syncline are locally referred to as the "River Lode" and the "Dambo Lode" respectively. On the River Lode side, the dips are steep to vertical, and in places are overturned. Along the Dambo Lode limb, the dips average 25° to 30°. It was in 1923 that traces of copper were first found by prospectors of the Rhodesian Congo Border Concession within a small outcrop on the River Lode side of the syncline. It was towards the close of 1924 that trenching and potholing located copper-bearing strata on the Dambo Lode limb. Since then, diamond-drilling, corroborated by preliminary mining operations, have revealed the presence of large tonnages of ore in which the copper values are, in major part, in the form of "oxide" copper minerals and the remainder as sulphides.

Within this area the Bwana M'Kubwa Series includes the following sequence of strata :—

(1) At the base of the series on the River Lode limb there is 1,500 ft. or more in thickness of much altered felspathic sandstones or arkose, some beds of which contain an abundance of pebbles and boulders. These conglomeratic beds apparently have no equivalent at the base of the series on the Dambo Lode limb.

(2) Basal felspathic sandstones and quartzites, known to vary from 225 to 500 ft. in thickness.

(3) Sandy micaceous shales or biotite schists and a few intercalated beds of sandstone, with a total thickness of about 80 ft. On the River Lode side, towards the top of this group of strata, at least for considerable distances along the strike, is a bed of conglomerate a few feet in thickness.

(4) Lower banded shales, varying from 20 to 80 ft. in thickness.

(5) Sandstones and quartzites with intercalated layers of micaceous schists or shales, from 25 to 85 ft. in thickness.

(6) Felspathic quartzites varying from 40 to 75 ft. in thickness.

(7) Upper banded shales, up to 70 ft. thick.

(8) Dolomitic schists which towards their top include some layers of sandstones and micaceous shales, with a total thickness in excess of 1,000 ft.

Many of the strata within the N'Changa syncline are saturated with water. Several of the diamond-drill holes have encountered heavy flows of artesian water.

The Ore-Bodies.—The "ore-bearing horizon" along the River Lode limb involves (4) the lower banded shales with (3) the underlying biotite schists which include a few beds of sandstones. What are believed to be these same beds, or their equivalent, on the Dambo Lode limb have proved to be barren.

It is the felspathic quartzites (6) which, on the Dambo Lode side of the syncline, are most uniformly mineralized to commercial grade. Here also the lower portions of the upper banded shales (7) are quite universally copper-bearing, and in many places important thicknesses of the sandstones, quartzites, and interbedded schists (5) immediately underlying the felspathic quartzites are mineralized.

On the River Lode limb, within a length of strike characterized by subsidiary folding of the strata and local crumpling of the lower banded shales and underlying biotite schists, an ore-body, with a maximum width of 125 ft. and a length of about 1,000 ft. has been proved by three levels, established at depths of 50 ft., 150 ft., and 300 ft. On the 50 ft. level there has been some leaching of copper values, and yet, with an average width of 69 ft., the ore-

body here carries 3·31% copper chiefly in the form of "oxide" copper minerals and with very little sulphide. On the 150 ft. level, chalcocite, bornite, and chalcopyrite are more in evidence, and the ore-body, with an average width of about 70 ft., carries between 4·5 and 5% of copper. On the 300 ft. level the average width of about 70 ft. is maintained, with an average content of between 4 and 4·5% copper, of which only a fraction of 1% is in the form of "oxide" copper minerals. Recently, two inclined diamond-drill holes from the 300 ft. level show that the average copper content does not diminish to a vertical depth of 600 ft. from the surface. The deeper of these holes, inclined 54°, penetrated ore from 305 ft. to 395 ft. in depth, averaging 4·79% total copper, of which 4·65% is in the form of sulphides, chalcocite, bornite, and chalcopyrite. Shaft No. 9, sunk within the massive beds of the footwall felspathic sandstones, gives access to the 300 ft. level. From this shaft it is approximately 275 ft. to the foot-wall of the lode. The mineralized beds are here biotite schists (with an included bed of conglomerate), and the lower banded shales with dips that are practically vertical, but in places are slightly overturned.

Along the Dambo Lode limb of the syncline exploration to January, 1929, has resulted in the discovery of two ore-bodies, each of which occupy areas within which important drag-folding was developed within the ore-bearing beds prior to their mineralization. In the central southern portion of the area, one of these ore-bodies, known as the "Dambo Lode," with a maximum known length of about 2,500 ft. along the strike, has been proved by drilling to a vertical depth of 870 ft. With an average dip of 25°, and a true thickness of about 50 ft., this ore-body averages 3·74% copper, of which about 1·30% is in the form of sulphides and 2·44% as "oxide" copper minerals, chiefly malachite and azurite, with small amounts of chrysocolla, cuprite, and tenorite. Between vertical depths of 795 and 820 ft., one of the deepest drill holes penetrated ore carrying 2·2% copper, of which 1·8% is in the form of sulphides. Another drill hole traversing the ore-bearing beds at a vertical depth of from 935 to 1,040 ft., found them to carry less than 1% of copper as sparsely disseminated chalcopyrite. To check up drilling results on the "Dambo Lode," and to provide bulk samples of the ore for metallurgical tests, two inclined shafts followed the ore horizon downward for 600 ft., and at this depth a level was developed.

Westward from the Dambo Lode some trenching and potholing done in 1924 located copper values in felspathic quartzite. In the ill-founded belief that this occurrence, which has come to be known locally as the "New Discovery," was merely a loose boulder of ore, no further work was then done. During 1928 diamond-drilling has been progressing in this area. To January, 1929, an ore-body with a length of at least 6,500 ft. along the strike has been proved to a depth of over 800 ft. This ore-body has been shown to extend for 1,500 ft. or more across the western boundary of the N'Changa mineral area into ground held by the Rhodesian Congo Border Concession, Ltd. Seven diamond-drill holes have shown the ore-body to have an average true width of 85 to 90 ft., with an average copper content of 3·51%, of which 0·77% is in the form of sulphides. From 735 to 830 ft. in vertical depth, the deepest of these holes penetrated ore averaging 2·93% copper, of which 0·58% occurs as sulphides.

(*To be concluded.*)

BUCKET DREDGE PRACTICE IN MALAYA

A second paper for discussion at the December meeting of the Institution was by E. J. Vallentine, who gave some notes on Malayan bucket dredges. The discussion on the evening of presentation mainly centred on the question of suction-cutter *versus* bucket. A summary of Mr. Vallentine's paper is given here.

The author says that the Cooley type of jig is now generally accepted as having supplanted the sluice-box for tin-ore recovery on dredges where either method of treatment might be adopted.

On many dredges the bow or digging end can overload the stern or treatment end at will, whereas the reverse is much more desirable. It is hard to find a dredge where the stoppage of one roughing jig does not cause an appreciable loss in recovery due to overloading the others. Two roughing jigs more than are estimated to be sufficient should be provided. The cost of these jigs and the extra few feet of deck space, with another foot of height for the top tumbler, does not entail much outlay, and the operator could dig to full capacity with the assurance that he was still getting a full recovery of tin-ore.

Regarding clean-up jigs it is preferable to have two, in order that concentrates from the lower hutch or hutches can be freely returned and treated again without any risk of overloading. The extra jig justifies itself when rich ground is being treated.

Some designers favour raising the top tumbler, the screen, and the roughing jigs, high enough to provide a gravity flow of concentrates from the roughing to the clean-up jigs. This adds considerably to the cost of the dredge, but it has the advantage that the tailings launders are so high above pond-level that the disposal of treated ground is made easy. The minimum height above deck-level at which the top tumbler can be placed, so that the tailings discharge is still high enough for adequate disposal, is a most important factor in lessening the cost of a dredge. Therefore a design which provides a pump or other means of elevating concentrates from the roughing to the clean-up jigs is probably chosen. Frenier pumps, although they occupy a large deck space and have a relatively small capacity, seem to be well adapted for this particular purpose.

Cooley jigs require beds of "ragging" on top of the screens. Some authorities say the ragging should be of the same specific gravity as the mineral which has to be saved. A ragging bed made up of sized particles of tin-ore, however, is not satisfactory. Hard haematite makes a suitable ragging bed, which traps and passes down the tin-ore and associated minerals whilst shutting out the lighter sands once the correct plunger stroke and speed have been determined. When starting up a new jig dredge, several tons of haematite all broken up

into pieces from $\frac{3}{4}$ in. to $\frac{3}{16}$ in. in diameter, are required. The initial order should not be less than 50 lb. per sq. ft. of screen area. A preliminary treatment of "rumbling" should be given for at least two hours, in a cylinder about 4 ft. in diameter, revolving at about 25 rev. per min., which rounds the corners off the particles and ensures an efficient bed from the start. The bed is usually made about $2\frac{1}{2}$ in. deep and is kept in position by cross-bars in the frame which holds down the screen. Selected round particles, all of which should pass through a $\frac{3}{8}$ in. sieve, are used for forming the bed of a clean-up jig. About 34 lb. of sized ragging per sq. ft. of screen area are required.

It is customary to speed roughing jigs at about 110 rev. per min., and clean-up jigs at 190 rev. per min., the lengths of stroke being then adjusted to give the best service. Where roughing jigs are heavily loaded the speed can be increased to advantage. After making an alteration to the stroke it takes a jig considerable time to settle down and stabilize its operation.

Much discussion has taken place about the type of screen that should be used. However, it is now being realized that the ragging bed is the most important factor, and that the function of the screen is to support the ragging while containing sufficient apertures to let the pulse come through freely and the trapped tin-ore to pass down to the hutch. A common size of screen aperture is $\frac{1}{2}$ in. by $\frac{1}{4}$ in. Some coarse ore which may be retained on the screen will be periodically cleaned out of the ragging. The screening on the roughing and clean-up jigs should usually have the same size of aperture. Crimped wire mesh of, say, 12 S.W.G. gives a larger percentage of aperture than punched steel plate, with equally good wear and stiffness against "breathing," but the punched plate is more commonly used.

Roughing jigs have either three or four cells or compartments, each of which has a separate screen, plunger, and hutch. The cells are generally 3 ft. wide by 4 ft. in length, but the screens are not arranged in horizontal steps, as the jig-bed is given one continuous slope of 1 in 16 throughout its length. The dredge type of Cooley jig is therefore somewhat different from its dry-land parent, and is really a form of a sluice-box with a pulsing action and a porous bottom. Three cells are enough if the jig is carefully adjusted, but clean-up jigs should have at least four cells so as to safeguard against loss. Not only the tin-ore but the black sand is sent ashore for final treatment. Where there is much black sand a magnetic separator in the dressing shed is advisable. Passing the ore through vibrating or shaking screens so as to give three grades (coarse, medium, and fine) makes it much easier to dress afterwards.

With regard to other dredge details, the main gear is usually driven by a pulley on the first motion shaft, which is engaged by a friction clutch. It is an important unit, which is subjected to sudden strains and which should have an ample margin of safety. A double drive through gear wheels on both ends of the top tumbler-shaft is now standard practice on all large dredges. With careful fitting the load is equally distributed.

Built-up tumblers, screen roller paths, and so on, have been introduced, but many of them cause more loss of running time than can be offset by any saving in material. A reversion to simplicity has set in, however, and solid bottom tumblers, ladder rollers, and screen roller paths are becoming more common. It is true that the top tumbler, which is established as a hexagonal cast steel boss with manganese steel wearing plates on tread and flanges, is of a standard type which has been proved to give satisfactory service. Bottom tumblers are now invariably circular. British founders seem reluctant to cast one of solid manganese steel, but will supply one of high-carbon steel, with manganese steel wearing plates. Wearing plates on the tread are generally unsatisfactory, as they elongate and break their fastenings. A solid high-carbon steel tread 3 in. or more in thickness should give a reasonable period of service before it wears too thin. The wearing plates on the flanges usually give little trouble. They should be riveted on, not bolted. However, a solid manganese steel bottom tumbler which would give several years of service with a minimum amount of attention would be welcomed.

Although Malayan dredging ground is generally easy to dig, it contains a large proportion of hard sharp sand, and the bottom tumbler bearings therefore require to be protected by strong, well-packed glands with no projecting outside parts which might be displaced by a knock from a piece of timber. This point has not received sufficient attention. The bearings are almost always under water and out of sight, and a few hours' run, with sand having free admission, causes considerable damage. The common practice of protecting the bearing with a piece of belting held in position by half-circle clamps with projecting lugs is too crude.

White metal or gun-metal bearings are generally provided, but the American practice of cast-iron bearings is more sensible. A bottom tumbler revolves at such a slow speed that an anti-friction metal is not necessary. Cast-iron gives good wear, and is cheaper, while it can be usually renewed locally. In order to guard against cracking it is customary to make these bearings at least an inch thick, with a driving outside fit. Deep grease grooves are essential.

A hollow shaft, with a substantial gas-threaded tie bolt to hold the horns of the ladder together, is good practice. A wearing plate on the end-plate of the ladder which faces the bottom tumbler is advisable.

Solid ladder rollers of chilled cast-iron keyed on to shafts of ample diameter are now generally preferred to built-up rollers with wedged-on cast-iron wearing spools, but the bearings are still not sufficiently protected. Good grit-excluding glands with no projecting parts should be standard, especially for the two or three bottom rollers which get the hardest service. The roller nearest the top tumbler is sometimes subject to a threshing action from the bucket band when the ladder is at such an angle that its upper end is not quite in line with the top tumbler, owing to the position of the pivot shaft. American practice is to make this roller extra strong, with a larger shaft, and British designers might well follow suit. The roller nearest the bottom tumbler should also be strengthened, possibly by making it of steel. Ladder hangers should always be linked, as rigid hangers are almost certain to get bent.

The built-up bucket is a thing of the past, and they are now generally cast in manganese steel. Most British types do not provide sufficient flare or positive cutting edge on the curve of the lip, which throws extra strain on the bow lines. The

outer edges of the lips are usually chamfered or sharpened up, which seems useless and wasteful, being an unnecessary anticipation of the wear that must occur on square-edged lips. The rivets on the cutting corners should be countersunk or at least half countersunk on the outside, as projecting heads get worn away very quickly. Sometimes on a hard irregular bottom they are worn off in a few weeks.

Buckets specially designed for tipping clay can be obtained, but as most properties contain some clay, it would be easier to standardize on a shape which will tip clay and which at the same time will have the strength to stand up to hard digging. In close-connected bands two small guiding vanes cast on the back of each bucket would tend to focus tipping and lessen side-spill.

There are special circumstances, such as where large boulders have to be dredged, when an open-connected bucket band with trays may be suitable. Trays are a distinct advance on the old open links, and can bring up an appreciable amount of extra ground, while the tipping is also cleaner, but there is no doubt that in ordinary ground the tray should be looked upon as a "passenger" which ought to give place to a working bucket.

The fixed drop-chute answers very well for an open-connected band, but many dredges with close-connected bands are now equipped with drop-chutes hinged to the ladder so that the position of reception is adjusted to the angle of digging. With a dredging depth of 60 ft. or over, an idler wheel at the back of the well is advisable. When digging in heavy ground at shallow depths, as the dredge moves along the face the slack of the bucket band may be forced hard against the bottom edge of the well and cut into the plating. Chafing beams along the bottom of the well in addition to those usually provided would minimize this danger, which is much more real than one might imagine and can result in the sinking of a dredge.

Regarding bushes and pins, the half bush, left short in length to allow for "flow," is the usual modern practice, while alternate right-and-left-hand pins with "L" heads or lugs are standard. Countersunk bolts are almost invariably provided for keeping the pins in place, but hardly anyone troubles to use them. Lugs with keys are a constant worry, as the keys will not stay tight and consequently drop into the pond. The most recent practice is to provide lugs which are made to fit the recesses in the buckets and which can be tightened up when necessary by inserting a thin liner before driving the pin home. Once a pin becomes worn and develops a "shoulder" it usually stays in place. Pins are commonly made of chrome steel, as manganese steel has sometimes proved unreliable in pins of large diameter.

In many cases the diameter of the screen is too small, while the percentage area of aperture in the perforated part is much less than it should be. This is partly due to the modern practice of making the screen with inside wearing plates which line an outer shell. The outer shell is usually perforated with $\frac{3}{4}$ in. holes which coincide with $\frac{5}{8}$ in. or $\frac{1}{2}$ in. holes in the wearing plates; but it is obvious that if one shell only be adopted the percentage of aperture can be considerably increased without unduly weakening the plating. In recent American practice the perforated plates are fastened direct to a substantial skeleton frame, which permits of these closer apertures.

The modern tendency is to increase the diameter of the screen, and this would seem to be a move in the right direction. A customary slope on British screens is 1 in 12, but American screens are usually set steeper, with slopes up to 1 in 8. It is a common practice to bolt on retarding angle plates, so as to turn over the spoil and assist disintegration, but one cannot do much of that on a flat slope without overloading the screen. It must be remembered that a heavily loaded screen needs a lot of extra power to turn it, and on electrically-driven dredges the motors provided are often too small to stand much overloading.

The customary screen drive is by means of a friction roller driven through bevel gears, which engages from below a cast-steel path centred by trunnions and bolted on to the screen frame at its upper end. A similar path at the bottom end rests on trunnions and is engaged by a thrust roller. Some attempts have been made to provide wearing plates on the roller paths, but they are usually unsatisfactory. The best practice would seem to be solid cast-steel paths, with plenty of wearing material.

The delivery of the screened product to the roughing jigs, so as to ensure an equal distribution of feed, is another important point about which no finality of design has been established. One should aim at getting this effect with the last possible loss of head. A series of doors, operated by levers, which are placed at intervals in the bottom of the screen housing so as to release the discharge at points opposite the jig-intakes is customary. On a recently constructed dredge a form of distribution is provided which would seem to mark an advance. Boil boxes are placed under the discharge doors so as to prevent wear. The overflow from these boxes runs down an inclined table on each side, above which are wash-water cocks, and drops into launders running parallel with the jig intakes. Sliding doors at each intake regulate the feed to each jig.

The stone-chute which dumps the oversize spoil from the screen overboard is nearly always set too flat to discharge freely when any clay is encountered. The easiest way to deal with sticky clay is by means of a stacker or belt conveyor discharging at least 50 ft. beyond the stern. The stacker should receive the clay down a short slope of at least 1 in 2.

In the dumping of jig tailings it seems to be generally considered that sand chutes discharging, say, 40 ft. behind the stern need not be higher than 6 feet above the pond level. This may answer well enough where the bottom is level and no height of bank has to be carried, but cases occur where another 2 ft. or so of height in the discharge would make working conditions much easier. As a general rule the operator prefers tailings-discharge chutes to be kept as high above pond-level as is consistent with reason in the design. A grade of 1 in 16 in tailings launders is sufficient to maintain a free flow. The discharge lip of the stone-chute should never be higher than the tailings launders, as stones or clay may be piled up in heaps so high that they can damage the launders when the dredge swings round. This trouble is hard to avoid while running at night.

With regard to the service pumps, the pond water usually contains much grass, roots, wood, and other vegetable matter which ought to be prevented from reaching the suction pipes. A pipe placed along the top of the straining box provided

with jets which spray water on the surface of the pond with some pressure keeps practically all the floating material away from the screen. The loss of running time on account of pump stoppages is often a considerable item, and much of it is caused by ineffective straining of the water supply.

Manœuvring winches are now usually made with a central train of gear-wheels, the various drums being actuated at will by friction clutches. On electrically-driven winches it is advisable to provide two speeds, as there are occasions when the normal speed of 18 ft. to 20 ft. per minute is much too slow for some particular duty. The drums are generally on the small side, and would be preferred with more rope accommodation.

Sheaf pulleys in fairleads are frequently too light to stand much hard wear and should have more metal round the base of the sheaf, which could be provided at a negligible extra cost. Again, fairleads which have to withstand vertical strains are sometimes insufficiently fastened down to the deck and may be pulled adrift by vigorous winching. The average Asiatic winchman gives his gear occasional tests of a severity not contemplated by the designer or builder.

On several deep-digging dredges with large buckets the ladder hoist winch is somewhat underpowered and takes an inconveniently long time to lift the ladder, the more so as many operators prefer to keep the buckets turning while hoisting, which consumes extra power although it may be a safe practice.

Wilkinson process rubber-sheeting has proved itself much more durable than metal for lining tailings launders. In a thicker form it is also suitable for stone-chutes where rounded boulders are discharged, but it is liable to be cut and damaged by heavy sharp angular rocks. Raw plantation crepe rubber is also used in tailings chutes and gives satisfactory service.

MANGANESE DEPOSITS ON THE GOLD COAST

At the January meeting of the Institution a paper entitled "A contribution to the Geology of the Manganese Ore-deposits in the Gold Coast Colony and in Ashanti," by Messrs. D. W. Bishopp and W. J. Hughes, was introduced by Mr. J. Allen Howe.

The authors after giving a bibliography of the relevant literature, proceeded to outline the principal geological features of the Colony. As a statement of the latest views, contained in Bulletin No. 2 of the Gold Coast Geological Survey, was given in our October issue, it will be unnecessary here to deal further with this aspect of the work.

The local geology of the Insuta area was next described. This country lies immediately east of the Sekondi-Kumasi railway, and north of the Bonsa river, and except for a few clearings beside the railway, and at Insuta Mine, the land is covered by thick tropical forest. The valley floors are at an average elevation of 250 ft. above sea-level, while the hills rarely exceed 600 ft. Looking eastward from the Insuta heights over a sea of forest, the view suggests a multitude of isolated hills scattered above the landscape, without reference to any particular scheme of topography. Actually, however, there is a well-defined valley and hill-range relief, which is in close agreement with the geological structure of the area. This is best described as a system of successive belts of formations, which are roughly parallel, and trend north-east.

These belts are tabulated below in succession from west to east; the characteristic rocks and the maximum outcrop width of each formation are set forth, together with the topographic features to which they correspond.

The Insuta-Dagwin deposits of manganese are located on the Insuta belt which is composed mainly of manganese- and iron-bearing phyllites and clay-slates, associated with narrow intrusions of porphyry and porphyrite. Concentrations of manganese in this belt invariably occur either at its junction with intrusive porphyry of the Kawere group or in masses of phyllite trapped between two intrusions. There is a recurrence of manganese- and iron-bearing phyllites and clay-slates in the Asikuma belt.

Description of the Manganese Ore-Deposits. —(*a*) *Enrichment of Phyllite.*—The manganiferous phyllite represents a stage in the metamorphism of an argillaceous sediment which contained manganese, almost certainly in the form of oxide. The manganese content of the phyllite now exposed at the surface is greater or less than the original primary content, according as to whether it has been enriched or impoverished by secondary processes. At Insuta there are one or two exposures of decayed phyllite from which practically all the manganese has been removed; but as a rule, the body of phyllite above the water-table is enriched. The process apparently operates in two ways:

(1) Concentration takes place, by the removal in solution of iron, silica, alumina, and other components of the rock, and re-precipitation of manganese, practically *in situ*. This may be termed "differential enrichment."

(2) Concentration takes place by the precipitation, on a suitable surface, of manganese derived from a higher level in the deposit. This may be termed "additive enrichment."

Hence a body of enriched phyllite contains all or nearly all of its primary manganese, *plus* a certain amount derived from a considerable original upward extension of the phyllite; but not all the

The Formations of the Insuta Area

Name of Belt.	*Characteristic Rocks.*	*Max. Width, Miles.*	*Topography.*
(*a*) Kawere	Grits and extrusives	1·25	Kawere Valley.
(*b*) Insuta	Manganiferous sediments	0·60	Insuta-Besease range of hills.
(*c*) Tarkwa-Banso	Grits and extrusives	0·80	Broad depression of Tarkwa-Banso.
(*d*) Asikuma	Manganiferous sediments	0·80	Asikuma-Odumase (local) range of hills.
(*e*) Aiyinasi	Amphibolites	1·40	Western slopes of Bonsawere Valley.
(*f*) Achobuana	Ferriferous sediments	3·00	Well-marked range of hills on the west of the belt, with broken, hilly country to the east.

manganese of that denuded extension is retained in the rock at lower levels. Much, possibly most of it, is carried outside the body of phyllite in solutions which contribute to the growth of detrital ore. It is of interest to note that no manganese oxide was found replacing the porphyry. On the whole, differential enrichment tends to produce a body of manganese oxides which retain definite structural characteristics of the original phyllite; while additive enrichment, being a later effect, tends to obliterate the structural features, and to produce a massive, compact body of ore. This view is supported by the fact that, while massive ore is found adjacent to faults, where circulation of solutions is fairly free, ore of a similar grade, but retaining the structural characteristics of the phyllite, is found farther away from faults, where permeating solutions meet with more obstruction.

From the foregoing considerations, it will be gathered that there are all types of transition from unenriched phyllite to massive high-grade ore, the final product of enrichment. All deposits other than detrital deposits of manganese ore in the area under review may therefore be regarded as members of a series of enrichment products of phyllite. They are referred to hereafter as concentrations.

(*b*) *Loci of concentration.*—The typical locus of concentration is the phyllite-porphyry-contact. The phyllite is enriched in zones of varying width, everywhere along such contacts. Where a slab of phyllite is sandwiched between two porphyry intrusions, enrichment proceeds from both contacts. As a rule, however, the concentration at the contact alone is not sufficiently high to be taken as ore. Ore-bodies are found at the intersections of contacts and faults; thus, faults determine the loci of most intense concentration. On the Asikuma belt, and north-east of Insuta on the Insuta belt, the ore-bodies are small, and are developed along one contact from its intersection by a fault. The common form of the ore-body, in plan, is a wedge, based on a fault, and tapering out along the contact. Generally, the ore on the north side of the fault is much richer in iron. The Asikuma occurrence is typical of this class of ore-bodies. On the other hand, the huge ore-bodies of the Insuta and Dagwin hills appear to be due to the enrichment of blocks of phyllite set among the branching arms of a great porphyry intrusion. Several powerful faults cut across the phyllite-porphyry complex and determine the lengths of the blocks. Each block forms a well-defined hill—and the displacement due to the faults is reflected in the staggered or *echelon* arrangement of these hills along the strike of the phyllites. The ridge of hills known as E and D on the mine, is separated from that of hill C by a deep narrow valley carved along the outcrop of a porphyry intrusion. Another great porphyry band outcrops on the lower western slopes of hill D.

(*c*) *Lower limits of concentration.*—The usual experience when sinking in ore-bodies at Asikuma, Dixcove, and places outside Insuta, was that the ore-body tapered out towards the water-table and merged into enriched phyllite of a grade that would not be classed as ore. The depth of an ore-body appears therefore to be determined largely by the relief.

It may be mentioned here that certain siliceous manganese ores were found occupying fissures in the Dixcove area. At Asikuma, siliceous ore also abuts on a fault. There is no information as to the vertical range of these concentrations, nor is it known whether the silica was deposited from ascending or descending solutions. The possibility of concentration by hydrothermal processes cannot be ignored in this connexion.

(*d*) *Detrital Ore.*—Detrital ore is developed in the red earth which covers the hill slopes. The bulk of it has been shed from the outcrops of ore-bodies. Large boulders are frequently found down the slope, immediately below an existing ore-body; others mark the approximate position of a lens of ore, the rate of downward growth of which was exceeded by the rate of denudation of the softer ground around it. In size, the detrital fragments vary from that of a grain of barley to boulders of several cubic feet. All the fragmentary material tends to assume rounded forms.

This is due to the modifying action of solutions circulating in the blanket of red earth. Water is abundantly provided, not only by the heavy seasonal rainfall, but by nightly condensation from the humid atmosphere, with alternate evaporation by day. There is continual solution and re-deposition of manganese oxide, and, no doubt, much of the manganese oxide, derived from destruction of phyllite extending above it, is deposited on the shed fragments. The amount of pisolitic ore formed in a similar manner, by deposition of manganese oxide round suitable nuclei, is considerable.

The unconsolidated ore, found in the upper parts of the huge ore-bodies at Insuta may be considered here, although it is not strictly detrital in character. It has been stated that differential enrichment of the phyllite results in the formation of ore retaining the structural features of the original rock. This "pattern ore" is sometimes very porous or cellular, with the walls of the spaces conforming in pattern to the system of joints in the original phyllite. Such ore is found in the heart of an ore-body, well away from faults. The continuous abstraction of minerals, other than manganese oxide, from the body of a hill, during weathering processes, results in a gradual subsidence, in which any cellular ore involved is crushed. Such is probably the origin of the friable ore found in the bodies of hills E and D. The veins of "sand" (angular quartz grains) running through them, represent crushed quartz terminals of pegmatite veins, or possibly, in some cases, the residual quartz granules of a vein of porphyry. The tendency is always for the crushed ore to become cemented by fresh material deposited from descending solutions. Judging, however, from the great thickness of detrital ore capping the ridge, coalescence of the fragments is not always completed; and as the land surface is lowered by denudation, these fall automatically within the zone of true talus. Actually, of course, there is no line of demarcation between ore-body and detrital. The angular fragments of the ore-body, which have a sugar-like fracture surface, merge by imperceptible gradations into pisolitic detrital of the capping. Where several fragments have coalesced, irregular lumps of concretionary detrital result. The principal minerals are the oxides, psilomelane and pyrolusite, which take various forms, such as stalactitic, botryoidal, reniform, and reticulate, according to the modes of solution and re-deposition that have been at work upon them. Manganite and polianite are also found.

The authors then consider in some detail the processes involved in the concentration of manganese oxides. They deal with the formation of laterites, the action of bacteria, the action of the porphyry

intrusions, and the solution of manganese, iron, silica, and alumina. These considerations have led the authors to the conclusions stated above, and they conclude by saying that while manganese ore-deposits are widely distributed in the colony, only one has attained great pre-eminence, and this is due to a fortunate combination of several operating factors, each of which tends to concentrate oxides of manganese. These factors are :

(1) The purely geometrical packing of manganiferous strata by shear-stress and folding under earth-movement.

(2) The intrusion of a particular type of porphyry into the manganiferous beds, involving metasomatic and prophylitic action. This has modified the beds both chemically and mechanically; in the first case by the introduction of carbon-dioxide and pyrite; in the latter, by rendering them more porous near the contracts with the intrusions. The possibility of concentration by hydro-thermal action at this stage has been suggested.

(3) The occurrence of transverse faults and shatter-lines, which give the same mechanical effects as the porphyries.

(4) The circulation of atmospheric carbon-dioxide in water, in a tropical forest covering the terrain.

(5) The liberation, by weathering, of sulphuric acid from pyrite already introduced into the rocks.

The same factors are of course operative in the concentration of other minerals, and some of them may certainly be held responsible for the formation of economic deposits of iron ores and bauxite in West Africa.

In view of the wide-spread occurrence of gold in the country under review it is considered that manganese may have influenced the concentration of gold during the comparatively recent peneplanation of the Gold Coast and Ashanti.

Influence of Wolfram on Tin-Slags.—The influence of wolfram on the "combined tin" content of tin-slags was discussed by Messrs. K. V. Christie and E. O. Jones in a paper presented at the January meeting of the Institution of Mining and Metallurgy.

The authors pointed out that although the tin-stone as mined is invariably water-concentrated before smelting only the lighter gangue is removed, and a considerable proportion of the heavier impurities (pyrite, ilmenite, wolfram, scheelite, etc.) remains in the resulting concentrate. The nature and amount of the impurity remaining will clearly effect the efficiency and cost of the smelting process, a fact well recognized by tin smelters who purchase their ores on schedules which include penalties for undesirable constituents. According to Thibault the chief impurity associated with cassiterite, and the one causing most trouble metallurgically, is wolfram. Dyson has also made the observation that among admixtures frequently occurring with tin ores, tungsten ores are the most important, since not only do they provide a source of that element, but, in addition, they have to be removed from the smelter ore if the finest quality and *highest yield* of tin is to be obtained.

The following schedule of penalties which was drawn up by a tin-smelting company in Malaya indicates the extent to which the presence of tungstic oxide in the smelter concentrate was considered to react unfavourably on the smelting process, and how this adverse effect was charged for.

Schedule of Penalties for Tungsten Content.

Tungstic Oxide in Concentrate.	Units Tin deducted from Tin Assay Value.
0·0 — 0·49%	0·0 units
0·5 — 0·99%	0·3 ,,
1·0 — 1·49%	0·5 ,,
1·5 — 1·99%	0·75 ,,
2·0 — 2·99%	1·0 ,,
3·0 — 3·99%	1·5 ,,

Penalties ceased on reaching 4% of tungstic oxide, as it was considered that material of this or higher tenor would be able to bear the cost of a magnetic-separation treatment yielding both tin and wolfram concentrates.

Although, as has been shown, the presence of tungstic oxide in tin concentrates is considered undesirable, the authors were unable to find any references to a study of the influence of this oxide on the smelting process. It was decided to try to determine whether the presence of tungstic oxide was detrimental because (*a*) it was partially reduced, and contaminated the resulting tin; or (*b*) its presence favoured the passage of tin into the slag; or (*c*) wolfram-bearing slags required a higher working temperature and/or had a higher viscosity.

The smelting process is influenced by such factors as (*a*) basicity of the charge, (*b*) chemical nature and proportions of the respective basic and acid constituents, (*c*) proportion and character of the reducing agent, (*d*) temperature attained and rate of heating. There are thus many variables to consider, and an extended investigation was necessary to take into consideration all the factors. It was decided to confine the research to a set of conditions in which the only variable would be the ratio of silica to tungstic oxide in the charge, and to study, more particularly, the effect of increasing the tungstic oxide content on the tin content of the resulting slag. Accordingly, a standard charge was decided upon and a series of experiments performed in which the only variable was the ratio $SiO_2 : WO_3$.

From a consideration of known data it was decided to use a mixture of 10 parts SnO_2, 11·75 parts SiO_2, 16 parts FeO, 7·5 parts CaO, and 2 parts of C as the standard charge. These constituents were introduced into the charge in the forms of pure stannic oxide, silver sand, reputedly pure siderite, crushed marble, and powder charcoal respectively. Several experimental runs were made in order to fix the operating conditions so as to obtain reproducible slags, and as a result of this preliminary work the following modifications were made.

(1) The reputedly pure siderite which had been used as the source of FeO was replaced by the oxide which was prepared from ferrous oxalate.

(2) The crushed marble was calcined before use.

(3) The proportion of carbon was cut down to 1·5 parts.

The procedure finally adopted as standard was as follows: The charge components—stannic oxide, ferrous oxide, quicklime, sand, tungstic oxide, and charcoal in powder form, were weighed out in the required proportion, thoroughly well mixed by shaking in a wide-mouth stoppered bottle, and transferred to a No. 3 Morgan crucible. In the meanwhile an injector furnace had been heating up, the gas being full on and the air supply adjusted until only a small flame emerged from the port in the lid. In this way the maximum rate of heating consistent with a non-oxidizing atmosphere within

the furnace was obtained. Heating curves for different runs were taken and proved sufficiently similar to render the different experiments comparable. Temperatures were taken by means of a disappearing filament pyrometer which was sighted on to the image of the crucible and furnace interior in a mirror placed at a suitable angle about two feet above the furnace. When the melt had become quiet the furnace was shut down and the charge poured. The metal and slags were then examined and assayed.

The experimental results obtained offered several points of interest, and the following inferences would appear to be permissible.

(1) Increasing replacement of silica in the charge by tungstic acid results in an increased loss of tin in the combined form.

(2) The increase in the tungstic acid content of the slag brings about a noticeable increase in the slag viscosity.

(3) Assuming that commercial slags are not dissimilar in their behaviour from the type slag taken, the practice of penalizing wolfram-bearing concentrate is justified, both on the grounds of the increase in combined tin content of the primary slag and the increase in the prill tin content which will follow from the increased viscosity of the slag. It is recognized that further work using types of slags covering the whole range of commercial slags is desirable to test the assumption with which this inference opens.

(4) The purity of the resulting tin suggests that under the experimental conditions tungstic oxide is not reduced to metal.

(5) The slag analyses show that the combined tin is in the form of stannous oxide, which is in agreement with Louis' statement that stannic silicates do not exist. It is also strong presumptive evidence for the opinion that the reduction of stannic oxide takes place in two stages:

$$SnO_2 \rightarrow SnO \rightarrow Sn.$$

(6) The fact that when a suitable proportion of reducing agent is used the tin button is substantially free from iron, although the slag contains upwards of 30% FeO, points either to: (*a*) the affinity of ferrous oxide for silica is greater than the affinity of stannous oxide for silica, or (*b*) the rate of reduction of stannous oxide to metal is much more rapid than the corresponding reduction of ferrous oxide, or (*c*) that under the experimental conditions the affinity of oxygen for iron is greater than that for tin, and that in consequence the reaction $SnO + Fe \rightarrow Sn + FeO$ takes place.

(7) The high tin-content of the slag when a pure tin button is produced, coupled with the invariable formation of hard-head (Sn-Fe alloy) and low tin content slags when the amount of reducing agent is increased, suggests that (*a*) stannous silicate is *not* readily reduced by carbon or carbon monoxide, (*b*) the removal of tin from the slag is a precipitation process.

$$Fe + SnO.SiO_2 \rightarrow Sn + FeO.SiO_2.$$

(8) The distinctly lower tin content of the slags in experiments where the "lime" (CaO and MgO) content is high, is in agreement with Stack's observation that high lime content favours lower tin content. It is tentatively suggested that a distinctly lower solubility of stannous oxide in calcium silicate than in ferrous silicate would account for such a result by lessening the amount of stannous oxide removed from the influences of the reducing agent.

SHORT NOTICES

Large Electric Winder.—The *Engineer* for January 17 contains a description of the electric winder recently installed at the No. 4 shaft of the City Deep. The d.c. motor is rated at 5,000 h.p. and 12,500 h.p. on the maximum peak load.

Quarrying with the Wire Saw.—In Technical Publication No. 262 of the American Institute of Mining and Metallurgical Engineers, W. M. Weigel describes the application of the wire saw to marble quarrying in Northern Arkansas. It will be recalled that this method of quarrying marble has been used at Ashburton in Devonshire.

Magnetic Separation.—An explanation of the behaviour of magnetic particles when subjected to the action of alternating magnetic fields is contained in a paper by J. A. L. Ortlepp which appears in the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa for October, 1929.

Soluble Salts as Flotation Reagents.—In *Engineering and Mining Journal* for December 14 last, N. H. McKay explains the uses of certain soluble salts in flotation processes

Leaching of Oxidized Copper Ores.—The report of the West Australian department of Mines for 1928 contains a description of experiments carried out by W. G. Murray, the Government Mineralogist and Chemist, to determine the solvent effect of solutions of ferrous sulphate in sea water on an oxidized copper ore from the Whim Well Copper mine. The solvent action is found to be mainly due to the free sulphuric acid which is contained in commercial ferrous sulphate. the acidity of the solution being maintained by the continued separation of basic salt during leaching.

Season Cracking of Brass.—A. Morris, in Technical Publication No. 263 of the American Institute of Mining and Metallurgical Engineers, gives the results of tests to determine the resistance of brasses to stress-corrosion attack.

Electrolytic Iron.—At the general meeting of the American Electro-chemical Society held at Toronto, 1929, S. J. Lloyd described the production of electrolytic iron from a suspension of its oxide in hot strong caustic soda by the Estelle process.

Silica Refractories.—The position in Great Britain with regard to silica refractories is discussed by Professor George Knox in the *Iron and Coal Trades Review* for December 27 last.

Geophysics.—"Seismic Propagation Paths" is the subject dealt with in Technical Publication No. 267 of the American Institute of Mining and Metallurgical Engineers by M. Ewing and L. D. Leet.

Iron Ore on Bell Island, Newfoundland.—S. C. Mifflen describes the Wabana iron ore mines of the British Empire Steel Corporation in the *Canadian Mining Journal* for January 17.

Butte, Montana.—The age and structure of the vein systems at Butte, Montana, are discussed by J. C. Ray in Technical Publication No. 265 of the American Institute of Mining and Metallurgical Engineers.

Barytes in California.—In Technical Publication No. 266 of the American Institute of Mining and Metallurgical Engineers, W. G. Bradley deals with the barytes resources of California.

Radium Ore in Canada.—The *Canadian Mining Journal* for December 13 last describes the

results of the discovery of a vein containing uraninite in Haliburton County, Ontario.

Swaziland.—"Notes on the Mineralized Belt of Jamestown Series—Forbes Reef, Swaziland," forms the subject of a paper read by G. W. Bond on December 17 last before the Geological Society of South Africa. The account is interesting in view of the mining potentialities of the district.

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.*

14,522 of 1928 (321,911). H. D. Elkington, London. A chlorination process for pyritic ores by which pure sulphur and metallic oxides are separated. The process uses a dry treatment of the ore at high temperatures by a dilute chlorinating agent which results in the formation of metallic chlorides and sulphur vapour.

14,523 of 1928 (306,107). Comstock and Westcott, Inc., Massuchusetts. A cyclic process for the treatment of pyritic ores involving chlorination, the products being elemental sulphur and pure iron oxide.

23,818 of 1928 (321,927). P. T Williams and Minerals Separation, Ltd., London. Improvements in froth-flotation cells whereby dilute pulp carrying a preponderance of slimes may be drawn off and run into a slimes treatment cell, causing the pulp density in the end cells to be increased.

25,777 of 1928 (322,527). S. Tucker, London. The use of a small quantity of a cyanogen compound, such as an alkali cyanide, as an addition to the ordinary flotation reagents creosote and xanthate, is found to improve the recovery by froth-flotation of copper concentrates obtained by segregation processes.

38,105 of 1928 (303,066). F. E. Lathe, Ottawa. A method of refining nickel-copper matte. The matte is cooled rapidly at such a stage of conversion that it retains an appreciable amount of iron sulphide (2–10%). In this condition the nickel sulphide is extremely soluble in acid and can be leached out.

3,177 of 1929 (305,102). J. A. Seede, Shenectady, New York. A process for the electro-magnetic separation of ores. The crushed mixture of gangue and ore is passed through a magnetic field generated by means of coreless coils energized by an alternating current of high frequency, and the gangue and ore are forced to follow different paths.

16,345 of 1929 (321,943). The Bradley-Fitch Company, Minnesota. Improvements in the treatment of manganese ores in order to render the manganese content susceptible to selective leaching by ammonium salt solutions, while at the same time rendering the iron content susceptible to magnetic concentration.

31,981 of 1929 (321,920). H. D. Elkington, London. A process for obtaining pure sulphur and pure iron-oxide from pyritic ores by chlorination.

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.

Methods in Geological Surveying. By Dr. Edward Greenly and Dr. Howel Williams. Cloth, octavo, xvi + 420 pages, illustrated. Price 17s. 6d. London: Thomas Murby and Co.

Geochemische Migration der Elemente. Teil II. By Professor A. Fersmann. Paper backs, illustrated. Price 8 marks. Halle (Saale): Wilhelm Knapp.

Geologische Karte der Erde. Lieferung 1. Blätter 1—4. Scale $\frac{1}{15{,}000{,}000}$ Subscription price 150 marks. Berlin: Gebrüder Borntraeger.

Coal Mining. Definitions and Formulæ for Students. By M. D. Williams. Paper backs, 44 pages, illustrated. Price 6d. London: Sir Isaac Pitman and Sons.

Quarries: Year 1928. List of Quarries in Great Britain and the Isle of Man. Paper backs, 454 pages. Price 35s. London: H.M. Stationery Office.

Bulletin of the Imperial Institute. Vol. xxvii. No. 4. 1929. London: John Murray.

Coal Dust. The Relative Inflammability of Coal Dusts: A Laboratory Study. By A. L. Godbert and R. V. Wheeler. Paper backs, 25 pages, illustrated. Price 6d. Safety in Mines Research Board paper No. 56. London: H.M. Stationery Office.

British Columbia. Preliminary Review and Summary of Mining Operations for the Year 1929. Compiled by John D. Galloway. Paper backs, 84 pages, illustrated. Victoria, B.C.: Department of Mines.

Southern Rhodesia. Geological Survey Bulletin No. 15. (1) The Geology of the Central part of the Wankie Coalfield. By B. Lightfoot, (2) The Fossil Flora of the Karroo System in the Wankie District. By John Walton. Paper backs, 83 pages, illustrated, with geological map. Salisbury: The Geological Survey.

Gold Coast Colony. Report of the Mine Department, 1928–1929. Paper folio, 32 pages. Price 2s. London: The Crown Agents for the Colonies.

Tanganyika Territory. The Soil and Agricultural Development in Relation to the Geology of Portions of the Northern Kigoma and Southern Bukoba Provinces. By Dr. E. O. Teale. Geological Survey Short Paper No. 4. Paper backs, 29 pages. Price 4s. Dar es Salaam: The Government Printer.

Tanganyika Territory. Report on the Development of the Rufiji and Kilombero Valleys. By A. M. Telford. Paper folio, 75 pages, illustrated with maps. Price 5s. London: The Crown Agents for the Colonies.

Western Australia. Report of the Department of Mines, and Mining Statistics, 1928. Paper folio, 117 pages, with numerous plans, and 77 pages statistics. Perth: Mines Department.

South Australia. Annual Report of the Director of Mines and Government Geologist, 1928. Paper folio, 8 pages. Adelaide: Mines Department.

The Contact of the Fox-Hills and Lance Formations. By C. E. Dobbin and J. B. Reeside, Jr. Paper folio, 17 pages, illustrated. United States Geological Survey Professional Paper 158–B, Washington.

Alaska. The Chandalar-Sheenjek District. By J. B. Mertie, Jr. Paper backs, with map. Pages 85–139: Bulletin 810-B: The United States Geological Survey, Washington.

Montana. The Kevin-Sunburst Oil Field, and Other Possibilities of Oil and Gas in the Sweetgrass Arch. By Arthur J. Collier. Paper backs, illustrated. Contributions to Economic Geology, 1929, Part II, pp. 57–189, Washington: United States Geological Survey.

Suspended Matter in the Colorado River in 1925-1928. By C. S. Howard. Paper, illustrated. Water-Supply Paper 636-B; Contributions to the hydrology of the United States, 1929. pp. 15–44. Washington: United States Geological Survey.

Mineral Raw Materials. Survey of Commerce and Sources in Major Industrial Countries. By J. W. Furness and L. M. Jones, assisted by F. H. Blumenthal. Paper backs. 278 pages. Price 45 cents. Trade Promotion Series No. 76, Washington: Department of Commerce.

The Economics of the Coal Industry. By R. C. Smart. Cloth, octavo, 268 pages, illustrated. Price 12s. 6d. London: P. S. King and Son.

COMPANY REPORTS

Jos Tin Area (Nigeria).—This Company was formed in 1910 to work alluvial tin deposits in Northern Nigeria. The report for the year ended July 31 last shows that 252¼ tons of tin concentrates was won during the year as compared with 206¼ tons in the previous year. The amount realized per ton however was somewhat less. The year's working showed a profit of £18,362 out of which £9,375 has been distributed as dividends equal to 12½%.

Batu Caves Tin Dredging.—This company was formed in the Straits Settlements in 1927 to acquire alluvial tin-bearing property near Kuala Lumpur, F.M.S. The report for the period ended August 31 last shows that the dredge was completed in February last and was working well by the end of March. During the period from April 1 to August 31 a total of 683,000 cu. yd. was dredged and 192⅛ tons of tin concentrates recovered. Of the 254 acres held under mining title 11 acres were worked out at the end of this period. The net profit at the end of the period was $42,564, which was carried forward.

Rantau Tin Dredging.—This company was formed in the Straits Settlements in 1925 to work alluvial tin property in the State of Negri Sembilan, F.M.S. The report for the year ended July 31 last shows that the two dredges treated 2,608,000 cu. yd. of ground and recovered 533·9 tons of tin concentrates. The working profit for the year was $176,294, and the balance available for distribution $202,054, of which $189,000 was paid out as dividends. The mining area has been increased to 1,145 acres by the acquisition of 40 acres of new ground, and at the end of the year 125 acres had been worked out.

Sungei Way Dredging.—This company was formed in the F.M.S. in 1924 to work alluvial tin property at Sungei Way, Selangor. The report for the year ended June 30 last shows that the second dredge commenced work in December 1928 but did not work well for several months, owing to dirty water. Orders have been placed for a third dredge. The output from Nos. 1 and 2 dredges during the year under review was 627 tons, and 20·34 acres, of the 1,118 acres which the company holds, were worked out. The gross profit for the year was $328,027 and $185,625 has been distributed as dividends, equal to 15%.

Northern Tavoy Tin Dredging.—This company was formed in 1926 to work alluvial tin properties in the Heinze Basin, Northern Tavoy, Burma. The report for the year ended March 31 last shows that work on the No. 1 dredge has been temporarily suspended, and that the No. 2 dredge only commenced regular production in July last. This dredge produced 175 tons of tin-concentrates during the period August–November, 1929.

DIVIDENDS DECLARED

Ashanti Goldfields.—40%, less tax, payable January 31.

British South Africa.—2s., less tax, payable March 7.

Broken Hill South.—2s., less tax, payable February 26.

Changkat Tin Dredging.—1s., less tax, payable January 31.

Electrolytic Zinc.—12%, less tax, payable January 30.

Fresnillo.—25 cents, payable February 21.

Kampar Malaya Tin Dredging.—9d., less tax, payable February 28.

Kuala Kampar Tin Fields. — 3d., payable February 28.

Kent (F.M.S.) Tin Dredging.—10%, less tax, payable March 4.

Pato Mines (Colombia).—10s., less tax, payable January 20.

Selection Trust.—6d., less tax, payable February 6.

Sungei Way Dredging. — 5%, payable January 24.

Tekka.—4½d., less tax, payable March 4.

Tekka-Taiping. — 3d., less tax, payable January 31.

Tokatea.—2½%, less tax, payable February 1.

Zaaiplaats Tin.—6d., payable January 31.

Zambesia Exploring.—6d., less tax, payable January 31.

NEW COMPANIES REGISTERED

Abbaye Consolidated.—Registered January 24. Capital: £1,000 in 1s. shares. Objects: To adopt agreement with Abbaye Development (in liquidation), etc. Directors: Col. C. R. Finch Noyes and Col. B. H. O. Armstrong. Office: 1, Queen Victoria Street, E.C. 4.

Asbestos Consolidated Mines of Rhodesia.—Incorporated in Southern Rhodesia. British address, Cross Keys House, 56, Moorgate, E.C. Directors: G. B. Bernard and A. Chatwin, both of Salisbury, Southern Rhodesia.

London Nigerian Power Company.—Registered January 17. Nominal capital: £100,000 in 5s. shares. Objects: To produce, generate, store, and distribute electrical energy or power, etc. Directors: Baron Brabourne, Oliver V. G. Hoare, J. H. C. E. Howeson, and L. Hardy. Offices: 31 and 33, Bishopsgate, E.C. 2.

Mufulira Copper Mines.—Registered February 3. Nominal capital: £600,000 in 2s. shares. Objects: To acquire lands, farms, mines, mineral and other properties, to adopt an agreement with the Rhodesian Selection Trust, Ltd., the Bwana M'Kubwa Copper Mining Co., Ltd., and the British South Africa Co., Ltd., and to carry on the business of miners, mine-owners, merchants, engineers, metallurgists, etc. Office: Selection Trust Building, Mason's Avenue, Coleman Street, E.C. 2.

National Mineral Development.—Registered as a private Company Febuary 1. Nominal Capital; £10,000 in £1 shares. Objects: To develop any process or processes for the production of Zinc, copper, lead and other non-ferrous metals. Office: 95, Gresham Street, E.C.2.

COMPANY MEETINGS AND REPORTS SECTION

BURMA CORPORATION, LTD.

Directors : Sir Robert S. Horne (*Chairman*), P. E. Marmion (*Vice-Chairman and Joint Managing Director*), A. Chester Beatty, M. L. Burnet, C. F. Clifton, J. R. Govett, J. Hogg, Capt. O. Lyttelton, W. S. Robinson (*Joint Managing Director*), Sir H. Strakosch, Sir T. R. Wynne. *General Manager :* E. H. Taylor. *Secretary :* H. Ponsford. *Office :* 104, Strand Road, Rangoon. *Formed* 1919. *Capital issued :* 13,541,689 shares of 10 rupees each.

Business : Operates the Bawdwin lead-zinc-silver mine in Upper Burma.

The annual general meeting of Burma Corporation, Ltd., was held at the company's office, 104, Strand Road, Rangoon, on Friday, December 20, at 11 a.m., Mr. P. E. Marmion presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30 last, said : The tonnage mined was 463,057, an increase of no less than 33,212 over the preceding year, while its average grade was 19·7 oz., Ag. 22·6%, Pb. 12·9% Zn, and 1·07% Cu, which is somewhat less than the grade for last year. The ore was mined systematically from all ten operating levels, about 25% below Tiger tunnel and 75% above it, and no tonnage within the limits of the stoping areas worked was left in the mine, everything being extracted and railed to the treatment plants. Since the start of mining operations at Bawdwin no less than 3,115,518 tons of ore have been extracted, and the continuous settlement of the filling over the large areas from which this great tonnage has been removed has imposed a heavy strain on much of the timber placed in the mine from year to year. Having regard to the large tonnage of ore still remaining to be extracted from some of the upper levels, it has been considered advisable to provide new travelling ways yet further away from the operating stopes, and drives are being extended in the footwall country rock for this purpose.

In all mines where the size of the deposit is such that it takes years to extract fully the ore from any one level, the maintenance of adequate and safe travelling ways to ensure the complete extraction of the whole ore body is a matter of extreme importance, and the fact that we have found it advisable only now to review the location of some of our early workings after the extraction of over three million tons of ore speaks highly for the system of stoping adopted originally by the mine officials, and for the manner in which it has been conducted over a number of years. I have had occasion during the last fortnight to examine carefully the underground workings throughout the mine and am pleased to advise that they are in a thoroughly satisfactory condition. A great deal has been done during the year to finalize the work of ventilating in the upper levels, which was entirely disorganized by the unfortunate mine fires, and direct connexion with the ventilating fans installed at the surface has now been established in all sections underground.

The production of refined lead at 78,716 tons reached the highest figure yet recorded, and represents an increase of 6,328 tons, or 8·7%, over the preceding year, while the refined silver output at 7,376,841 oz. was also a record, being an increase of no less than 422,176 oz., or 6·1%. These record productions were obtained mainly because of the progress made in metallurgical efficiency, for, notwithstanding the larger tonnage extracted from the mine, it contained only 3·6% more lead and actually 1·3% less silver than the preceding year.

The tonnage of zinc concentrates fell from 62,195 to 60,180, due mainly to the reduction in the grade of ore milled from 16·1 to 14·1% zinc, and also partly to an improvement in the grade of concentrates shipped from 49·9 to 51·6% zinc. The production of concentrates from accumulated tailings was 5,780, against 3,973 tons in the preceding year. The percentage recovery improved from 54·79 to 56·96%.

The zinc content of the ore developed below Tiger Tunnel level is subject to great variations in grade from different sections of the mine, and generally is lower than the ore reserves above that horizon. Since an increasing tonnage will be mined below Tiger Tunnel in future years the grade of zinc in the ore to be treated is likely to fluctuate rather more than it has in the past.

As forecasted last year, the production of copper matte has been reduced from 12,388 to 10,719 tons following the reduction in the grade of the ore mined to accord more closely with the reserves available. There are considerable tonnages of copper ore of a somewhat lower grade available in certain sections of the mine towards the profitable treatment of which attention is now being directed.

Regular shipments of antimonial lead and copper nickel speiss were made throughout the year, in both of which an increased production was recorded.

Of almost equal importance to the actual production of metals is the price at which they can be realized. Fortunately, the prices of those metals which concern our revenue remained fairly stable throughout the year with the exception of copper, which improved very considerably. The average price of lead was £22 13s. 6d., an increase of £1 4s. over the preceding year, which, together with our increased production, improved our revenue from this metal by no less than £286,000. Only a slight decline was recorded in the price of silver, the effect of which was more than offset by increased production. Spelter showed a decline of 12s. 4d. per ton, which, together with our decreased production, adversely affected our revenue to the extent of £57,000. The price of copper had the very important gain of £14 4s. 3d. per ton, so that, notwithstanding a decline in production of 1,669 tons of copper matte, our revenue from the sale of this commodity was increased by over £50,000.

The gross result of the sale of the whole of our has production at the prices previously mentioned been to increase our revenue by over £297,000, or Rs. 39,57,000, when compared with the preceding year.

Turning now to the profit and loss account, you will find that the total operating expenditure is about £8,000 less than the preceding year, notwithstanding the mining and treatment of an additional 33,212 tons of ore. This is equivalent to a decline in the total operating expenditure of almost 8s. per ton of ore mined and treated, which highly satisfactory result, I am sure you will agree, is further evidence of the real progress made during the year. The trading account discloses a gross profit of £1,566,733, and after providing for loss on exchange, depreciation, income and super tax, the net profit resulting from the year's operation is £1,054,842, the highest figure ever recorded by the corporation. Out of this amount dividends Nos. 12 and 13 were paid, absorbing, with bonuses, £1,015,626, leaving a balance of £39,216 to be added to the carry-forward.

The tonnage of ore reserve in the mine is set out in detail in the general manager's report. During the period development enabled 511,275 tons to be brought into reserve, against 463,057 tons extracted, bringing the total of reserves to 4,140,969, against 4,092,751 tons the preceding year, an increase of 48,218 tons. The grade of this large tonnage remains practically unaltered, The result of the year's work was, therefore, highly satisfactory both as regards grade and tonnage developed.

The work of opening up the Chinaman and Shan sections on No. 9 level was energetically prosecuted and, as pointed out last year, the geological conditions in the former were somewhat disturbed by the bed of sediments encountered in the south end of the mine. Although these sediments have not been without their disturbing influence, I am pleased to say they do not appear to be as extensive as at first expected; furthermore, where intersected, the rhyolite underlying them has been proved favourable for mineral deposition as disclosed by the widths and value of ore intersected in crosscuts at 1,389, 1,499, and 1,589 south. Winze 740 south has been extended from No. 9 to No. 10 level, mainly in the sediments lying to the east of the ore channel, and development work to the west of it is now proceeding in order to expose the ore body. The total tonnage of ore developed in the Chinaman section during the year was 286,677.

Last year I referred to the increasing importance of the Shan section in depth, and I am glad to state that the year's results support this view as regards No. 9 level by comparison with levels above it. The five cross-cuts in the Shan at this level have exposed widths and values in excess of anything disclosed on any level in the same lode hitherto, and the strength of the lode at the farthest north point appears to lend support to the possibility of the ore body extending in that direction in conformity with its northerly pitch. The year's work in the Shan section added 224,598 tons to the ore reserve, having the remarkably high average of 25·4 oz. Ag, 33·1% Pb, and 10·8% Zn. The Marmion shaft in this section was sunk to No. 10 level, and the first cross-cut from it intersecting the Shan lode exposed 36¼ ft. of ore averaging 16·2 oz. Ag, 19·7% Pb, 18·5% Zn, which is of reduced width, but of similar value to the cross-cuts at the two levels immediately above. The work of exposing fully the Shan lode at this level is making good progress, and results will be published in the Press as development proceeds, in accordance with usual practice.

Last year I referred to the introduction of a vigorous policy of exploration outside and beyond the areas to which developments had been confined hitherto. The development covered in drives and cross-cuts exceeded that of the preceding year by 3,000 ft., all of which was in connexion with this programme of exploration, and I am pleased to say our efforts have been rewarded with definite success in two directions.

East cross-cuts at Nos. 1, 2, 3, and 4 levels exposed varying widths of payable ore in several footwall veins, and driving northwards at No. 1 level in the Bawdwin fault zone is being pushed on with the object ultimately of coming under the gold-hole workings where copper-lead ore appears to have been discovered by the ancient Chinese.

Right at the other end of the mine on No. 2 level, south of the Hsenwi fault, cross-cuts have been extended at 3,102, 3,302, 3,702, and 3,902 ft. south, and in each case old and extensive Chinese workings have been discovered.

It is too early yet to express any definite opinion on the full extent of this new discovery, but with a view to prospecting for the downward continuation of these ancient workings, a south drive is being extended to come under them at No. 4 level as well as a cross-cut from Tiger Tunnel at No. 6 level.

At last year's meeting I advised you of the large tonnage of low-grade ore available in the mine, apart from the tonnage of high-grade material with which you are all familiar, and stated that I hoped to be in a position to indicate more definitely our intention regarding it this year. The existing milling plant is being extended to increase its capacity ultimately by 15,000 tons per month, raising it to 45,000 tons per month, with the object of utilizing such portion of this low-grade ore as is capable of profitable treatment. When this additional milling plant is available it will be possible to contemplate a reduction in the average grade of ore treated without detriment to profit at similar metal prices. This would be attained by decreasing the tonnage of high-grade ore now being milled and supplementing it with a larger tonnage of the lower grade material, the effect of which would be to extend considerably the known life of the mine on the basis of its reserve of high-grade ore.

In addition to the extensions and alterations to our milling plant we have effected various improvements to our smelter and refinery and added to our hydro-electric station at Mansam Falls. The capital spent under this heading has been with the definite object of effecting economies and improving efficiency in our smelter department, and increasing the generating capacity of our hydro-electric plant to meet consumptive demand. Our treatment costs per ton of ore mined are the lowest on record, and over-all smelter recoveries the highest, while the units generated at the hydro-electric plant reached the record figure of 43,727,065.

In connexion with the hydro-electric plant, it will interest you to know that the alterations and extensions to the flume, forebay, and spillway—started in 1924 and completed by the addition of a 4,000 kw. set this year—have enabled the station to keep pace with the increasing requirements at Namtu and Bawdwin except for one or two of the driest months, notwithstanding the very great increase in the demand for electrical energy meanwhile.

In reviewing the metal position I prefer to make no attempt to forecast the future, as I regard such a step in present world conditions as imprudent. I shall, however, place some facts and figures before you, relative principally to the year 1928, which may enable you to form your own opinions.

The world production of lead for 1928 was 1,650,000 tons, an increase of about 30,000 tons over the estimate I quoted last year. Consumption reached a satisfactory total of 1,610,000 tons, from which it can be said that production and consumption remained evenly balanced. The estimated production for 1929 is about 1,700,000 tons and, as far as it could be ascertained, consumption was running at a similar figure up to the end of September last.

The world production of spelter for 1928 was 1,410,000 tons, an increase of 20,000 tons over the estimated figure quoted at our last meeting. Consumptive demand was 1,400,000 tons; an entirely satisfactory result. The estimated production for 1929 is about 1,440,000 tons and, while consumption during the first half of the year was running at a satisfactory figure, there has been a slackening off during the second half, and the present position is obscure. It can, however, be said that the level to which price has now fallen is entirely unprofitable for those mines which have to regard the metal as a prime product and, indeed, only barely profitable for any mine where transportation charges to the world's markets are heavy.

The world production of copper for 1928 was 1,682,000 tons, a decrease of 8,000 tons below the estimated figure quoted last year. Demand remained satisfactory throughout the period, with the stock position showing a decline at the close. The estimated production for 1929 is 1,900,000 tons. Consumption during the first half of the year was reported to have been on an increased scale, with the result that visible stocks were decreased, a condition reflected in the price during the months of March and April. In the present disturbed state of finance and industry the outlook is uncertain, but there is a sufficient measure of agreement among producers to expect that output will be adjusted to accord with consumptive demand in the interests of reasonable stability of price.

The world production of silver for 1928 was 257,980,061 oz., an increase of nearly 4,000,000 oz. over the preceding year. For the first half of 1929 there was a slight decline in the world figure, and it is probable the second half will show a still greater decline in consequence of the continued weakness of the metal. Since the close of our financial year the price of silver, as you no doubt are all well aware, has suffered a serious decline, which naturally has not been without its effect on our profits, seeing that each penny on an annual production such as ours means a loss or gain of about £30,000.

I referred last year to the connexion between the price of silver and the prosperity of the non-ferrous mining industry, and I adhere to the conviction that, if the decline in the price of silver is to be permanent, it must have its reflection ultimately in an increased price for those non-ferrous metals with which it is usually found in mineral association. The reason for this view will be apparent when it is realized that probably not less than 175,000,000 oz. of the world's production of silver for 1928 emanated as an incidence of the production of copper, lead and zinc. The value of this production at the average price ruling for silver during 1928 was about £21,000,000, while its value at to-day's price is about £17,000,000, representing a loss to the non-ferrous mining industry of £4,000,000, equal to an average of nearly £1 per ton on the world production of copper, lead and spelter.

I now pass on to the interesting subject of dividend payment, and I am sure you will all have been pleased to find that we were able to declare for the current half-year a dividend at the same rate as that paid for the first half of last year, notwithstanding the heavy fall in the price of silver and spelter meanwhile.

It is always a great pleasure to give expression to the indebtedness we feel to our general manager and to all members of his staff for the excellence of the work accomplished in all departments. We do not forget the excellence of the executive work which falls to the lot of our Rangoon and London secretaries, Mr. Ponsford and Mr. Anderson, and their respective staffs. It is also a pleasure to refer to the assistance we receive from the Burma Railways and the authorities of the Port of Rangoon.

In endeavouring to give you a complete picture of your company's affairs, my remarks have extended to greater length than intended, but, if asked to summarize the position in a few words, I would say the condition of the mine is sound and the outlook for the maintenance of our strong ore reserve position as favourable as ever. Our treatment plants are in course of extension and, wherever advisable the latest and most efficient machines are being installed to supplement or replace existing units, and we are confident, when the time arrives for them to go into operation, that our expectations of treating a larger tonnage more efficiently and at considerably lower cost than in the past will be fully realized. All is, therefore, sound and well at the operating centre without any apparent sign of weakness. On the other hand, we all recognize that we are passing through a period of trade depression, which has not been without influence on the demand for metals as well as their prices, a condition which naturally does not leave us free from anxiety. Apart from this unfavourable feature the general condition of our business is entirely satisfactory, and the strength of the financial position we have built up enables us to envisage the difficult times we are now experiencing with a degree of equanimity and confidence that otherwise would not be possible.

I have now much pleasure in moving: That the directors' report and accounts for the year ending June 30, 1929, as submitted at this meeting, be received and adopted.

Mr. Clifton: I have great pleasure in seconding the resolution.

The resolution was unanimously carried.

APEX (TRINIDAD) OILFIELDS, LTD.

Directors : Walter Maclachlan (*Chairman and Managing Director*), George R. Airth (*Managing Director*), W. T. Anderson, Dr. W. Cullen, T. G. Grant, H. Limebeer, F. A. Robinson. *Secretary :* S. H. Stacey. *Office :* 208–224, Salisbury House, London, E.C. 2. *Formed* 1919. *Capital :* £500,000 in 5s. shares.
Business : Operates oil lands in Trinidad.

The tenth ordinary general meeting of Apex (Trinidad) Oilfields, Ltd., was held on January 16 at Winchester House, London, E.C., Mr. Walter Maclachlan (Chairman and joint managing director) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended September 30 last, said the profit for the year was £313,208, an increase of £66,779 as compared with the previous year. The directors recommended the payment of a final dividend of 30%, less tax, making a total dividend of 52½% for the year. During the year under review a further general fall took place in the market value of oil, with the result that the prices realized from the sale of their production were materially reduced. As compared with the previous year, however, the increase in their production by 119,553 tons served to more than meet the fall in prices, so that the oil profits were increased to the extent of £99,127. As indicating the effect that the continually increasing fall in prices had had upon their profits, he would point out that had they been able to realize for their last year's output the prices which they obtained three years ago, the profits, instead of being £313,000, would have amounted to well over 100% on the present capital. However, in spite of these adverse conditions in the realization of their production, which were common to all oil-producing undertakings, he thought they would agree that they had good reason for considerable satisfaction with the results which have attended their operations for the year under review.

The production of oil for the year was 414,328 tons, as compared with 294,775 tons for the previous year. This production constituted a further record output and was obtained from 110 wells. The production for the first three months of the current financial year had been 103,690 tons, thus maintaining practically the average rate of production for 1928–29. The total production of their oilfield up to December 31 last had been approximately 1,800,000 tons, and it was anticipated that during the current year they would produce about 35% of the entire oil production of Trinidad. The oil delivered to Trinidad Leaseholds and that used in their own operations during the year amounted to 414,212 tons, the average price realized, as already indicated, being lower than that for the preceding year. Additional purchases of property had been made, including both surface and oil rights, and the oil rights controlled at September 30 last amounted to 3,354 acres. This included, approximately, 2,000 acres of Crown lands immediately to the south of their oilfield, which was held under prospecting licence from the Government; a Government mining lease was being granted in respect of 245 acres of this area. Another prospecting licence over a further area of about 265 acres was being granted, and applications had also been filed for additional areas immediately adjacent to their oilfields.

During the year 36,651 ft. was drilled, making a total footage of 206,433 ft. Five wells which had been started prior to October 1, 1928, were drilled to completion, fourteen new wells were commenced and completed, two wells were deepened and again brought into production, and five further wells which had been started were in progress at the end of the year. Of the twenty-one wells which were brought in during the year, none were failures, and the incidence of good producers was considerably better than during the preceding year. Very satisfactory results attended drilling with the object of extending already tested areas, while the increase in output spoke for the success of the operations which were directed towards maintenance and increase of production. A considerable amount of offset drilling had again to be included in the programme, but almost all the wells which were drilled under those conditions proved reasonably good producers.

With regard to the deep wells drilled to test the southern area, No. 69 continued in small production, pending the completion of an air-lift installation; No. 92 continued to be deepened for purposes of exploration, and No. 122, a third deep well adjacent to No. 69, had supplied valuable information by coming in as a good flowing well. The result of these three wells had been to increase very largely the proved area of the property, and they had pleasure in reporting that the development of the property as a whole was being attended with most satisfactory results, which in every respect confirmed their complete confidence with regard to its future.

He knew they would expect an expression of views as to the outlook for the current financial year. As he had already stated, their output was being maintained at practically the same rate as last year, and there was every prospect that the output for this year would not be less than that for the year under review. The continued general over-production, however, made it difficult to deal with the outlook as regards the realization of their output, as they were quite unable to make any forecast as to the course of prices. He could only express the hope that early success would attend the efforts for the restriction of output in the United States, upon which the oil industry was dependent for any material improvement in prices.

He would conclude by expressing their thanks to the management in Trinidad for the most loyal and efficient service which Colonel Hickling and his staff continued to render to their company, and he was certain that it would be their wish to associate themselves with this expression of their sincere appreciation.

Mr. George R. Airth seconded the resolution, which was carried unanimously.

ASHANTI GOLDFIELDS CORPORATION, LTD.

Directors: Jeremiah Colman (*Chairman*), Lord Luke (*Deputy Chairman*), J. H. Batty, O. V. G. Hoare. *Consulting Engineer:* J. S. Watkins. *Mines Manager:* G. W. Eaton Turner. *Secretary:* Horace Morgan. *Office:* 6, Southampton Street, Holborn, London, W.C. 1. *Formed* 1897. *Capital:* £250,000 in 4s. shares.

Business: Operates a gold mine in the Gold Coast Colony.

REPORT AND ACCOUNTS OF THE DIRECTORS SUBMITTED TO THE THIRTY-THIRD ORDINARY GENERAL MEETING OF SHAREHOLDERS HELD ON JANUARY 30, 1930.

The Directors herewith submit the Statement of Accounts for the year ended September 30, 1929. The share capital remains unaltered at £250,000; the reserve account is increased to £250,000 by the transfer of £50,000 from Profit and Loss Account sanctioned at the last annual meeting. The ore treated was 108,007 tons for a yield of 118,095 oz. of fine gold and 6,570 oz. of silver. In addition, 41 oz. of fine gold were recovered from sundry sources. Total recovery averaged 21·88 dwt. per ton.

	£	s.	d.	*Per ton.* s.	d.
The total income was	513,615	1	1 =	95	1·3
The working costs, general expenses and other charges in West Africa and London were	211,016	3	10 =	39	0·9
Showing a gross profit of	302,598	17	3 =	56	0·4
Less:—					
Cost of mines development	42,793	3	7 =	7	11·1
Government royalty	25,122	1	4 =	4	7·8
Amount written off main shafts and for depreciation of plant, machinery, etc.	31,099	6	2 =	5	9·1
	99,014	11	1 =	18	4·0
Leaving a net profit (subject to income tax) for the year of	203,584	6	2 =	37	8·4
To which must be added the credit balance of Profit and Loss Account, after payment of final dividend, 1927-28, and the transfer of £50,000 to Reserve Account	59,176	13	3		
Balance to be appropriated	£262,760	19	5		

An interim dividend of 25% was paid on July 31 last, and the Directors recommend the payment of a final dividend of 40%, less income tax at 4s. in the £, payable on January 31 next; these distributions will make 65% for the year, and will absorb £162,500 of the before-mentioned profit. The Directors propose to transfer £30,000 to an Exploring Account, £2,000 to establish a Benevolent Fund, and £5,000 to form the nucleus of a Pensions Scheme, leaving the sum of £63,260 19s. 5d. to be carried forward to the credit of Profit and Loss Account. Compared with the previous year, there is an increase of £40,144 1s. 3d. in the profit earned. The cost per ton of mining, treatment and general services was 39s. 1d. as compared with 40s. 9d. last year, a decrease of 1s. 8d. This was offset by an increase in development due to the larger footage made, and in Government royalty due to the higher grade of ore treated. The total cost per ton was 57s. 5d., the same as last year.

The ore reserves in Ashanti mine at September 30 were 590,200 tons (an increase of 40,800 tons) of an average value of 25·2 dwt. (an increase of 1 dwt.). There is no alteration in the figures given last year for blocks of ore in Ashanti, Ayeinm and Justice's Mines, which are, at present, classed as "unpayable," and which are not included in the reserves.

The metallurgical treatment gave a theoretical extraction of 92·7% and the tonnage was increased by 5,022 tons. Although the improvements and reconditioning of the Central Treatment Plant have not yet been completed, such progress was made as to enable a larger tonnage to be handled.

The Directors have to record, with deep regret, the death in May last, of their esteemed colleague, Mr. Charles W. Mann, who had been connected with the Company from its beginning. Mr. Oliver V. G. Hoare was appointed to fill the vacancy on the Board.

By Order of the Board,
HORACE MORGAN,
Manager and Secretary.

London, W.C. 1.
January 21, 1930.

EXTRACTS FROM CONSULTING ENGINEER'S REPORT.

Underground operations were again confined to the Ashanti Mine. The total development footage accomplished amounted to 10,358 ft., as compared with 8,435 ft. the previous year.

No sinking was done on the main shaft, but the repairs mentioned in the last report were effected. The Timberway was sunk 100 ft. and is now equipped for haulage from the 23rd level. This shaft is now through the reefs and in settled country, similar to that in the Main Shaft. Ventilation shaft was carried down a further 200 ft. The north-east extension of the sand-filling pass, from 15 level to 21 level, entailing some 600 ft. of rising and winzing, together with about 400 ft. of cross-cutting, was completed, and sand can now be passed from the surface dumps down to the north-east end of 21 level.

Lateral development on the two reefs was carried on at all levels from 19 to 24. While the exposures of new ore have not been so spectacular as during the previous two years, they have been good enough, not only to maintain the ore reserve position, but to improve it, both as to tonnage and grade—and that after a record year's output. The following are the chief points of interest: On the Obuasi Chute test cross-cuts have exposed ore of good widths and values at both 22 and 23 levels. These permit of a considerable tonnage of new ore being taken into the reserves, and have the effect of just about maintaining the total tonnage in the Obuasi Chute and of increasing the average grade of the ore in sight on that ore body by about 1·0 dwt. The "New Make" is developing very nicely upwards from 22 level and to the south-west, while the fact that quartz of high grade and good width has been proved to exist right down to 24 level is justification for believing that when we get through the disturbed zone (caused perhaps by the junction of the reefs) which we have been passing through from 19 level downwards, more normal conditions may prevail.

A new and larger fan was installed at the mouth of the ventilation shaft early in the year, and air conditions in the mine are now very satisfactory.

VENTURE TRUST, LTD.

Directors : Arthur A. Baumann (*Chairman*), G. Goldthorp Hay, Walter Maclachlan, Harcourt S. Middleton. *Secretary :* E. Fairweather. *Office :* Pinners Hall, Austin Friars, London, E.C. 2. *Formed* 1919. *Capital issued :* £246,205 10s. in 10s. shares.

Business : Carries on a financial and investment business.

The tenth ordinary general meeting of the Venture Trust, Ltd., was held on February 5 at Winchester House, Old Broad Street, E.C. Mr. Arthur A. Baumann (Chairman of the company) presided.

The Chairman in moving the adoption of the report and accounts for the year ended December 31 last, said : Our trading profit from dividends, interest and realized profits on the sale of securities amounts to £17,224. Against that, on the other side of the balance-sheet, there is a loss by depreciation of investments, including the investment and income-tax reserve accounts, amounting to £43,405, leaving to be carried to the balance-sheet a net deficit of £30,163. That, of course, is not a loss. It is merely the result of a market valuation on December 31 last of the securities you hold and have paid for. Already, I am glad to be able to tell you, £7,000 of that deficit has been recovered in market quotations. That leaves you with £23,000 which I would like to call your " cold storage " investments. That is to say, they are not taken into the accounts only because they have no market quotation, and not because the directors believe that they do not have a future substantial value. We believe that they have, but to be quite safe, and with that drastic conservatism which I am sure you will all appreciate, we have preferred to write them out of the books altogether.

I need hardly remind shareholders that we are not an investment Trust Company. We are a financial trading company with a small capital for our purpose. We are therefore debarred from the luxury of buying municipal corporation stock. That is a luxury we leave to the " Big Five." We are also debarred from investing your money in foreign Government bonds and in foreign railways, as they do not yield enough for our purpose and they do not vary enough. By the conditions of our existence we are almost tied down to Industrial and similar securities, and, as you know, in the present conditions of the modern world all such securities vary and fluctuate very much. Indeed, their fluctuations are one of their attractions for us, because we buy for capital appreciation rather than for dividends.

On previous occasions I have always declined to publish a list of our investments, and I am glad to say that I am fortified in that decision by a very eminent authority, Mr. Robert Fleming, who stated the other day to his shareholders that he thought it was unwise to publish such a list. This year is rather exceptional, and as there may be a good deal of uneasiness that might be allayed, we have thought it better to publish in the report the chief assets of which your capital consists. They are all good industrial and similar investments, and they are all quoted. The chief of them are Hudson Bay, Baltimore and Ohio Railroad, International Nickel, Swedish Match, Shell Transport, Underground Railway, Brazilian Traction, Apex (Trinidad) Oilfields, Courtaulds, Imperial Continental Gas, Imperial Tobacco of Canada, Turner and Newall and Rhodesian Selection Trust. These and some others account for over 75% of your capital. Of course, this is not an exhaustive list. When I looked at the list a month ago, just before the valuation I was interested to observe, and you may be to know, that one share which showed a profit was a Preference share in Beecham Pills.

This list accounts for 75½% of your capital. With regard to 12½%, that mainly consists of loans to the Stock Exchange on fortnightly accounts with ample margin. I believe that at the moment all the loans have been repaid, so you will find now that there is really nothing left of your depreciation but about 3%, which I do not think is a bad showing.

Now I want to return to what I called your " cold storage " investments, representing £23,000. We have an investment of something under £3,000 in the Chislet Colliery, Ltd. That company is being reconstructed, and we are getting new Preference shares and Ordinary shares for our small holding in debentures and Ordinary shares. Next we have some £5,000 in the Oilwells Selection Corporation. That is an industrial proposition trading in the oilfields of Rumania, and I believe that there are also oil wells, the drilling of which on contract is being carried on. Anyway, I can reassure you on that point by telling you that this proposition was selected for us by my friend Mr. Walter Maclachlan, who is chairman, as you know, of the Apex (Trinidad) Oilfields. The last and biggest of these items is £15,000, which we have invested in the debentures of a syndicate which has been formed for the exploitation of an apparatus in connexion with talking films for the cinema trade. The cinema trade, as perhaps you do not know, has the method of buying its apparatus on the hire-purchase system ; they give long-dated bills, running for 18 months or two years, to the vendors. When this business was begun the directors of the syndicate readily discounted such bills through the ordinary channels, but, brisk as the business was at the start, the development of unfavourable conditions in the discount market made it at first difficult and finally impossible to go on discounting that kind of trade bill. The directors of the syndicate therefore determined that they would restrict their operations for a time and collect their credits. That is the reason why, with our customary caution, we have written that £15,000 clean out of our books.

The securities which I have enumerated are locked up in your safe. They are paid for and they are unpledged. All that you have got to do is to sit and wait until the times mend. The future, as Mr. J. H. Thomas knows to his cost, depends on politics, on finance and on trade. If I knew what the next Budget was going to be, if I knew whether our basic industries in the North were going to improve, and if I knew what was going to happen about Free Trade and Protection, I need hardly say that I should not be standing here in an overheated room trying to get you to pass these accounts. As it is, gentlemen, I am here, and so I beg to move " That the report and accounts be adopted."

Mr. G. Goldthorp Hay seconded the resolution, which was carried unanimously.

RAND SELECTION CORPORATION, LTD.

(*Incorporated in the Union of South Africa.*)

Directors : A. F. Lyall (*Chairman*), Hon. H. Crawford, R. B. Hagart, A. Hicks, W. E. Hudson, Sir E. Oppenheimer, J. S. Wetzlar. *London Committee :* W. Dunkels, F. W. Green, H. S. Johnson-Hall, L. Oppenheimer. *Secretaries and Consulting Engineers :* Anglo-American Corporation of South Africa, Ltd. *Head Office :* Johannesburg. *London Office :* 5, London Wall Buildings, Finsbury Circus, E.C. 2. *Formed* 1889 as the Transvaal Coal Trust Co., Ltd. *Capital issued :* £900,000 in 5s. shares.

Business : Finance of and investment in mining companies operating in the Rand and elsewhere.

REPORT OF THE DIRECTORS FOR THE YEAR ENDED SEPTEMBER 30, 1929, TO BE SUBMITTED AT THE THIRTY-EIGHTH ORDINARY GENERAL MEETING OF SHAREHOLDERS, TO BE HELD IN THE BOARD ROOM, "ANMERCOSA HOUSE," JOHANNESBURG, ON SATURDAY, FEBRUARY 22, 1930.

The directors beg to submit their report and audited financial statements for the year ended September 30, 1929.

The issued capital of the Corporation remains unaltered at £900,000 in 3,600,000 shares of 5s. each.

The value of stands sold in the Corporation's townships at Brakpan and Springs was £3,100. Collections amounted to £3,025, and the amount outstanding at September 30 last in respect of unpaid instalments, plus accrued interest, was £2,275.

The Corporation's principal interests are in the following companies:—Brakpan Mines, Ltd., Springs Mines, Ltd., West Springs, Ltd., Daggafontein Mines, Ltd., De Beers Consolidated Mines, Ltd., Consolidated Diamond Mines of South-West Africa, Ltd., Cape Coast Exploration, Ltd., Rhodesian Anglo-American, Ltd., Rhodesian Land, Cattle and Ranching Corporation, Ltd., Anmercosa Land and Estates, Ltd.

Under existing arrangements with the Anglo-American Corporation of South Africa, Ltd., the Company was afforded the opportunity of participating in the formation of the Rhodesian Anglo-American, Ltd., and in this connexion shares held in mining companies in Northern Rhodesia were surrendered. The Company's interests in this sphere are now represented by its holding in the new Company.

The profit earned during the year ended September 30, 1929, amounted to £274,040 18s. 1d., to which must be added the unappropriated profit brought forward from 1928, amounting to £73,014 13s. 3d., making a total of £347,055 11s. 4d.

This amount has been dealt with as follows :—

Government and Provincial Taxation	£38,571 18 6
Dividend No. 53 of 10% . .	90,000 0 0
Dividend No. 54 of 15% . .	135,000 0 0
Balance unappropriated . .	83,483 12 10
	£347,055 11 4

The increase in the amount appropriated to meet Government and Provincial taxation compared with last year is accounted for by the larger amount of Provincial tax payable on account of the increased dividend paid during the current year, and also by a larger proportion of the Company's profits having been earned in London, where the rate of tax is higher than South Africa.

The tree planting programme is now almost complete. Revenue from this source is practically balancing expenditure.

Two dividends were declared during the year, as follows:—No. 53 of 10%, and No. 54 of 15%. These dividends absorbed an amount of £225,000.

The Board regret to report the death of Mr. F. R. Lynch, who has been associated with the Corporation for many years and was Chairman of the Board from 1915 to 1927.

Mr. R. B. Hagart was appointed to fill the vacancy caused by the death of Mr. F. R. Lynch, and shareholders will be asked to confirm this appointment.

In accordance with the Articles of Association, Sir Ernest Oppenheimer and the Honourable Hugh Crawford retire, but are eligible and offer themselves for re-election.

Shareholders are requested to fix the remuneration for the past audit and to elect auditors for the ensuing year.

The auditors, Messrs. Alex. Aiken and W. E. Goldby, retire, but are eligible and offer themselves for re-election.

L. A. POLLACK, *Acting Chairman.*
H. CRAWFORD,
R. B. HAGART,
W. E. HUDSON,
E. OPPENHEIMER. } *Directors.*

ANGLO-AMERICAN CORPORATION OF SOUTH AFRICA, LTD.,
Secretaries.
Per J. BOYD.

Johannesburg,
December 19, 1929.

JOHANNESBURG CONSOLIDATED INVESTMENT CO., LTD.

(Incorporated in the Union of South Africa.)

Mining Companies' Reports for Quarter Ended December 31, 1929.

GENERAL REMARKS.—The development figures are the actual results of the sampling of development work on reef; no allowance has been made for modifications which may be necessary when computing the ore reserves.

10/11, Austin Friars, London, E.C. 2,
January 17, 1930.

Government Gold Mining Areas (Modderfontein) Consolidated, Ltd.

(Incorporated in the Union of South Africa.)

Issued Capital - - - £1,400,000.

Tons crushed, 608,000, yielding **271,947** fine ounces of gold.		Per ton, based on tonnage crushed.
Total Working Revenue	£1,155,157	£1 18 0
Total Working Costs	494,874	0 16 3
Working Profit	£660,283	£1 1 9
Sundry Revenue	26,067	

Total Profit for Quarter £686,350

No allowance has been made in the above for Government's share of profits or South African taxation. The expenditure on capital account amounted to **£13,453.** The DEVELOPMENT FOOTAGE sampled totalled **4,700** ft., and gave the following results:—**Payable 2,860** ft., having an average value of **10·4** dwt. over **43** in. of reef. **Unpayable 1,840** ft., having an average value of **3·9** dwt. over **35** in. of reef. A Dividend of **45%** (**2s. 3d.** per share) has been declared payable to all shareholders registered at December 31, 1929. The Dividend will be payable on and after February 6.

Van Ryn Deep, Ltd.

(Incorporated in the Union of South Africa.)

Issued Capital - - - £1,196,892.

Tons crushed, 185,000, yielding **74,410** fine ounces of gold.		Per ton, based on tonnage crushed.
Total Working Revenue	£316,074	£1 14 2
Total Working Costs	192,499	1 0 10
Working Profit	£123,575	£0 13 4
Sundry Revenue	3,724	

Total Profit for Quarter £127,299

No allowance has been made in the above for South African taxation. The DEVELOPMENT FOOTAGE sampled totalled **4,485** ft., and gave the following results:—**Payable 1,990** ft., having an average value of **10·9** dwt. over **29** in. of reef. **Unpayable 2,495** ft., having an average value of **2·6** dwt. over **40** in. of reef. A Dividend of **17½%** (**3s. 6d.** per share) has been declared payable to all shareholders registered at December 31, 1929. The Dividend will be payable on and after February 6.

New State Areas, Ltd.

(Incorporated in the Union of South Africa.)

Issued Capital - - - £1,514,037.
6% Debentures - - - £279,900.

Tons crushed, 228,000, yielding **101,329** fine ounces of gold.		Per ton, based on tonnage crushed.
Total Working Revenue	£430,418	£1 17 9
Total Working Costs	243,723	1 1 5
Working Profit	£186,695	£0 16 4
Sundry Revenue	5,726	

Total Profit for Quarter £192,421

No allowance has been made in the above for Government's share of profits or South African taxation. The expenditure on capital account amounted to **£152,** and debenture interest to **£4,199.** The DEVELOPMENT FOOTAGE sampled totalled **3,380** ft., and gave the following results:—**Payable 1,510** ft., having an average value of **18** dwt. over **25** in. of reef. **Unpayable 1,870** ft., having an average value of **9·1** dwt. over **13** in. of reef. A strike of white miners lasting three days occurred during the quarter; operations were unaffected. A Dividend of **5%** (**1s.** per share) has been declared payable to all shareholders registered at December 31, 1929. The Dividend will be payable on and after February 6.

The Langlaagte Estate and Gold Mining Co., Ltd.

(Incorporated in the Union of South Africa.)

Issued Capital - - - £1,519,833.

Tons crushed, 234,500, yielding **78,848** fine ounces of gold.		Per ton, based on tonnage crushed.
Total Working Revenue	£334,924	£1 8 7
Total Working Costs	254,227	1 1 8
Working Profit	£80,697	£0 6 11
Sundry Revenue	6,630	

Total Profit for Quarter £87,327

No allowance has been made in the above for South African taxation. The expenditure on capital account amounted to **£2,534.** The DEVELOPMENT FOOTAGE sampled totalled **5,390** ft., and gave the following results:—**Payable 2,760** ft., having an average value of **71** dwt. over **7** in. of reef. **Unpayable 2,630** ft., having an average value of **8·3** dwt. over **9** in. of reef. A Dividend of **7½%** (**1s. 6d.** per share) has been declared payable to all shareholders registered at December 31, 1929. The Dividend will be payable on and after February 6.

Witwatersrand Gold Mining Co., Ltd.

(Incorporated in the Union of South Africa.)

Issued Capital - - - £469,625.

Tons crushed, 160,500, yielding **35,547** fine ounces of gold.		Per ton, based on tonnage crushed.
Total Working Revenue	£150,995	£0 18 10
Total Working Costs	143,785	0 17 11
Working Profit	£7,210	0 0 11
Sundry Revenue	5,462	

Total Profit for Quarter £12,672

No allowance has been made in the above for South African taxation. The DEVELOPMENT FOOTAGE sampled totalled **2,550** ft., and gave the following results:—**Payable 630** ft., having an average value of **11·9** dwt. over **41·8** in. of reef. **Unpayable 1,920** ft., having an average value of **2·7** dwt. over **36·1** in. of reef. A Dividend of **2½%**, (**6d.** per share) has been declared, payable to all shareholders registered at December 31, 1929. The Dividend will be payable on and after February 6.

SAN FRANCISCO MINES OF MEXICO, LTD.

Directors : The Earl of Denbigh (*Chairman*), Thomas Ford, Joseph Kitchin, Walter Maclachlan, Cyrus T. Pott, Sir Henry Strakosch, Major F. G. Trobridge. *Secretaries :* Union Corporation, Ltd. *Office :* Princes House, 95, Gresham Street, London, E.C. 2. *Formed* 1913. *Capital issued :* £763,425 10s. in 10s. shares.

Business : Operates lead-zinc-silver mines near Parral, Mexico.

The seventeenth ordinary general meeting of shareholders of San Francisco Mines of Mexico was held on February 11 at Winchester House, London, E.C. 2, the Earl of Denbigh (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended September 30 last, said that for reasons to which he would refer later, the ore milled during the year rose only from 300,010 to 307,450 tons, but the total revenue rose from £650,084 to £709,198, and the operating profit from £366,316 to £415,267, owing principally to improved terms for their lead concentrates, and higher recovery of metals. Charges were rather smaller at £81,678, against £88,186, resulting in a net profit of £333,589, against £278,130. In view of the capital expenditure in prospect, it was considered prudent to maintain the dividend for the year at 3s. 9d. per share. There was an undivided surplus of £47,305, which resulted in the amount carried forward being increased from £125,260 to £172,565.

The fears expressed last year as to the effect of a continued failure of rains were unfortunately justified, and they had set about the erection of the second-hand thermo-electric plant to which he had referred. This was not available until two months after the close of the year, so that the ore milled dropped from 27,950 tons in July to 22,220 tons in August. The plant was just sufficient in size to enable them to mill at the present rate, and it was at present being supplemented by outside hydro-electric supply.

The combined blocked-out and partly blocked-out ore reserves, totalling 1,894,500 tons, showed practically no increase for the year, this being due to the lack of power. 58% of the reserves applied to the San Francisco Vein and 14½% to the Footwall Vein, the remaining 27½% applied to other reefs such as the Madronos, Brown, and Bronces. The development of the Brown Vein at the 7th Level had been the feature of recent work. As far as taken into the ore reserves it accounted for about 8%, calculated over a width of 1 to 2 metres. The San Francisco mine, laterally and in depth continued to give every encouragement to assume a long and prosperous future. In view of this strong position it was intended to increase the mill from a capacity of 300,000 to 500,000 tons per annum, and preliminary work with this in view is now in hand. The additional capacity could deal with either sulphide or oxidized ores, as the conditions might dictate.

The report and accounts were adopted.

GOVERNMENT of the COLONY of SOUTHERN RHODESIA.

VACANCIES FOR TWO GEOLOGISTS AND ONE MINERALOGIST.

Applications are invited for the following posts in the Department of Geological Survey, Southern Rhodesia :—

(*a*) **Geologist**—Senior. Salary £630 per annum, thence by annual increments of £30 to £750 per annum.

(*b*) **Geologist**—Junior. Salary from £400 to £450 per annum according to experience, thence by annual increments of £25 to £600 per annum.

(*c*) **Mineralogist**—Junior. As (*b*) above.

Applicants must have taken a University degree with geology and its allied sciences in their final examination and some qualification in mining geology is desirable.

Steamship and railway fares will be provided from London to Salisbury.

The appointments will be under agreement for a period of three years and thereafter, subject to satisfactory service, applicants will be eligible for appointment to the Fixed Establishment of the Civil Service.

Further details and particulars may be obtained from the Secretary, Office of the High Commissioner for Southern Rhodesia, Crown House, Aldwych, London, W.C. 2, with whom applications with copies of qualifications and testimonials must be lodged not later than the 31st March, 1930.

Professional Directory

ADDICKS, Lawrence,
Consulting Engineer,
Bel Air, Maryland, U.S.A.
Cables: Galis, New York.

AGNEW, John A., Tel.: London Wall 7751.
49, Moorgate London, E.C.2.
Cables: Lingulina, London.

AGUILAR-REVOREDO, J. F.,
Mining Engineer,
Casilla 900, Lima, Peru.

ALDRIDGE, Walter H.,
Mining and Metallurgical Engineer,
41, East 42nd Street, New York.

ALLAN, Clyde,
Mining Engineer,
P.O. Jos, Northern Nigeria.

ANDERSON, Robert J.,
Aluminium Consultant,
704, Locust Ave., Fairmont, W. Va., U.S.A.

ASHCROFT, Edgar A.,
Consulting Metallurgist,
New Methods in Metallurgy.
Waye House Laboratories, nr. Ashburton, S. Devon.
Cables: Nutalgy, Ashburton.

BANKS, Charles A.,
Mining Engineer,
612 Pacific Building, Hastings Street, W.,
Vancouver, B.C.
Cables: Bankca. Code: Bedford McNeill.

BARRY, John G.,
Consulting Mining Geologist and Engineer,
609, Mills Building, El Paso, Texas.
Cables: Bargo. Code: Bedford McNeill.

BARTON, Donald C.,
Consulting Geologist and Geophysicist
Specialist: Eotvos Torsion Balance.
Petroleum Building, Houston, Texas.

BEATTY, A. Chester,
25, Broad Street, New York.
No professional work entertained.

BELL, J. Mackintosh,
Mining Geologist,
Ottawa Electric Building, Ottawa, Ont., Canada.
Cables: Jamackbell.

C. P. C. BERESFORD. J. T. GLIDDEN.
BERESFORD & GLIDDEN,
Mining Engineers,
Cassilla 557, La Paz, Bolivia.
Cables: Beresford, La Paz.

BEST, James P.,
Mining & Mechanical Engineer
(Alluvials),
P.O. Jemaa, Plateau Province, N. Nigeria.
Code: Broomhall.

Tel.: London Wall 8900.
BEWICK, MOREING & Co.,
62, London Wall, London, E.C.2.
Cables: Bewick.

BOISE, Charles W.,
Mining Engineer,
Foreign Exploration,
Room 1507—14 Wall Street, New York.
Cables: Mukeba.

BOTSFORD, R. S.,
Mining Engineer,
Fraser Brace, Ltd., Medellin, Colombia, S.Am.
265, Gresham House, London, E.C.2.

BOYD, Julian,
Consulting Mining Engineer,
1014, Central Building, Los Angeles, California.
Cables: Boydite.

BOYDELL, H. C.,
Mining Geologist and Engineer,
310, McKinnon Building, Toronto, Canada.
Cables: Husky.

BOYES, H. H. W.,
Messrs. Foley, Boyes, Butler & Peek,
Consulting and Mining Engineers,
P.O. Jos, Northern Nigeria.
Cables: Foyes, Jos. Codes: Bentley, Broomhall.

Tel.: London Wall 6940.
BROADBRIDGE, Walter,
Consulting, Mining & Metallurgical Engineer,
Minerals Separation, Ltd., 62, London Wall, E.C.2.
Cable: Rillstope, London.

BRODIE, Walter M.,
Mining Engineer and Metallurgist,
1807, Phelps Place, Washington, D.C., U.S.A.