The Mining Magazine

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EDITORIAL

THE 1930-31 session of the Sir John Cass Technical Institute, of Jewry Street, Aldgate, commences this month. The classes are held in the evenings and include courses in petroleum technology, metallurgy, and geology.

THE closing of the great arch of the Sydney Harbour marks the concluding stage of what will be regarded as one of the greatest engineering feats, it being the heaviest steel arch yet erected. It is satisfactory to realize that this is yet another tribute to British engineering skill both in design and workmanship.

SUPPORTERS of an amalgamation of the two Rhodesias have been helped by the stir created by the publication of the White Paper on the native question in Equatorial Africa. A conference of leading men from both the colonies has been arranged for September 26, when the White Paper will be the principal item on the agenda.

FOR his discovery on August 29, 1831, of a principle in which lies the origin of the dynamo the name of Michael Faraday is to be honoured in September of next year, by a number of centenary celebrations arrangements for which are in the hands of the Royal Institution, assisted by the Institution of Electrical Engineers. Faraday's discovery of induced currents is often quoted as the classical example of the utility of advances in pure science.

THE British Red Cross Society proposes to start a course of instruction on the subject of tropical hygiene, doubtless prompted by the recent spell of sub-tropical weather some of us have been enjoying in London of late. Particulars of this course, which should be of interest to many MAGAZINE readers, can be obtained from the London branch of the society at 27, Grosvenor Place, S.W. 1. It is to be hoped that the instruction will be repeated at intervals.

PROSPECTING conditions in the Gold Coast Colony and particularly in the area west of the Tano River have been considerably improved by the development of the system of motor roads. Last year saw the completion of the new road from Insu railway station (67 miles from Takoradi) to Enchi, while a good road already exists from Dunkwa to Sefwi Wiaso. The Goaso district of Western Ashanti is also now served by a good motor road from Kumasi.

THE first world conference on the incidence, causation, and prevention of silicosis was opened in Johannesburg on August 13 by Mr. Sampson, Union Minister of Posts and Telegraphs. The work of the conference extended over a fortnight and much of that time was devoted to an examination of the mass of material which has been collected on the Rand since gold mining began there. The chief recommendation of the conference was that some standard method for the routine sampling of air should be established in those industries in which silicosis may occur.

THE announcement that the British Non-Ferrous Metals Research Association proposes to centralize its offices and to provide accommodation for laboratory and workshops in London reveals that the recently-organized appeal for increased support has met with encouraging success. Recent appointments to the staff have been those of Dr. H. H. Ingall, of the Constantine Technical College, Middlesborough, as assistant director and research manager, and Mr. G. L. Bailey, of the Metallurgy Section, Research Department, Woolwich, as development officer.

DURING the past month there has been a fair amount of publicity with regard to the erection of a copper refinery in this country. Whilst no definite decision has been reached up to the present, there is but little doubt that arrangements will ultimately be made to refine the product of the Rhodesian mines in this country and the site for the works is expected to be Liverpool. As the erection of a refinery is not only an expensive but a responsible undertaking, it is anticipated that those carrying out the work will receive the support of the Government in bringing to fruition a project calculated to benefit the Empire.

Sieve and Screen Sizes

The standardization of screen sizes would appear to be an ideal almost as difficult of attainment as that greater and much more widely demanded ideal of international agreement upon weights and measures, such as can only be achieved by the universal adoption of the metric system. There are two important screen systems now in wide use—the Tyler and the Institution of Mining and Metallurgy, or the I.M.M., as it is generally known—but in addition to these there are the United States Bureau of Standards series—which is a revivification of the old Rittinger series—and the de Kalb and the Hoover series. As though these were insufficient and with a view to a step in the direction of uniformity the British Engineering Standards Association has just issued a draft specification for a new English series bearing a resemblance to the United States Bureau scale as closely as the differing wire gauges in the two countries will permit. The Institution of Mining and Metallurgy, which was naturally represented on the British Engineering Standards Association committee examining this matter, is in the unfortunate position of having submitted a revised and extended I.M.M. scale which was not acceptable to the main committee. There is so much to be said for both cases that it is extremely difficult to arrive at a conclusion as to which deserves to be adopted and time alone can show which is to be the survivor.

At this juncture it may be as well to examine the existing and proposed systems a little more closely with a view to throwing some light on a controversy of considerable significance in the field of ore-dressing. In virtue of the fact that it is most widely used, the Tyler series deserves the first place in this consideration. Here it is important to distinguish between the Tyler series itself and the United States Bureau of Standards series, with which it is often confused. The Tyler screen series, originated by a manufacturing organization, has been available since 1910, and is based on a fixed ratio between successive members of the series of $\sqrt{2}$, or 1·414, taking as base the 200-mesh sieve having an opening of 0·0029 inch and made from wire 0·0021 inch in diameter. The only difference between this and the United States Bureau of Standards series is that the base of the latter is 1 millimetre. Both these series introduce for closer sizing intermediate screens, which bring the series into a new scale having as the ratio between successive members $\sqrt[4]{2}$, generally known as the Richards series or "Double Rittinger." These two ratios refer to those existing between the linear dimensions of the aperture and the reason for the reduction is evident since they represent an area difference respectively of $\frac{1}{2}$ and $\frac{1}{4}$, or, expressed differently, an area ratio between successive members of 2 and 4. In addition, the American sieves are made of wire, the thickness of which is not so great as is recommended by the Institution of Mining and Metallurgy, thus resulting in a bigger screening area. The constant ratio between successive members of the series coupled with the use of thinner wire for the reason given constitute the essential advantages of the American screens. The Institution of Mining and Metallurgy series, which has been available since 1907, measures the aperture in terms of the inch, each successive member being a round fraction of the unit. It has the important advantage, that the mesh figure is an exact measure of the aperture. This is secured by having the diameter of the wire equal to the linear dimension of the aperture, so that, to take a random example, a 20-mesh screen has 20 apertures (and 20 wires) to the inch, each aperture being, therefore, $\frac{1}{40}$th of an inch. The available screen area is thus only 25% of the whole, which while not a disadvantage in laboratory sieving, is definitely a fault in commercial screening in bulk.

The new series proposed by the British Engineering Standards Association proposes apertures equal to those of the United States Bureau of Standards sieves and the same range, but, because the wire gauge and the wire-weaving conventions in this country are not the same, it follows that the number of apertures to the inch, or, in other words, the mesh, will not be the same. The following table, showing a few in the two series, exemplifies this and for purposes of comparison the corresponding commercial Tyler series has been added:

Present American (U.S. Bureau of Standards).	Proposed New British.	Tyler Series (Commercial).
200	240	200
170	200	170
140	170	150
120	150	115
100	120	100
80	100	80
70	85	65

On the other hand, the Institution of Mining and Metallurgy, through its two delegates

to this committee, was dissatisfied with this proposal and brought up a counter suggestion in the shape of a new Institution of Mining and Metallurgy series, which has two important features—the sieve number is the reciprocal of the aperture size and the wire is not of the same diameter. This means that the 400 screen has an aperture of $\frac{1}{400}$th of an inch (= the present 200 mesh) and the 200 screen has an aperture of $\frac{1}{200}$th of an inch, and so on. There are moreover 25 screens in the series against 17 in the existing one and because of the reduced size of wire gauge used the average screening area is 35%.

The various advantages and disadvantages inherent in these systems, both existing and prospective, have been alluded to *en passant*, nevertheless it may be as well to summarize the position as to the claims of the two proposed new systems. The Tyler system is widely used and therefore a British system possessing the same apertures, even if these are called by a different mesh number, is an evident contribution to the standardization of screen sizes. On the other hand, the Institution of Mining and Metallurgy series, in spite of its disadvantages of a small screening area, is still standard for testing purposes in Australia and South Africa and the new series appears to be the rational improvement on the old, for here the screen number is for the first time a true index of the size of the product and the series possesses the further advantage of a considerably increased screening area.

The Life of the Rand

With the almost universal adoption of the gold standard, it is inevitable that as the result of the world-wide depression experienced for some time past increased attention should be attracted to gold itself, since, in a time of falling values, the standard metal alone preserves its full worth. Thus the position of the Rand, the present producer of more than half of the world's supply of new gold, becomes of even greater importance than in normal times and factors relating to the future prosperity of this great goldfield, an Imperial asset of such importance, cannot fail to be of surpassing interest. In the June issue of the MAGAZINE, following the publication of the annual reports of the companies controlling operations on this field, some attention was given to the pronouncements of Sir Sothern Holland on the future of the Rand and also to the fact that, owing to the efforts of Sir Robert Kotze in the Union Parliament, a government investigation of the position of the Rand has been promised. Attention has once again been directed to this matter by the publication of a new edition of the Union of South Africa *Official Year-Book*, which contains an estimate of the mining life of the Witwatersrand, specially prepared by Dr. Hans Pirow, the government mining engineer, who, in view of the very great importance of the subject, "has gone carefully into the available data."

Dr. Pirow in his survey, after noting that the probable lives of the fully-developed areas as estimated annually for taxation purposes are almost certainly calculated conservatively, returns to the truism that "the cost of production is a very important factor," as any fall in working costs on the Rand, or indeed on any mining field, would add enormously to ore-reserves. In the report under consideration the view is expressed that a reduction of costs by two shillings per ton would mean that there would be no appreciable diminution in the output of this field in the next eight or ten years. Interwoven with the cost factor is the question of the adequate supply of native labour, for this is absolutely essential if the existing mines are to work to full capacity, and Dr. Pirow estimates that if this were ensured it would be equivalent to a reduction of two shillings per ton in costs. Yet another factor remains, and this is the opening of new mines. The government engineer makes the further estimate that six new mines—three each on the East and West Rand—will start crushing between 1935 and 1940, adding to the demand for native labour.

Basing his calculations on the qualifying factors referred to and assuming no further changes, Dr. Pirow estimates the annual production of gold in the next 20 years, starting from 1930, at £43,500,000. He anticipates there will be a falling off in 1931 of £900,000, an increase in 1932 of £1,200,000, and a relapse in 1933 of £1,300,000. During the subsequent four years the estimated returns are: 1934, £40,700,000; 1925, £39,034,250; 1936 and 1937, £34,400,000 for each year. The first serious fall is expected to occur in 1939, when on the basis of present costs the output will fall £7,000,000 to £27,400,000. For 1940 and 1941 the output is put at £25,500,000 and by 1945 it is

estimated it will have fallen to £15,500,000. For the final three years, 1947–49, the annual return is put at approximately £10,000,000.

Recent surveys of the labour position on the Rand would seem to show that the supply is unlikely to be increased to any great extent, even by the proposal of the Union Government to subsidize "poor white" labour in order that more natives may become available for the mines, a proposition which, in view of the incidence of taxation, would certainly increase the expenditure of the mines, whilst at the same time there would be no guarantee that they would secure the natives who had been relieved of their work in other industries. It is difficult to see how production costs can be reduced except by Government aid in the way of reduced freight charges for supplies to the mines, although here again the loss to the Government could only be replaced by increased taxation in other directions, some of which would have to be borne by the mines. Dr. Pirow may therefore be correct in his assumption that the conditioning factors are unlikely to change and his calculations will probably be justified.

Australia and the Gold Bonus

The financial conference of Federal and State Ministers which recently concluded its work at Melbourne has unanimously decided that energetic and concerted measures are necessary to enable Australia to combat the effects of her present economic position. The details of the proposals involved have yet to be settled, but may include a drastic cutting down of expenditure, a curtailment of internal development, and a postponement of further external borrowing until the present short-term indebtedness has been covered.

The report of Sir Otto Niemeyer presents very clearly the nature of the present crisis, and, wisely, does not attempt to hide the grave situation which has arisen. It is shown that the strongest feature which has contributed to the present difficulties has been the attempt to maintain a standard of living which was unjustified by existing economic conditions. Rising wages, forced by powerful Labour unions, usually met by increased measures of protection, have raised costs of production in the Commonwealth to such a level that to outside observers it was evident that the reckoning would some day be very heavy, although probably few people realized that this point would be reached so soon. The rapid fall in the world prices of the two main primary products of the continent, wool and wheat, has hastened the crisis and the whole internal economy of the Commonwealth has temporarily been thrown out of gear, leaving Federal and State budgets unbalanced. In this predicament Australia has been forced to pay the interest on long-term loans contracted since the war by the expedient of obtaining short-term loans in London. Here we are mainly concerned with the position of the mining industry and under the circumstances mentioned it was perhaps inevitable that the recent agitation for the granting of a bonus on new gold produced in the Commonwealth, or, alternatively, for a bonus on increased gold production, should have been met by refusal from the Federal Premier. This decision, which was contained in a letter from Mr. Scullin to the Premier of Western Australia, means that the whole question is deferred until the advent of better times "down-under."

As to the advisability of granting a bonus on the production of gold, although this may be somewhat outside our province, there are certain circumstances in the position of Western Australia worthy of review. The general policy of protection forced on successive Federal governments has hit the producers of primary commodities very badly, as, indeed, production under artificial conditions with sale on the open market would be likely to hit any primary producers. West Australia has a large wool production and its wheat crop is at least as large as that of any other Australian State. In these circumstances it is evident that the demand of the State for a measure of protection was not entirely unwarranted. It is to be doubted, however, whether any such extension of the bounty system could ever be warranted, especially in the case of gold. Gold occupies little space and gold smuggling might well become profitable. In addition, it is not altogether certain that the granting of a bonus would ensure the development of mines; on the contrary, it might well lead to their rapid impoverishment in the rush to earn the bounty. State-aided development might be a better solution of the problem. Also there is no guarantee that Australian labour would be content to see the granting of a gold bonus without wishing to take its share. Finally it is to be questioned whether an article the price of which is stabilized at £4 can ever be worth £5.

REVIEW OF MINING

Introduction.—During the past month there has been evidence of improvement in some directions, but with little diminution in the stocks the prices of base metals show little change. The effects of the restricted output of tin during the next two months will be watched with interest.

Transvaal.—The output of gold on the Rand for August was 878,474 oz. and in outside districts 42,607 oz., making a total of 921,081 oz., as compared with 912,652 oz. in July. The natives employed on the gold mines at the end of the month totalled 202,257, as compared with 201,111 at the end of July.

A meeting of shareholders in Kleinfontein Estates is to be held in Johannesburg on September 15, when it will be proposed that the capital be reduced from £42,500 to £31,875. The reduction will be effected by a return of 2s. 6d. capital on the 10s. shares.

The quarterly report of Onverwacht Platinum, Ltd., covering the period to June 30 last, shows that during this period 6,956 tons of ore was milled and 764 oz. platinum group metals recovered. Milling operations were confined to the treatment of eluvial ground and accumulated sands, the mill being closed down early in June and the final clean-up completed in July.

There is a prospect of the area owned by the Grootvlei Proprietary Mines, which adjoins the East Geduld and Daggafontein, being developed, the finance being provided by the groups controlling the three companies mentioned.

During the year ended June 30 last the Modderfontein East increased the ore milled by 41,500 tons to 817,000 tons, a record figure, and working costs were reduced by 6d. per ton. Owing, however, to decreased yield, the working profit was less by £21,788 at £206,538. Dividends paid during the year absorbed £186,161, equal to 20%. The ore-reserves at the end of the year were estimated to be 2,013,000 tons, averaging 5·8 dwt. over 46·9 in., a decrease of 32,400 tons in amount and 0·3 dwt. in value when compared with the previous year.

The report of Nourse Mines, Ltd., for the year ended June 30 last shows that the extended development programme added considerably to the ore-reserves, which were increased by 24,800 tons to 1,291,500 tons, averaging 5·9 dwt. over a stoping width of 43 in. During the year 719,700 tons of ore was crushed, a decrease of 11,300 tons when compared with the previous year, while working costs increased by 5d. per ton. With increased yield, however, the working profit was greater by £2,472 at £56,326. Dividends paid during the year absorbed £39,183, equal to 5%.

Diamonds.—The returns of the Union Department of Mines for the first half of 1930 give the value of the diamond production during that period as £4,144,175, a decrease of over £1,500,000 when compared with the corresponding six months of 1929. The most notable falling off was in the Namaqualand stones, the sale of diamonds from this source being only £600,000, against £2,195,000. The average value of all Union stones has fallen from 79s. 6d. to 60s. 1d. per carat. It is reported that differences of opinion exist between the Union Diamond Control Board and the syndicate, the former wishing to increase the Government's quota.

Southern Rhodesia.—The output of gold from Southern Rhodesia during July was 45,810 oz., as compared with 45,208 oz. in June and 46,369 oz. in July of 1929. Other outputs in July were : Silver, 5,759 oz. ; copper, 143 tons ; coal, 79,982 tons ; chrome ore, 35,622 tons ; asbestos, 1,572 tons ; mica, 24 tons ; scheelite, 9 tons.

Northern Rhodesia.—The report of Roan Antelope Copper covering the period to June 30 shows that diamond drilling has been curtailed and that development and construction work and the erection of plant are all proceeding smoothly. Operations at the pilot plant were suspended on June 5, sufficient concentrates for the smelting experiments having been produced. During the quarter 1,053 tons of ore was treated and 57 tons of concentrates shipped.

According to the quarterly report of the Bwana M'Kubwa the pilot plant on the N'Kana mine started work on May 16 last, 4,848 tons of ore being treated to the end of June, producing 180 tons of concentrates averaging 45·43% copper.

Shareholders of N'Changa Copper Mines, Ltd., have been informed that bore-hole B.36 was completed to 1,588 ft., no values being disclosed below 1,540 ft. From 1,420 ft. to 1,485 ft. the core averaged approximately 11·5% copper.

At the annual meeting, held in June last,

shareholders in Luiri Gold Areas, Ltd., were informed of promising developments in No. 5 winze, which in 107 ft. sunk below the first level showed 30 in. of ore averaging 3 oz. per ton. It has now been announced that a further 35 ft. has been sunk on the same winze, the good values continuing the whole way. The new main vertical shaft was 78 ft. deep at the end of July.

South-West Africa.—It has recently been revealed that the British Administrator of South-West Africa has granted exclusive prospecting rights over a large area to the Consolidated Mining and Smelting Company of Canada.

Gold Coast.—A circular to shareholders of the Ariston Gold Mines states that the fully developed ore reserves at the end of June amounted to 70,450 tons, averaging 9·96 dwt., while there were in addition 73,926 tons of partially developed ore estimated to contain 16·41 dwt. per ton. Satisfactory values continue to be exposed in the lower portion of the mine.

India.—The returns of the Indian Copper Corporation, Ltd., for July recorded the initial output of yellow metal sheet from the new rolling mill. Thus, with the exception of the new converters, which will shortly be in operation, the programme of equipment recommended at the time of the debenture issue in 1927 is now completed.

Australia.—On the recommendation of the general manager, the South Kalgurli Consolidated has decided to reduce the grade of ore treated, which, it is estimated, will bring down the monthly profit to approximately £1,500.

Recent developments at the Lake View and Star have continued favourable. From a cross-cut west at the 2,000 ft. level in the Chaffers section the Horseshoe No. 2 lode has been cut, showing a value of £24 12s. 6d. over 6 ft. In addition, driving along the Maclaren ore-body from a cross-cut 750 ft. south of the Horseshoe main shaft, on the 2,000 ft. level, values averaged £2 6s. over 63 in. for a distance of 56 ft. The results from the new flotation plant continue to be satisfactory, the amount of ore now being treated being approximately 150 tons per day.

An extraordinary general meeting of shareholders of St. Paul's River Tin, Ltd., is to be held toward the end of this month, when it will be proposed that the company be wound up voluntarily and a liquidator appointed.

Malaya.—At the extraordinary general meeting of the Temengor Tin Mining Company, Ltd., which was held at the end of July, a committee of shareholders was appointed to confer with the directors on the company's position. As a result it has been decided to ask shareholders to provide the amount necessary to carry out the recommendations of the engineers consulted, Messrs. Osborne and Chappel, to prove the value of the stone dumps, and meanwhile to carry on operations on a minimum basis.

Siam.—The reconstruction of Pattani Consolidated Alluvial Tin, Ltd., was approved by shareholders at the meeting held at the beginning of this month. The company will be put into voluntary liquidation and a new company formed with a capital of £170,000 in 5s. shares, which will acquire the undertaking and assets of the present company and discharge all its liabilities. New shares to the number of 639,993 are to be issued, shareholders having the right to subscribe for one new 5s. share, credited as 3s. 1½d. paid, for every fully-paid share now held. The alterations to the dredge have been completed and it is said to be working well. It is expected that the recovery of tin will start about the middle of October. During 1929 the old company treated 130,280 cu. yd. of ground by hydraulicking and recovered 59 tons of tin concentrates, which realized £8,398.

The report of the Kamra Tin Dredging company for 1929 shows that the dredge was completed towards the end of last year and was ready for digging early in the current year, but, owing to a mistake, it had been wrongly positioned and was unable to reach tin-bearing ground before June. In addition, severe drought has hampered operations, but it is expected that full working will commence as soon as ample water is available. Owing to this delay it has been found necessary to provide new capital for the repayment of debentures and to cover additional expenditure. An issue of £70,000 8% debenture stock has, therefore, been created and issued.

Mexico.—The report of the Mexican Corporation, Ltd., for the quarter ended June 30 last shows that at the Fresnillo mines earnings were considerably reduced owing to the fall in metal prices, unfavourable developments in preceding quarters, and abnormal development expenditure. During the current quarter favourable developments have materially improved the

stoping situation, so much so that it is hoped to be able to discontinue development work in the near future.

Spain.—A progress report issued by the Tigon Mining and Finance Corporation, Ltd., last month showed that it was desirable that alterations should be made in the design of the condensing system on the treatment plant. This will delay operations by approximately two months, and meanwhile the drilling programme is being continued. The negotiations for the acquisition of the properties in Chile, referred to in the July issue of the MAGAZINE, have been delayed for various reasons.

Yugoslavia.—Shareholders in Trepca Mines, Ltd., have been informed that production started on August 20. It is also reported that bore-hole No. 55 on the Stantrg mine, which was drilled at an inclination of 70° from the 760 m. level, has encountered ore at an inclined depth of 161·3 m. Preliminary results indicate 15·7 m. width of ore assaying 23·9% lead and 2·3% zinc. This ore has been found at approximately the horizon of the deep adit now being driven.

Russia.—The result of the Lena arbitration is that the company has been awarded £12,965,000, the Court finding that the Russian Government was the cause of the company's difficulties.

Consolidated Tin Smelters.—The Consolidated Tin Smelters have announced a dividend of 7% on the preference shares, payable September 30. It is the intention in future to pay the dividend on these share half-yearly.

Francois Cementation.—The report of the Francois Cementation Co. for the year ended March 31 last shows a net profit, after allowing for depreciation of plant, of £28,574, as compared with £47,517 in the previous year. The dividend on the 8% preference shares absorbed £16,000 and the balance was carried forward. The earnings of the company were affected partly by the depressed conditions in the heavy industries, which led to a falling off in contracts available, and also by the fact that certain contracts had presented unexpected difficulties. The company's work is spread over a variety of operations, but among other contracts may be mentioned that for the cementation of the sea-wall at Dawlish for the Great Western Railway. The Bicknell tunnelling machine has undergone a practical test during the year, as a result of which improvements have been effected which make the prospects of success with this machine more favourable. The programme of work in hand and in view and the continual growth of the business render new capital desirable, but the present time is not considered opportune for securing it.

Selection Trust.—During the year ended March 31 last Selection Trust made a profit of £307,325 and, after appropriations for reserves and dividends paid during the year, there remained an available balance of £233,072. From this £192,500 is to be distributed as dividends, equal to 27½%, leaving £40,572 to be carried forward. This distribution brings the total amount disbursed during the year to 30%. An extraordinary meeting is to be held at the end of the present month for the purpose of passing a resolution voluntarily to wind up the company. It is proposed after winding up to redeem the debenture stock at £103%, plus interest, and to pay off the preference shares at the rate of 21s. for each £1 preference share, plus a half-year's dividend, surplus assets being distributed to holders of the ordinary shares. In July last an offer was made to the ordinary shareholders by the Canadian Selection Company to acquire their shares and this offer has been accepted.

Mining Trust.—The first report of the Mining Trust, Ltd., which covers the period to June 30 last, shows that operations resulted in a net profit of £34,605, which has been carried forward. The issued capital of the company is now £5,745,988 and the value of the company's investments is given in the balance sheet as £4,404,046. Under the arrangements which have been recently made with the American Smelting and Refining Company 1,245,988 shares have been issued, while options over 467,500 shares have been surrendered to the company. At an extraordinary meeting to be held following the annual general meeting at the end of this month, it is proposed to alter the articles of association of the company in order that the restrictions over foreign shareholders shall be removed. An accompanying progress report gives the total ore-reserves of the Mount Isa mines as 30,554,000 tons sulphide and carbonate ore. It is expected that the power-house will be started in October next, the mill in November, and the smelter during January, 1931. It is added that good progress is being made with the survey of the Lawn Hills Concession.

HYDRAULIC MINING IN COLOMBIA

By R. S. BOTSFORD, A.R.S.M., M.I.M.M.

The author gives an account of progress and of hydraulic mining activities near Medellin, in the department of Antioquia, Colombia.

Medellin, the capital of the department of Antioquia, is one of the most progressive cities of Colombia. The Republic of Colombia, with 7,000,000 inhabitants, occupies the north-west corner of South America, adjacent to Panama. While the coastal towns are low and tropical both on the Atlantic and Pacific side, the adjacent interior is occupied by the ranges of the Andes mountains, in which the mining districts occur. Beyond Bogotá, the capital, there are very extensive plains leading down to the Amazon. The emeralds of Muzo and Chivor, near Bogotá, are world-famous, while the platinum of the Choco and gold dredging of Pato have become well known outside the country. Oil is being exploited and refined at Barranca Bermeja, on the Magdalena River, and there is a pipeline 500 kilometres to the sea at Cartagena in operation.

It is believed in Colombia that there are very extensive oilfields, principally east of the Magdalena River, towards Venezuela, and many foreign companies have been endeavouring to obtain concessions. The new President Olaya Herrera, who took office on the 7th of August, and who has represented Colombia at Washington for 9 years, is less fearful of foreign contacts and expects to grant suitable concessions, or otherwise exploit the oil, mines, and other natural resources. The question of a third Panama canal up the Atrato and through to the Pacific has been raised, but, whether desirable or not, in some quarters there is a fear of foreign influence.

Like some other South American republics, Colombia has devoted considerable attention to road and railroad construction to make the interior accessible, attracting much of the labour in the country to the public works, with the result of increasing wages to more than double the usual standard. In many cases the public works have not been completed, the loans for the purpose have been used up, and the work has been stopped for lack of money, and, consequently, wages have fallen to 60 cents a day. This has greatly facilitated gold mining and in the early part of this year the gold production increased 30%, while it is expected that the production for the year will be doubled. It is a great advantage to have the year's pay-roll only 40% of what it was in previous years.

Panoramic View of Medellin.

Medellin, with 120,000 inhabitants, with improved roads, electric light, power and cooking, telephones, sewage system, modernized buildings, good hotels, theatre, two movie theatres including the latest talkie system, automobiles, and a large country club, is an agreeable place to live in. The altitude is about 5,000 ft. and temperature 64°F., such that one can develop films

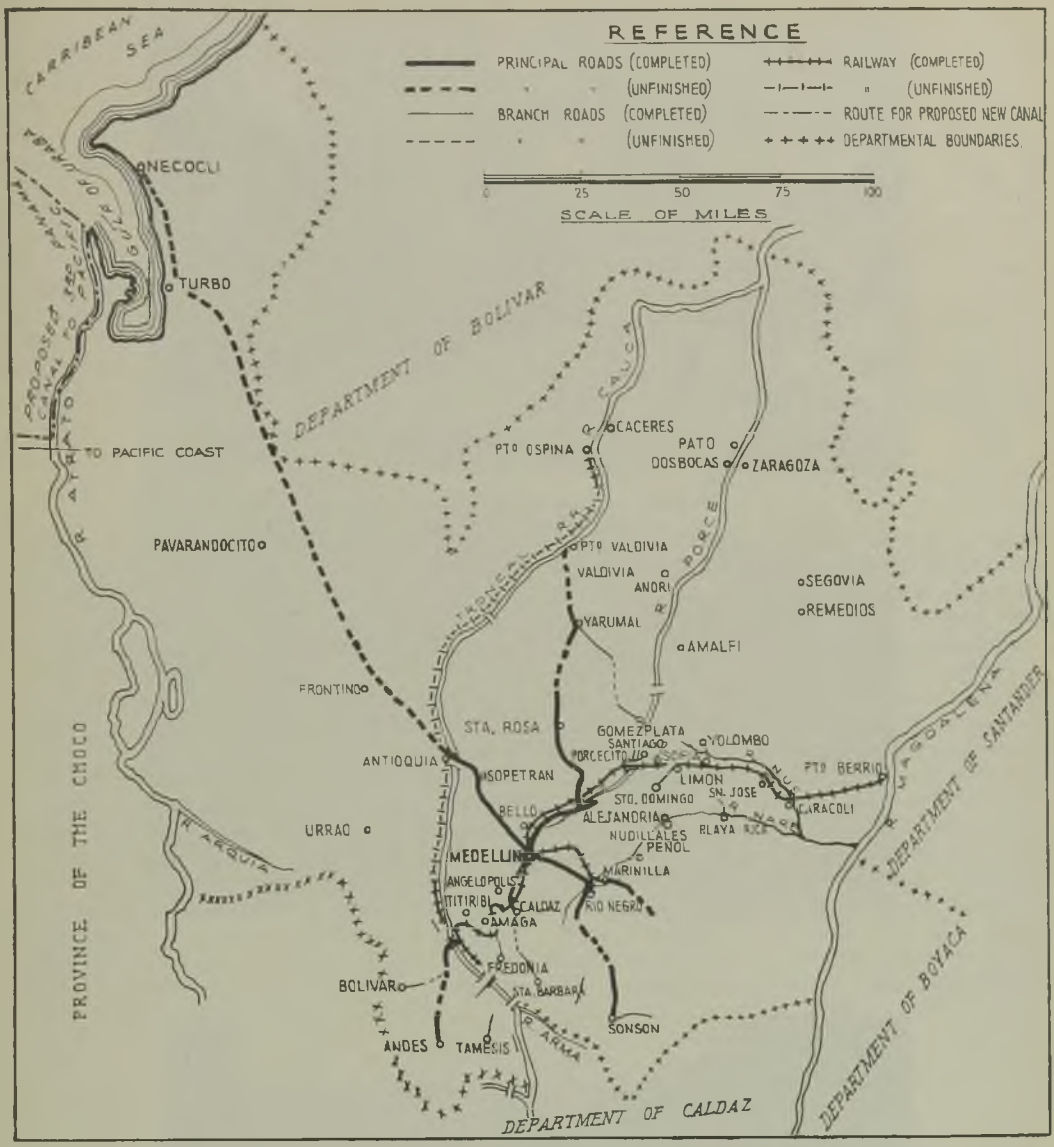
without their suffering in the slightest from excessive temperature. In fact, owing to the altitude, it is a sub-tropical climate in the tropics. Bogotá at 10,000 ft. is cold and warm clothing is required. Practically any climate is obtainable in Colombia by selecting a suitable spot at the right altitude, perhaps no more than a few miles away. For example, the hills on both sides of the Medellin valley are about 10,000 ft. above sea level, with automobile roads out of the valley on both sides, and at Bucaron, on the "Carretera al Mar," Mr. Caton, the engineer, in constructing the road, found it very convenient to have a fire at night. The road up is 5% grade and the rarified air affects the adjustment of the carburettor in some cases before reaching the top.

Power-Shovel used in Tunnel on Railway between Medellin and the Magdalena River.

Medellin is reached from the sea from Puerto Colombia, at the delta of the Magdalena River, a few miles to Barranquilla by train, and thence by very frequent stern-wheel river boats up the Magdalena River, which flows at 5ft.per second, some 800 km. to Puerto Berrio, and 200 km. off to the right by train to Medellin. The railway continues on to the Cauca valley and lacks 200 km. of joining up with the railway from Buenaventura, the port on the Pacific. Alternatively, starting at 5 o'clock in a Scadka aeroplane, the trip up the river is made in five hours, and one can catch the 12 o'clock train to Medellin, arriving at 7.20 in the evening.

Up to the middle of last year the railway journey to Medellin took all day, as the tunnel of nearly 4 km. long had not been completed. Prior to this automobiles and motor trucks took passengers and freight from one side of the hill to the other, meeting another train at the other side. The contracting firm of Fraser Brace, Ltd., Montreal, Canada, was called in, the tunnel was constructed, and is now in operation. The saving effected will pay off the cost of the tunnel in about 7 years. Antioquia is naturally very proud of their tunnel, especially as, unlike many other large undertakings in the country, it was completed on time. Although single track it appears to be the longest railway tunnel in South America. Contrary to early borings carried out before letting the contract to Fraser Brace, Ltd., a large part of the tunnel passed through soft ground, and necessitated delays for timbering. Had the rock been hard as advised the tunnel would have been completed several months before the specified time. A 1000kw. hydro-electric plant was installed and power brought to both portals for compressors and drill sharpening, &c. Water leyners and electric shovels were used at both ends and in general, in hard ground, 11 ft. 6 in. was blasted out, using five relays. Modifications were made as required. After a blast, the fan removed the smoke, taking twenty minutes, and drilling commenced on the upper part of the face on a working platform 12 ft. high, while the shovel operated below. When the muck had been cleared away, generally amounting to 42 four-yard cars, the drills attacked the lower part of the face and the cycle was repeated. Actually after the blast, with softer rock, barring down and even timbering occupied more or less time.

The rock was the so-called granite of Antioquia, which is really a quartz syenite, as the felspar constituent is plagioclase, and



Sketch Map of the Department of Antioquia.

there is some, but very little, free quartz. The rock was hard enough, as originally indicated, but the tunnel seemed to be directed through a fault breccia and for the most part, on the Santiago or western end, ran between the fault walls, while the drill holes had been in the solid rock. The tunnel holed through with about 2 in. error in alignment and less in level, a very creditable performance in every way. Joseph Hilton was in charge of the organization in Antioquia, as vice-president of Fraser Brace, Ltd., and great satisfaction was expressed by both contracting parties.

At, and within, 25 km. of Medellin there are local industries of various kinds. There are a number of coffee cleaning and sorting establishments for export and local use. There are glass works, potteries, brick plants, foundries and machine shops, railway repair shops, weaving establishments, soap and cigarette plants; buttons, nails, and horse-shoes are manufactured, as well as sheet-iron water pipe for pelton wheels and hydraulic

HYDRAULIC ELEVATOR IN OPERATION.

work. There are milk pasteurization plants, modern bakeries, a modern cold storage plant, breweries, and aerated water, ice, &c. The mail goes to New York in 7 days by plane.

HYDRAULIC MINING.—The Medellin river is known as the Porce River beyond where the Rio Grande joins it at the railway station of Porcecito, and from here it runs through a deep valley for 35 km. until it opens out into the large alluvial flats, where the Pato dredges are situated and $1 per cu. yd. is not uncommon. Not all of this 35 km. has been worked, as the lower end contains boulders approximately 18 in. diameter, although there is plenty of gold amongst them. The river is swift and narrow in parts, not permitting diversion, and under these conditions there is often practically no gravel in the bed, and comparatively little gold in consequence, but where the valley is wide enough to permit diversion of the river and the gravel is of suitable size, as it is in the upper half, hydraulic elevator mining has been undertaken as one-man operations or small partnerships. It takes about $100,000 to equip a mine with ditch, pipe-line, monitors, and pumps, although a start has been made with much less, and the properties have been rented for anything from 12 to 22% of the gold produced. The available water rights for the pumps and monitors are an important consideration, as well as the abundance of gold. As an indication of this it might be mentioned that at La Clara mine, near Porcecito, the operators took out $1,000,000 from 4 km., the extent of that

BOULDERS LEFT AFTER HYDRAULIC OPERATIONS AT THE HORMIGUERA MINE.

mine, or $250 per metre on the average, and this was done in a period of 18 years. In addition they ran a large farm in conjunction. The workmen worked alternately on the river and farm, as the state of the river permitted. In the wet weather the river may rise 6 ft. or more in a few hours, usually at night. Under these circumstances it might flood the workings and perhaps bury the pumps and monitors, which must be pumped out again with a spare pump. Even sluice boxes have been upset and carried away, with or without, say, 50 to 100 lb. of gold content. The sluices do not contain much gold until three or four days before clean up. Usually when it occurs the sluices upset in the hole and the gold is recovered. It is usual to repair the damage by filling the hole with soft fine material by monitor from the hillside and pumping the hole out again in four or five days. There are considerable periods of fairly constant dry weather and others when trouble may be expected. Much of the success of the operations depends on the skill and judgment of the operator. The same operators have been interested at various times also in Segovia, on the Rio Grande, and on the Porce, the "Hormiguera," and "La Leona." The latter is now being equipped. The imported sheets, 3 ft. long, are punched to template, rolled and riveted, laid in place, and staked or covered to hold them in place. The pipe, made up in about 20 ft. lengths, is joined as usual by inserting one end in the other and securing them with wire around the lugs. At the workings flanges are used.

The richest part of the channel is more often than not some 75 ft. in width and where the gravel is wide enough to divert the river it may occur in the existing river bed or to the side. It is better to ascertain by drilling. Where there is extensive low flat land to the side, the river can often be pushed about without previously digging a channel. Generally, on the Porce and neighbouring rivers, a long hole is excavated in the gravel by driving the gravel to the pump and delivering it by sluice to the river. The gold recovered on bedrock may result in an average of 50 cents per cu. yd. of excavation, especially where there is sloping bedrock on the inside of a bend in the river. There is often a concentration among a cluster of boulders, and behind or on the downstream side of a large boulder, much like any other swift river where gold is obtained. If the bedrock is shallower than, say, 16 ft. it is probable that the ancients have taken it out with their water wheels. In any case when the excavation for the new channel has been completed, the entrance and exit are broken through with a monitor and the river admitted. Both ends of the section of the river to be diverted are dammed up, using rocky material from the hillside. The gravel is pumped from the diverted river channel and the gold recovered in the sluices. On the Porce and in Antioquia the sluice boxes are made of hard wood and a box is 10 ft. long on account of the length of the available timber. The width is 38 in. although in some parts it is 42 in. depending on the size of the pump to feed it. The sluice boxes may extend from 100 to 150 ft., according to circumstances. Some have undercurrents.

Starting a Hole on the Porce River.

At Playa Rica, where the Nusecito joins the Nare River over the divide, south from the Nus division of the Puerto Berrio-Medellin railway, recently a larger equipment was installed costing about $270,000, and earlier efforts resulted in over $1 per cubic yard. Adjoining this property, immediately above, on the Rio Nare, another property, the Nudillales, is being worked. The Playa Rica drilled area averaged 61 cents per cubic yard and the Nudillales 59 cents. Results have justified the drilling in both cases, producing more. On the last mentioned the channel is found to have a width of about 75 ft., with 50 cent ground to the side.

Hydraulic Elevator at work on Nare River.

Whilst most of the Porce has been worked more or less, the Rio Nare, somewhat further from the railway, has not been subjected to hydraulic elevator operations, except those mentioned, and that within the last two years. Of the 69 km. of river comprised on the Nudillales area, the lower half is suitable for hydraulic elevator operations where the river can be diverted. Intensive work has been done in the past where there were benches above water level, but 10 to 15 ft. is about the limit for hand pumps in dry weather, and the ground drills 20 to 30 ft. The property has a history. For about 30 years in the early part of last century off-and-on attemps were made to divert the river at a point known as the "Cortada de Nudillales," where the river makes a horse-shoe bend and there is a considerable difference of level. When going through the artificial cut the author was struck with the large amount of work and persistence of the slave owners of over 100 years ago. There was very little left to do to finish the cut and divert the river, but it had not been done. They had neither monitors nor dynamite, but worked by pick and shovel. Likewise above the cortada there are river flats in front of the town of Alejandria which were drilled years ago and for which a dredge was ordered and shipped, but never arrived on the property for reasons in no way connected with the merits of the proposition.

It is very interesting to examine the gold from the clean-ups at the various mines. Not only is it possible to recognize the gold from the feeders or various auriferous side streams that contribute to the river deposit, but gold fish-hooks, ancient gold ornaments of small size, earrings, nose rings, bracelets, &c, are also found.

At the present time a Belgian company is erecting a modern 5 ft. electric-driven elevator gold dredge near Porcecito, close to the mouth of the Rio Grande, on the Porce River. It has been launched and is being completed. The 300 kw. power plant is likewise being completed ready to work the dredge. At the same time hydraulic elevator operations are being carried on by the same company.

A power plant and transmission line are being installed at Guadalupe River, near its entrance to the Porce, for the city of Medellin. The head is 1,820 ft. and of the 100,000 kw. available, 13,000 is to be developed to start with. They require additional capital to complete it. Cheap electric power is very necessary for Medellin, although they have crude-oil and fuel-oil from the Tropical Oil Co. at Barranca Bermeja, on the Magdalena river, and lignite coal at $10 per ton from Amaga, on the railway to the Cauca.

MINERAL ASSOCIATIONS IN CORNISH TIN LODES

By E. H. DAVISON, B.Sc., F.G.S., Lecturer in Geology at the Camborne School of Mines

The author here gives conclusions formed after a detailed examination of material collected from many Cornish tin lodes

In the course of twenty years study of Cornish veinstones the writer has been able to recognize certain general relations between the composition of the country rock and the mineralization of the lode and also between the gangue minerals of the lode and the depth of the point relative to the original surface of the granite. These points have already been dealt with in certain papers by the author.[1] It is also well known that the metallic minerals of the Cornish lodes are arranged in a series of overlapping Primary Zones which vary in relation to the granite surface.[2]

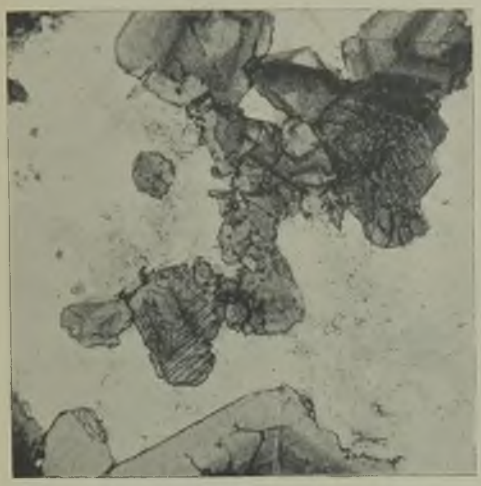


FIG. 1.—CASSITERITE, DARK-GREY, WITH QUARTZ AND FLUORITE IN GREISEN, PARC-AN-CHY MINE.

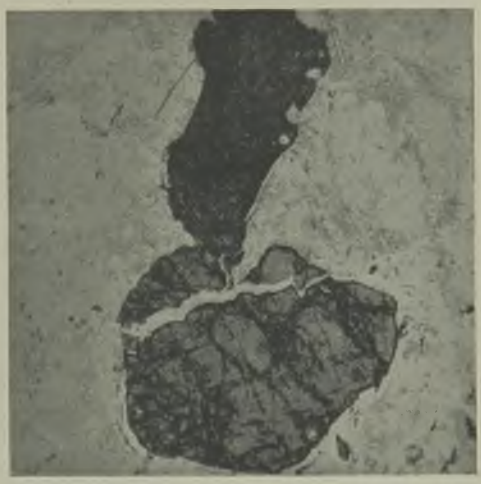


FIG. 2.—CASSITERITE, BLACK, AND GARNET, DARK-GREY, WITH QUARTZ, IN PEGMATITE FROM WILLIAMS SHAFT, DOLCOATH MINE.

The object of the present paper is to bring together the various observations and at the same time to incorporate the results of more recent work which, to a great extent, confirm previous ideas and thus strengthen the views previously expressed.

GENERAL CHARACTERS OF CORNISH LODES.—The chief characteristic feature of the Cornish fissure lodes is the occurrence of primary mineral zones which have been described by various authors. These are shown in Table 1.

It is generally accepted that the mineralization of the lodes originated from the action of magmatic solutions rising from the residual granite magma below, the metallic and gangue minerals being either deposited from these solutions or being formed by the reaction of the solutions with the constituents of the country rock. During this process the temperature would fall, upwards, from the granite surface which, at the time when the lode fissures were filled, was covered by a great thickness of overlying rocks. It is therefore reasonable to refer the primary zones of the lodes to the surface of the granite as a datum level and it will be seen that this method is justified by the behaviour of the zones.

If this principle be adopted and an area of Cornish mining country such as that illustrated in Fig. 3 be studied, it would be expected that a lode situated as No. 1, in a position near the middle of the granite outcrop from which a considerable thickness of granite has been removed by denudation, to have the characters of a deep zone lode

[1] Davison, Handbook of Cornish Geology; Primary Zones of Cornish Lodes, *Geol. Mag.*, Nov., 1921; Study of Cornish Granite, *Trans.* R.G.S. Corn., 1927; Cornish Veinstones, *Geol. Mag.*, May, 1924, and *Mining Magazine*, July, 1924.

[2] MacAlister, Geology of Camborne and Falmouth. Cronshaw, Structure and Genesis of Tin Lodes, *Trans.* I.M.M., vol. xxx. Dewey, Mineral Zones of Cornwall, *Proceedings* Geol. Assn., vol. xxxvi.

and this actually proves to be the case as is shown by the mine records in Table 2.

Thus the zone exposed at the outcrop of a lode depends on the position of the outcrop relative to the original granite surface.

RELATION OF GANGUE MINERALS OF LODE TO DEPTH.—It will have been seen from the table of primary zone minerals, given above, that not only do the metallic constituents of the lode change with increasing depth, but that the gangue minerals also change and this change has been confirmed by the recent examination of a large number of veinstone

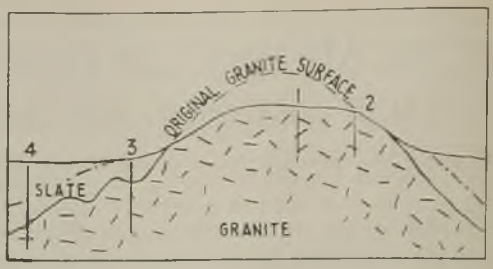


FIG. 3.—RELATION OF LODES TO GRANITE SURFACE AND METAMORPHIC AUREOLE. 1. PORKELLIS MINE. 2. POLHIGEY MINE. 3. STRAY PARK MINE. 4. LAMBRIGGAN MINE.

TABLE 1

MacAlister.	*Cronshaw.*	*Dewey.*	*Davison.*
	9. Calcite		
	8. Pyrite, Hæmatite, Siderite, Quartz, Fluorite	4. Carbonates of Iron and Manganese	6. Hæmatite, Limonite, Siderite, Pyrite and Marcasite, Pyrolusite
3. Galena, Blende, Pyrite, Ni.Co.Cu Arsenopyrite, Quartz, Chlarite	7. Galena, Blende, Chalcopyrite, Fluorite	3. Sulphides of Antimony, Sulphides of Pb + Ag, giving place in depth to Zn	5. Galena, Blende, Pyrite, Quartz, Dolomite, Chalcedony, Minerals ofU, Ni, Co, Fluorite
2. Copper, Tin	6. Chalcopyrite, Quartz, Fluorite, Tourmaline, Cassiterite, Chlorite	2. Sulphides of Copper + Wolfram + Tin	4. Chalcopyrite, Wolfram, Arsenopyrite, Quartz, Fluorite, Pyrite, Jasper
	5. Chlorite, Tourmaline, Cassiterite, Arsenopyrite, Quartz, Fluorite		3. Chalcopyrite, Wolfram, Arsenopyrite, Quartz, Cassiterite, Chlorite
	4. Fluorite, Tourmaline, Cassiterite, Arsenopyrite, Quartz, Chlorite		
1. Tin	3. Cassiterite, Arsenopyrite, Tourmaline, Quartz, Fluorite	1. Oxide of Tin + Wolfram	2. Cassiterite, Arsenopyrite + Wolfram, near granite cupolas, Chlorite, Tourmaline, Quartz
	2. Cassiterite, Arsenopyrite, Quartz, Tourmaline		1. Cassiterite, Quartz, Tourmaline, Specular Hæmatite
	1. Quartz, Wolfram, Arsenopyrite, Cassiterite, Felspar, Tourmaline		

TABLE 2

Mine.	*Situation in Fig.* 1.	*Metals produced.*	*Zone according to Davison.*
Porkellis . .	No. 1. Near centre of granite outcrop.	Tin.	1.
Polhigey . .	" " "	Tin + little sulphide.	1.
Old Dolcoath .	No. 2. Close to edge of granite outcrop.	Copper in shallow levels. Tin below.	3.
Stray Park .	No. 3. In the slate not far from granite outcrop.	Lead Zinc shallow zone.	5.
		Copper below.	4.
		Tin below again.	3.
Lambriggan .	No. 4. In the slate well away from granite outcrop.	Lead Zinc Silver.	5.

specimens collected from the working Cornish mines and others from old disused mines. These specimens were examined under the microscope and by means of the co-ordinate micrometer, the relative proportions of the more important minerals being determined, while in some cases the specimen of veinstone was crushed and subjected to microanalysis by means of heavy-liquid, magnetic, and electrostatic, separations, the fractions being subsequently examined under the microscope. The results of these determinations are given in Table 3.

From the results in Table 3 it will appear that each type of veinstone is characterized by fairly well marked difference in composition from that of the others. Summarizing these characters they are as follows :—

1. Greisens. Much muscovite, little chlorite, no felspar.

2. Pegmatites. Muscovite and felspar with coarsely crystalline texture.

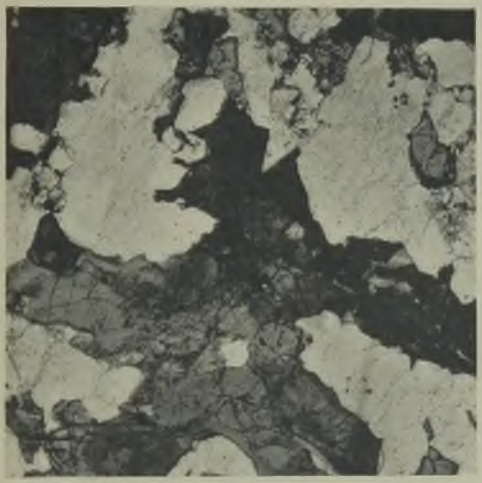


FIG. 4.—CASSITERITE, DARK-GREY TO BLACK, AND TOURMALINE, GREY, WITH QUARTZ AND TOPAZ IN GREISEN, BELOWDA BEACON, ST. COLUMB.

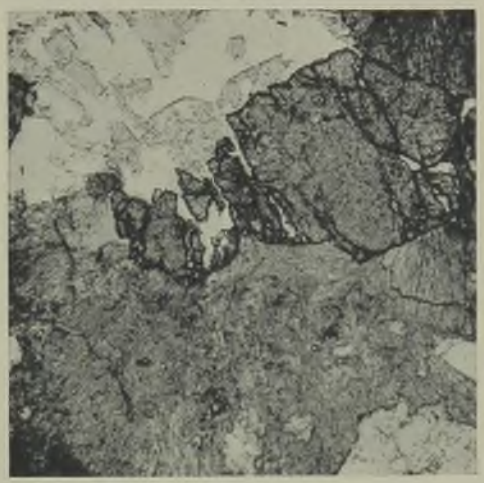


FIG. 5.—CASSITERITE, GREY WITH BLACK BORDER, AND CHLORITE, GREY, WITH QUARTZ IN VEINSTONE FROM ROSKEAR SHAFT.

3. Lodes in Slate. Predominance of Chlorite.

4. Lodes just below granite surface. Not so clearly marked as the other types, but both tourmaline and chlorite usually present.

5. Lodes deep in granite. Presence of tourmaline and almost complete absence of chlorite.

Type No. 3 is also characterized by the occurrence of veinlets of cassiterite, of more than one age, penetrating the slate, while type No. 5 usually shows brecciation and often contains "capel," a blue grey rock composed of quartz saturated with microscopic needles of blue tourmaline.

The above conclusions were confirmed by a series of mechanical analyses of crushed tinstones. The figures obtained must not be taken to represent the actual percentage of the mineral in the tinstone as the slime material was not included in the determination, they do, however, indicate the compara-

TABLE 3

MICROSCOPIC ANALYSIS OF VEINSTONES

Locality of Sample.	*Quartz.*	*Muscovite.*	*Tourmaline.*	*Chlorite.*	*Felspar.*	*Topaz.*	*Fluorite.*	*Pyrite.*	*Chalcopyrite.*	*Wolfram.*	*Arsenopyrite.*	*Hæmatite and Limonite.*	*Cassiterite.*
Greisens.[1]													
St. Michael's Mount	M	M	l			m				l			m
Cligga Head	M	M	m			l				m			m
Wheal Coates	M	m											M
Parc-an-chy	M	M	m	l			M						m
Lady Gwendoline	M	M	m				l						m
Pegmatites													
Roskear	M	M			m	M					m		m
William's Shaft													
Dolcoath	M	M	wit	h An	dalu	site	and	Gar	neta	nd A	lbite		m
Cligga Head	M	M			M					m			m
Lodes in Slate above Granite.													
Wheal Kitty No. 1	M	m	m	M									m
,, 2	M		m	M			m						m
,, 3	M			M									m
,, 4	M			M									m
Roskear Shaft No. 1	M			M		m							M
,, 2	M			M			m						m
,, 3	M	m	m	M		m	m						m
,, 4	M			M		m							m
Mount Carbis Mine	M			M									M
King Edward Mine	M			M				m	m				l
Wheal Busy	M			M				m	m		m		m
West Towan Mine	M			M							m		m
Levant Mine No. 1	M			m								M	m
,, 2	M			M							M		m
,, 3	M			M				M					m
,, 4	M			M							M		m
Lodes just below Granite.													
Roger's Lode East Pool	M			M					m	m	m		m
Geevor Mine, No. 1	M		m									l	m
,, 2	M		m	m								l	m
,, 3	M		m	m							m		m
,, 4	M		M									l	m
,, 5	M		M	m									m
Clitter's shaft	M		m	M						m			m
Tresavean Mine, No. 1	M		m	M									m
,, 2	M		m	M						m			m
Lodes well below the granite surface.													
Jantar Mine, No. 1	M		M									l	M
,, 2	M		M										M
,, 3	M		M									l	M
South Francis	M		M									m	m
Grenville Mine	M		M										m
South Crofty, No. 1	M		M	m									M
,, 2	M		M	m									M
,, 3	M		M	m									M
Polhigey Mine, No. 1	M		M					m					m
,, 2													
,, 3													
,, 4													
,, 5													
Basset Mine	M	m	M									m	m
Dolcoath Mine	M		M										M

[1] M: Large proportion $\frac{1}{6}$–$\frac{1}{3}$. m: Moderate proportion $\frac{1}{10}$–$\frac{1}{6}$. l: Small proportion $<\frac{1}{10}$.

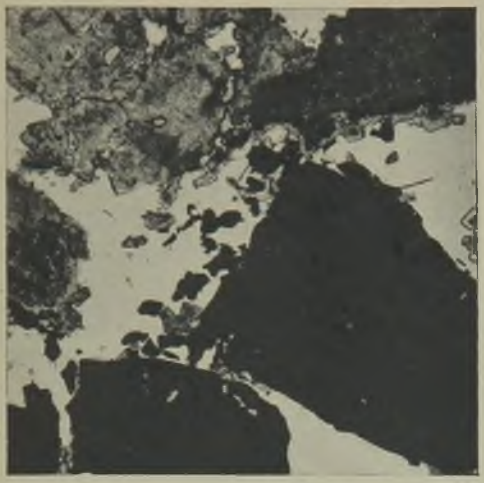


FIG. 6.—CASSITERITE, GREY, WOLFRAM, DARK-GREY, AND ARSENOPYRITE, BLACK, WITH QUARTZ IN VEINSTONE FROM ROGERS LODE, EAST POOL MINE.

tive proportions of the minerals present. These results are set out in Table 4.

The practical value of this classification of the various veinstones into types depending on the position of the stone relative to the granite surface is that it is possible to determine from an inspection of the veinstone character what likelihood there is of persistence of the ore in depth. For example, a veinstone found at surface in granite country composed of quartz, chlorite, tourmaline, and cassiterite essentially would be much more likely to persist to a considerable depth than a fine grained veinstone composed of quartz, tourmaline, and, cassiterite.

RELATION BETWEEN THE MINERAL COMPOSITION OF THE GRANITE AND ITS "MINERALIZATION."—Further investigations were carried out to determine the

FIG. 7.—CASSITERITE, DARK-GREY WITH BLACK BORDER, AND MUSCOVITE, SHOWING MARKED CLEAVAGE, WITH QUARTZ IN VEINSTONE FROM PARC-AN-CHY MINE

TABLE 4

MECHANICAL ANALYSES OF VEINSTONES

Locality of Sample.	*Quartz.*	*Muscovite.*	*Tourmaline.*	*Chlorite.*	*Fluorite or Topaz.*	*Pyrite.*	*Arsenopyrite.*	*Cassiterite.*
	%	%	%	%	% Topaz	%	%	%
Greisen, Lady Gwendoline .	42	28			5 CaF_2			2
Greisen, Parc-an-chy Mine .	40	18			25 CaF_2			2
Roskear Shaft, average of 4 samples . . .	31	1·5		44	2	6		1
Wheal Kitty, average of 4 samples . . .	38		20	45		1		2
Geevor Mine, average of 3 samples . . .	60		35				1·0	1·3
South Crofty Mine, average of 3 samples . .	52		41	2				0·8
Polhigey Mine, average of 3 samples . . .	47		45					0·8
Jantar Mine, average of 3 samples . . .	51		42					1·2
Levant Mine, average of 4 samples . . .	38		12	16		10	16	1

extent to which the presence of "mineralization" in the granite could be determined by the mineral composition of that rock. The term "mineralization" is used to indicate the presence of veins carrying metallic minerals. (This work was aided by a grant from the Royal Society.)

Samples were collected from as many localities as possible, both on surface and underground, and in the case of the underground samples (which were largely supplied by the management of the various mines), the position of the sample relative to the lodes was indicated. Thus the locality of the sample was described as being, (1) near a rich part of the lode, (2) near a poor part of the lode, or (3) far from any lode.

Several microscope slides were cut from each sample collected and these were examined under the microscope, while several of the samples were subjected to mechanical analysis. The results obtained are given in Tables 5, 6, and 7.

The following conclusions seem to be justified.

1. In areas without lodes the granite usually contains much biotite, but seldom tourmaline.

2. In areas which are highly mineralized the granite always contains some tourmaline, usually accompanied by much muscovite.

3. Near poor lodes of low tin content biotite is usually present, but near rich lodes it is invariably absent.

TABLE 5

A.—GRANITE AT SURFACE

Locality.	*Quartz.*	*Orthoclase.*	*Albite.*	*Biotite.*	*Muscovite.*	*Tourmaline.*	*Chlorite.*	*Apatite.*	*Zircon.*	*Fluor.*	*Iron Ore.*	*Topaz.*	*Cassiterite.*	*Remarks.*
1. *Areas without Lodes.*														
Long Downs [1]	M	M		M	M		l	l	l					
Burnthouse	M	M	M		M		l	l	l					
New Mill	M	M	m	M	m			l	l			M		
Castle an Dinas	M	m	M		M	M	l							
Sheffield Qy.	M	M		M	m	m		l	l		l			
Lamorna	M	M		M				l	l		l			
Farmer's Common	M	M		M	m			l			l			
Praze	M	M	m	M	m			l	l		l			
Long Downs 2nd	M	M	m	M	m		l							
Delank Qy.	M	M	m	M	m		l	l	l			l		
2. *Areas Highly Mineralized.*														
Bottallack	M	M	M	M	m	M	l	l	l	l				
Geevor	M	M	l	l	M	M		l				l		
Porkellis	M	M	l		M	M		l		l		l		
Parc-an-chy	M	m			M	M	m			M			M	
1st Belowda Beacon	M	m	M			M						M	M	
2nd do. do.	M	m	M			M			l	l				
Wheal Providence	M	m	M		M	M		l	l				l	
Tetloe	M	M	l		M	M		l	l					
Trowlesworthy	M	M	M		M	M		l	l	l				
Worvas Hill	M	M			M	M	l	l	l		l	l		fine grain
Ding Dong	M	M	l	M	m	M	l	l					l	
Polhigey Mine	M	M	l	l	M	M		l			l	M		
Carn Brea	M	M		M	M	M		l			l		l	
Condurrow	M	M	m		M	M	M	l	l				l	
Luxulyan	M	M				M							l	
3. *Areas with some Mineralization.*														
Constantine	M	M	l	M	M	m	l	l						
Ponsanooth	M	M	m	M	M	m		l						foliated
Zennor	M	M	l		M	M		l		l	l		l	
Carn Marth	M	M	l	M	m	l	l	l						
St. Agnes	M	M	m	M		l					l	l		fine grain
St. Dennis	M	M	m	M		m		l			l	l		"
Coverack Bridge	M	M		M		l		l			l			
St. Day	M	Mk	m		M			l				l		kaolinized felspar

TABLE 6

B.—SAMPLES OF GRANITE FROM MINE WORKINGS

1. *Tresavean Mine.*													
345 Fm. level cross cut S.	M	M	l	M	M		l	l	l				poor lode
370 Fm. level cross cut	M	M	l		M		M	l	l				,,
395 Fm. level cross cut W	M	M	l	M	M		l	l	l				,,
South Crofty Mine.													
S. dipping lode 260 Fm.	M	M		l	M	l		l		M	l		,,
do.	M	M		l	M	l		l		M		l	,,
N. dipping lode 260 Fm.	M	M		M	l	M	M	l		l			,,
do.	M	M		M	l		M	l					,,
East Pool and Agar Mine.													
Near poor lode	M	M		M	l	l	M	l				l	,,
2. *Tresavean Mine.*													
345 Fm. level F. W.	M	M			M	l	M	l	l		l	l	rich lode
370 Fm. level	M	M			M	M	l	l	l			l	,,
395 Fm. level cross cut S.	M	M	l		M	l	M	l					lode fair
395 Fm. level cross cut	M	M	l	l	M	l	l	l	l				,,
South Crofty Mine													
S. dipping lode 260 Fm.	M	M				l		l		M		M	rich lode
do.	M	M			M	M							,,
N. dipping lode 260 Fm.	M	M				M	l						,,
East Pool and Agar Mine													
Near good lode	M	M			M	M	l	l	l		l		,,

[1] M : Large proportion. m : Moderate proportion. l : Small proportion.

The indications do not seem to be very decisive, but it appears that the granite composition does help one to distinguish between hopeful and hopeless areas. The texture of the granite is also a useful indicator. In highly mineralized country the felspar crystals of the granite are ill-formed and are usually much sericitized or kaolinized, but in unmineralized country the felspars are fresh and unaltered, of large size, and often idiomorphic or nearly so.

Two specimens met with in this investigation deserve special notice. The first was altered granite from Wheal Coates, St. Agnes, which had the composition of greisen with idiomorphic crystals of quartz, while the felspar crystals had been replaced by cassiterite. Pseudomorphs of cassiterite after felspar have long been found at Wheal Coates, but they occurred in soft kaolinized granite. In the case mentioned above the rock was a hard tough greisen. The second sample was a greisen from one of the St. Austell clay pits, which was composed of quartz and gilbertite mica with veinlets filled with coarsely crystallized cassiterite and fluorite. Both specimens seem to throw light on the origin of cassiterite, the first indicating that the tin was carried in a watery mobile fluid, while the second suggests the association of fluorine with the deposition of cassiterite.

TABLE 7

MECHANICAL ANALYSES OF GRANITES

Locality.	*Quartz and Felspar.* %	*Biotite.* %	*Muscovite.*[1] %	*Tourmaline.* %
1. Long Downs	54·8	6·9	4·2	0·6
2. New Mill	55·1	7·5	1·2	nil
3. Sheffield Qy.	58·2	6·2	1·8	2·3
4. Lamorna	60·3	8·1	nil	nil
5. Geevor	61·4	1·5	5·9	6·1
6. Polhigey Mine	59·3	2·1	6·2	6·9
7. Condurrow	60·3	nil	8·3	7·4
8. Parc-an-chy	59·4	nil	7·8	8·1 + Fluor 5·8

1—4 Districts void of mineralization.

5—8 Mineralized areas.

[1] Includes lithia and fluor-bearing micas.

THE EARTH RESISTIVITY METHOD OF GEOPHYSICAL PROSPECTING

SOME THEORETICAL CONSIDERATIONS

By G. F. TAGG, B.Sc., A.M.I.E.E.

In the June and July issues of the MAGAZINE an article by Mr. E. Lancaster-Jones appeared which gave a report on a specific resistance survey carried out with a Megger Earth Tester at Hodbarrow, Cumberland. In the latter part of this article Mr. Lancaster-Jones developed the theory for a horizontal underlying stratum.

The theory advanced and employed by the American users of this method, is based on the assumption that the body of earth included in the test is limited substantially to the region extending from the line joining the potential electrodes to a distance equal to the electrode separation. Consequently, if tests are carried out at a fixed position with varying electrode separations, and the values of the specific resistances obtained are plotted against the electrode separation, a break or abrupt change in the curve will be found, at the point where the electrode separation is equal to the depth of the stratum. No theoretical proof of this appears to have been given, and a little consideration will show that theoretically it is unsound.

It has been shown by Mr. Lancaster-Jones that for a horizontal stratum, the apparent specific resistance obtained on measurement is governed by the following relation $\frac{\rho_a}{\rho_1} = 1 + 4\,F$.

In this expression

ρ_a = apparent specific resistance obtained on measurement ;

ρ_1 = specific resistance of upper layer ;

F = the sum of an infinite series of terms.

The quantity F is actually equal to

$$\sum_{n=1}^{n=\infty} \left(\frac{k^n}{\sqrt{1+\left(2n\frac{h}{a}\right)^2}} - \frac{k^n}{\sqrt{4+\left(2n\frac{h}{a}\right)^2}} \right)$$

where

h = depth of underlying stratum ;

a = electrode interval ;

n = any positive integer ;

$k = \frac{\rho_2 - \rho_1}{\rho_2 + \rho_1}$, in which

ρ_2 = specific resistance of second stratum.

The ratio ρ_a/ρ_1 may be calculated for definite values of ' k,' ' h ' and ' a.' As in practice only ' a ' is known there are two quantities ' h ' and ' k ' which are unknown and if therefore a method can be devised of obtaining these from the measured values of the specific resistance and the electrode separation it should prove of great service.

Consider the quantity ' k.' This may be written as $\frac{1 - \frac{\rho_1}{\rho_2}}{1 + \frac{\rho_1}{\rho_2}}$ and is therefore dependent only on the *ratio* ρ_1/ρ_2. Thus ' k ' may have any value between + 1 and − 1 ; the values of ρ_1/ρ_2 corresponding to various values of ' k ' are given in Table I.

TABLE I

k.	ρ_1/ρ_2	k.	ρ_1/ρ_2
1·0	1/∞	− 1·0	∞
0·9	1/19	− 0·9	19
0·8	1/9	− 0·8	9
0·7	1/5·67	− 0·7	5·67
0·6	1/4	− 0·6	4
0·5	1/3	− 0·5	3
0·4	1/2·33	− 0·4	2·33
0·3	1/1·85	− 0·3	1·85
0·2	1/1·5	− 0·2	1·5
0·1	1/1·33	− 0·1	1·33
Zero.	1/1	Zero.	1

Positive values of ' k ' correspond with the condition that the lower stratum has the higher resistivity, negative values of ' k ' occurring when the resistivity of the lower stratum is less than that of the surface layer.

For given values of the electrode separation ' a ' and of ' k,' a curve can be drawn showing the relation between ρ_a/ρ_1 and ' h.' By giving ' k ' the values in Table I a series of curves can be drawn for one given electrode interval. When ' k ' has a positive value, however, it is more convenient to express the results in terms of conductivity by plotting the values of σ_a/σ_1 instead of ρ_a/ρ_1, σ_a being the apparent conductivity as measured, and σ_1 the conductivity of the surface layer. It is obviously as easy to obtain these curves as those showing ρ_a/ρ_1, since $\sigma_a/\sigma_1 = \rho_1/\rho_a$. Typical curves, of the

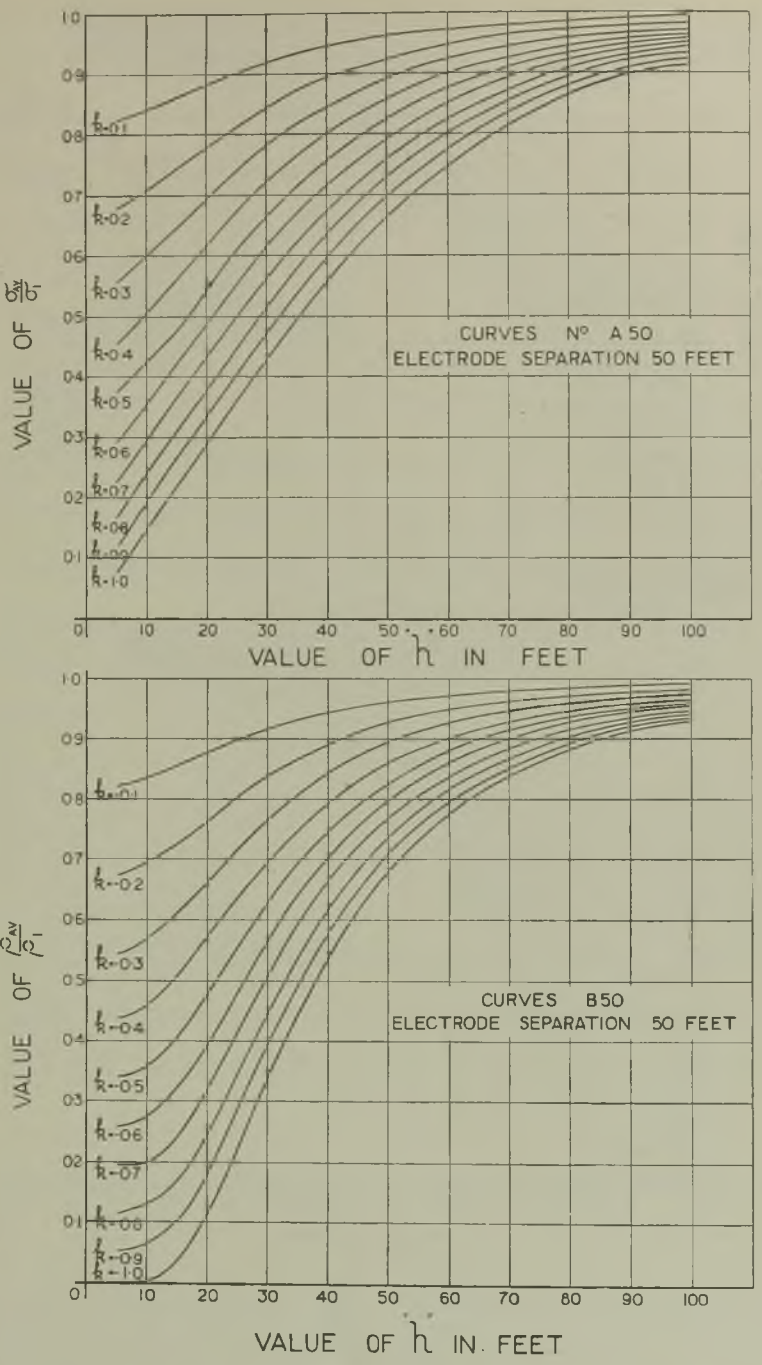


FIG. 1.

types just described, are shown in Figs. 1, 2 and 3, which are for electrode intervals of 50, 100 and 150 ft. respectively. The sets of curves marked "A" correspond with positive values of 'k' and show the variation of the conductivity ratio σ_a/σ_1, while those marked "B" are for negative values of 'k', and show the variation of the resistivity ratio ρ_a/ρ_1. Similar sets of curves can be drawn for any desired electrode separation.

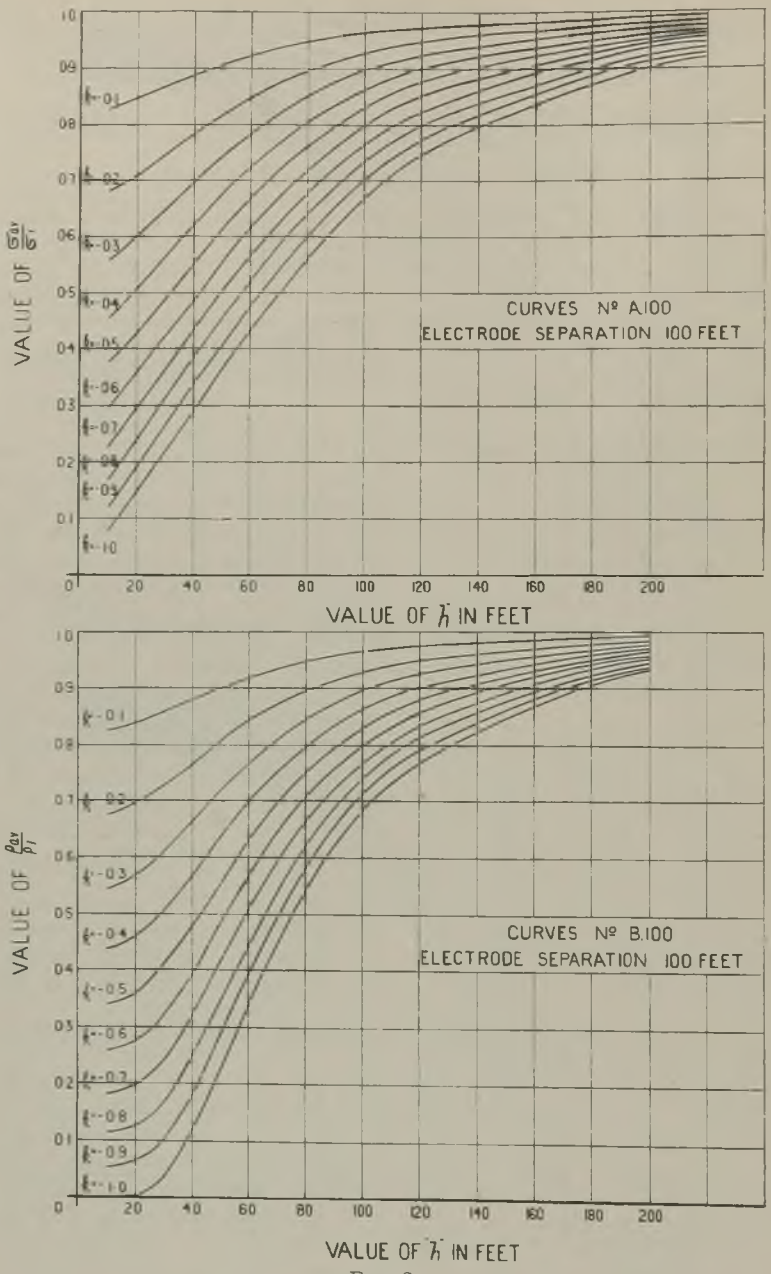


FIG. 2.

The method in which it is suggested that these curves may be used is as follows: Resistivity measurements are first made with one or two *small* electrode intervals, the electrodes in each case being disposed along the traverse in positions symmetrical about the selected station. The object of these first measurements is to enable a fairly accurate determination to be made of the resistivity of the surface stratum. Then further tests are carried out using electrode intervals of, say, 50 ft. and 100 ft. In these two latter tests let the values of the apparent specific resistances be ρ' and ρ'' respectively. Then for the 50 ft. interval, the value ρ_a/ρ_1 is given by ρ'/ρ_1, the corresponding value for the 100 ft. interval being ρ''/ρ_1. If these ratios are greater than unity, this indicates that ρ_2 is greater than ρ_1 and the reciprocals of these ratios should be taken. These will

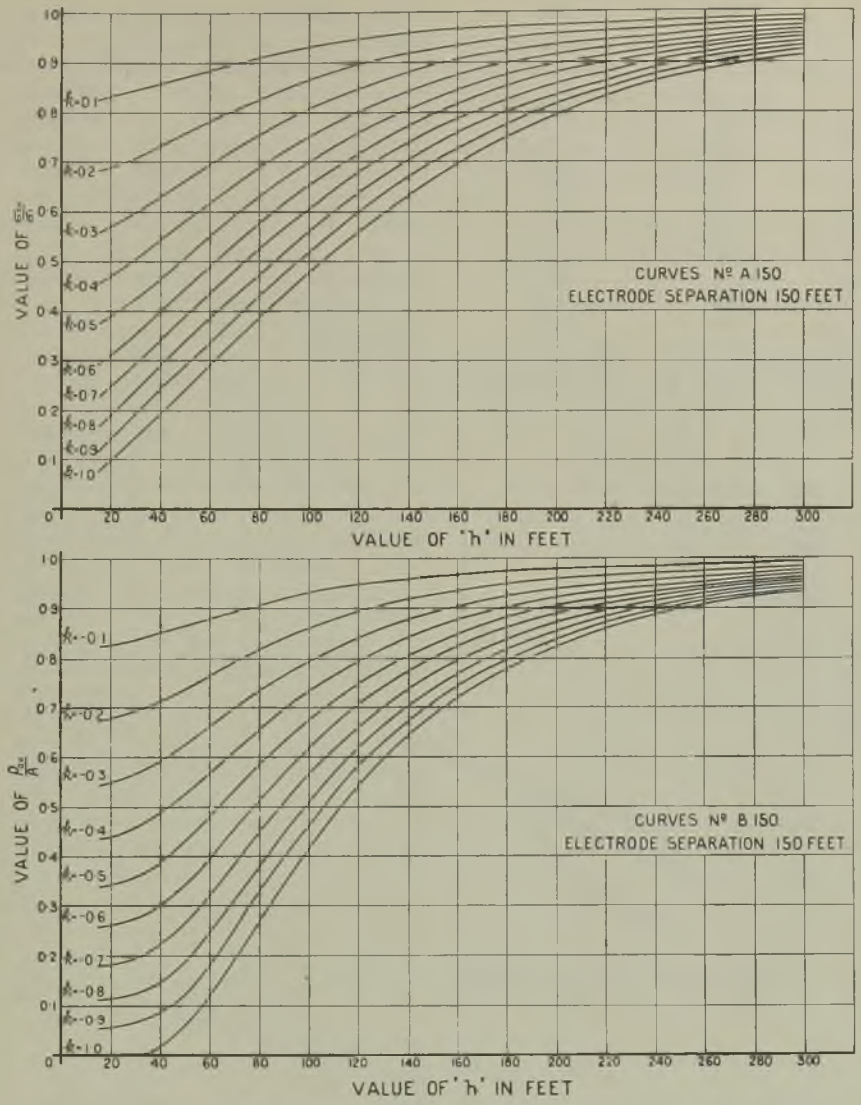


FIG. 3.

be σ'/σ_1 and σ''/σ_1 respectively. On referring to the curves in Fig. 1, a series of corresponding values of 'h' and 'k' can be read off for the values of $\rho_a/\rho_1 = \rho'/\rho_1$ or of $\sigma_a/\sigma_1 = \sigma'/\sigma_1$ as the case may be. A similar set of values could be read off the curves in Fig. 2 for ρ''/ρ_1 or σ''/σ_1. These two sets of values can then be plotted in the form of curves of 'h' against 'k' and the point of intersection gives the values required. It is only necessary to take a few values, corresponding to points close to where the point of intersection of the curves can be roughly estimated to lie.

This can best be illustrated by an actual example. Suppose ρ_1 is found to be 5,000 ohms per inch cube and the values of ρ_a obtained in tests at 50 ft. and 100 ft. electrode separations are $\rho' = 4{,}500$ ohms per inch cube and $\rho'' = 3{,}500$ ohms per inch cube. Then $\rho'/\rho_1 = 0{\cdot}9$ and $\rho''/\rho_1 = 0{\cdot}7$. These ratios are less than unity showing that ρ_2 is less than ρ_1, and thus that 'k' is negative. On referring to the "B" sets of curves in Figs. 1 and 2, the following table (Table II) of values of 'h' and 'k' are obtained for the values of $\rho'/\rho_1 = 0{\cdot}9$ at 50 ft., and $\rho''/\rho_1 = 0{\cdot}7$ at 100 ft.

TABLE II

Value of k.	Value of 'h' from 50 ft. curves $\frac{\rho'}{\rho_1} = 0.9$	Value of 'h' from 100 ft. crvs $\frac{\rho''}{\rho_1} = 0.7$.
—0·1	25 ft.	—
—0·2	41 ,,	21·5 ft.
—0·3	51·5 ,,	43·5 ,,
—0·4	59·5 ,,	60·5 ,,
—0·5	64·5 ,,	71·0 ,,
—0·6	96·5 ,,	79·0 ,,
—0·7	74 ,,	87·0 ,,
—0·8	78 ,,	92·5 ,,
—0·9	81 ,,	97·0 ,,
—1·0	84 ,,	103· ,,

A brief inspection of this table shows that the required values are approximately three curves intersect at points very close together giving a small triangle of error as in this case, it may be assumed that the variations obtained in the apparent specific resistance are due to the presence of an underlying stratum at a depth given by the centre of the triangle of error. In the case under consideration this will give 'h' = 58·5 ft. If the variations obtained are not due to an underlying stratum, it is highly improbable that the result obtained with an electrode interval of 150 ft. would be in agreement with the values of 50 ft. and 100 ft. As a rule, therefore, the observation made at the 150 ft. interval would

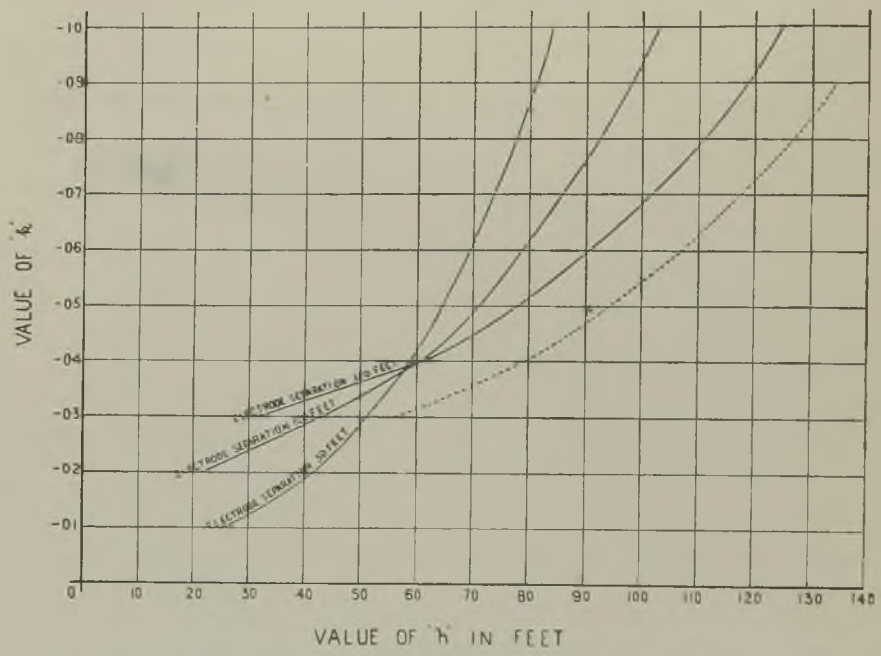


FIG. 4.

'h' = 60 ft. and 'k' = — 0·4. To determine the values exactly the sets of Figures in Table II are plotted in the curves shown in Fig. 4. The point of intersection of these two curves gives 'h' = 57 ft., 'k' = — 0·38.

It will be shown later that the presence of bodies other than horizontal underlying strata will give results very similar to those described above and it is desirable to check the result obtained by taking tests at a third electrode separation. Thus, suppose tests are taken at 150 ft. and ρ_a is found to be 2,900 ohms per inch cube. Then in this case ρ_a/ρ_1 is 0·58. A set of values similar to those in Table II can be obtained from Fig. 3 for an electrode separation of 150 ft. and plotted as a third curve in Fig. 4. If the serve to indicate whether the structure being investigated was of the simple "horizontal stratum" type or not. If, for example, a value of 3,250 ohms was obtained for the specific resistance as measured with a 150 ft. interval, giving a ratio of $\rho_a/\rho_1 = 0.65$, the series of values of 'h' and 'k' corresponding to this in Fig. 3 would give the dotted curve marked X in Fig. 4. This would indicate that some structure other than a single underlying stratum is the cause of the variations in the apparent specific resistance.

Referring again to the theory put foward by Messrs. Gish and Rooney, that a marked change in the gradient of the apparent specific resistance curve is found at an

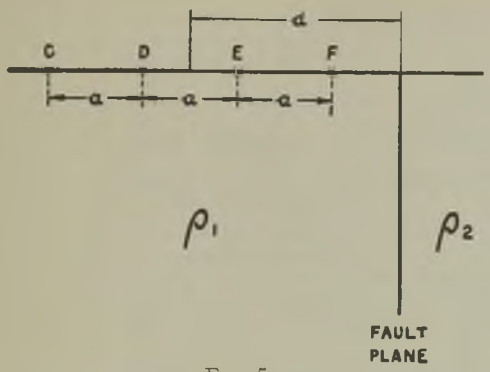


FIG. 5.

electrode separation equal to 'h,' it will be seen from the curves in Figs. 1 to 3, that this has no theoretical foundation. This has already been pointed out by Mr. Lancaster-Jones, and the curves he obtained from his practical observations also show no such sudden changes of gradient.

Discontinuities are, however, obtained if a traverse is made over a fault plane, and it may be of value to give the results of a theoretical consideration corresponding to the simple case of a vertical fault. In the case where the line of the electrodes is at right angles to the plane of the fault (Fig. 5), it is to be expected that, as each electrode crosses the fault plane, a discontinuity in the curve showing the apparent specific resistance will result. There are five different conditions, namely :—

(*a*) When C, D, E and F are all in the region ρ_1.

(*b*) When C, D and E are in the region ρ_1 and F is in the region ρ_2.

(*c*) When C and D are in the region ρ_1 and E and F are in the region ρ_2.

(*d*) When C is in the region ρ_1 and D, E and F are in the region ρ_2.

(*e*) When C, D, E and F are all in the region ρ_2.

It can be shown that the relations giving the apparent specific resistances in the five cases are

$$(a)\ \frac{\rho_a}{\rho_1} = 1 + k\left\{\frac{q}{(q^2-1)} - \frac{4q}{(4q^2-1)}\right\}$$

$$(b)\ \frac{\rho_a}{\rho_1} = 1 + k\left\{\frac{1}{2} - \frac{1}{(2q+1)} + \frac{1}{(2q+2)}\right\}$$

$$(c)\ \frac{\rho_a}{\rho_1} = \left\{\frac{1+k^2}{1-k}\right\} + \frac{k}{(2q+2)} - \frac{k(1+k)}{(1-k)}\left\{\frac{1}{(2-2q)}\right\}$$

$$(d)\ \frac{\rho_a}{\rho_1}\left\{=\frac{1+k}{1-k}\right\}\left[1 + k\left\{\frac{1}{(2q+1)} - \frac{1}{(2q+2)} - \frac{1}{2}\right\}\right]$$

$$(e)\ \frac{\rho_a}{\rho_1} = \left\{\frac{1+k}{1-k}\right\}\left[1 + k\left\{\frac{4q}{(4q^2-1)} - \frac{q}{(q^2-1)}\right\}\right];$$

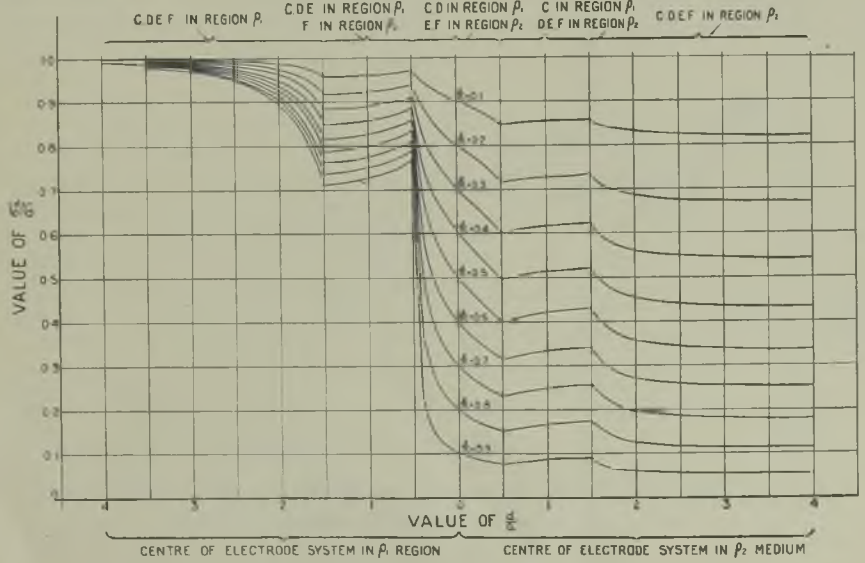


FIG. 6.

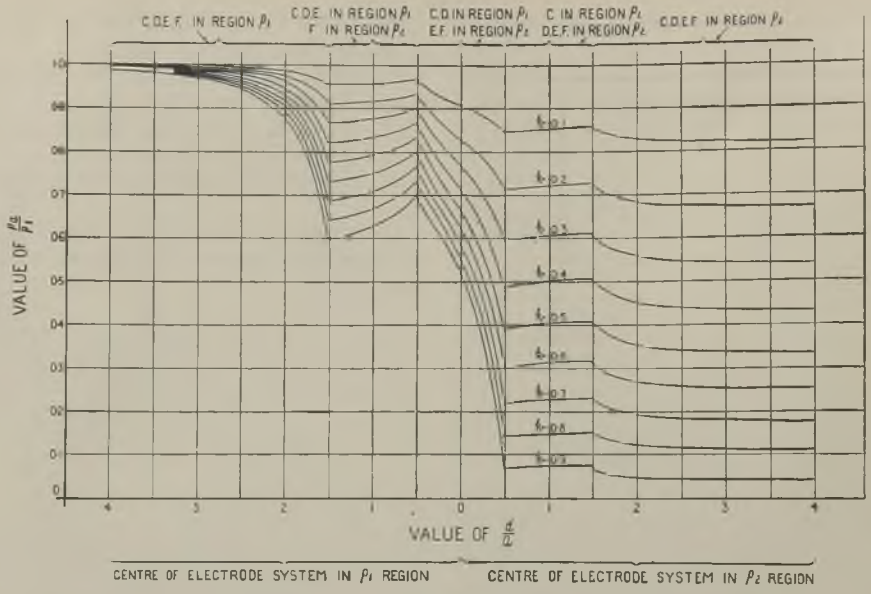


FIG. 7.

where, $q = d/a$,

ρ_1 = resistance of region to left of plane in diagram ;

ρ_2 = resistance of region to right of plane in diagram ;

ρ_a = apparent specific resistance obtained on measurement ;

$k = \dfrac{\rho_2 - \rho_1}{\rho_2 + \rho_1}$ as before ;

d = distance of centre of electrode system from fault plane ;

a = electrode separation.

These equations all lend themselves to calculation of the values of ρ_a/ρ_1 for different values of ' k ' and ' q,' i.e. d/a, and Figs. 6 and 7 show set of curves of ρ_a/ρ_1 or its reciprocal σ_a/σ_1 plotted against d/a for various values of ' k.' The curves in Fig. 6 are for positive values of ' k,' in which case the ratio σ_a/σ_1 is used for convenience, the curves in Fig. 7 are for negative values of ' k,' and the ratio ρ_a/ρ_1 is used. There are four discontinuities in these curves corresponding to the points at which each electrode in turn crosses the fault plane, and consequently these discontinuities are separated by distances corresponding to the electrode interval. If a test is made along

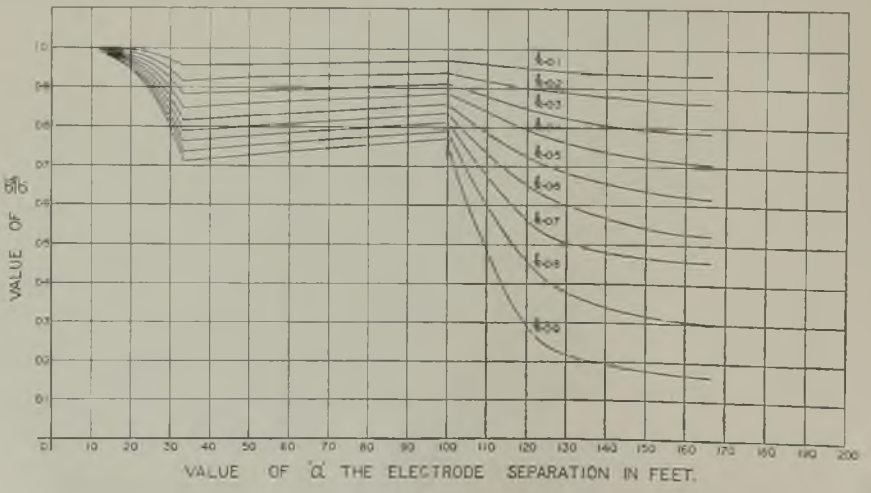


FIG. 8.

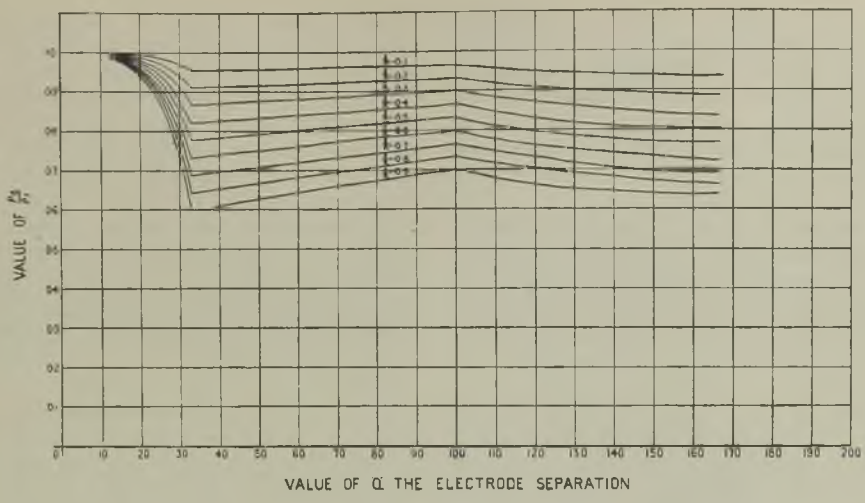


FIG. 9.

a line using a constant electrode interval, and four discontinuities occur in the curve at distances apart corresponding to this interval, they will indicate the presence of a fault.

If, instead of carrying out tests along a line with a constant electrode separation, tests are made at a fixed station, using varying electrode separations, the discontinuities will only be two in number, as only two electrodes can pass the fault plane ; in this case the discontinuities will not be so marked. In Figs. 8 and 9 are curves showing the variations in the ratio ρ_a/ρ_1 or σ_a/σ_1 with the value of the electrode separation where the distance of the station, that is, the distance of the centre of the electrode system from the fault plane is 50 ft.

Another case which can be investigated is that of the effect of a vertical fault plane parallel with the line of the electrodes, as indicated in Fig. 10, where

ρ_1 = specific resistance of region in which electrodes are placed ;

ρ_2 = specific resistance of region on far side of fault plane ;

d = distance of line of electrodes from fault plane ;

a = electrode separation ;

$k = \frac{\rho_2 - \rho_1}{\rho_2 + \rho_1}$ as before.

The value of ρ_a is then given by the expression

$$\frac{\rho_a}{\rho_1} = 1 + 2k\left\{\frac{1}{\sqrt{\left(\frac{d}{a}\right)^2 + 1}} - \frac{1}{\sqrt{\left(\frac{d}{a}\right)^2 + 4}}\right\}$$

This is plotted in the form of curves in Fig. 11 for different values of d/a and ' k.' From these curves it can be seen that provided the distance of the electrode system from the fault is four times the electrode separation the effect is practically negligible.

It will be seen that the curves showing the variation in the apparent resistivity in this case are somewhat similar to those corresponding to the case of a horizontal under lying stratum. If, however, curves of this form are obtained in an actual survey, it should be possible, as a rule, to determine whether the effects are attributable to a horizontal stratum, by comparing with one

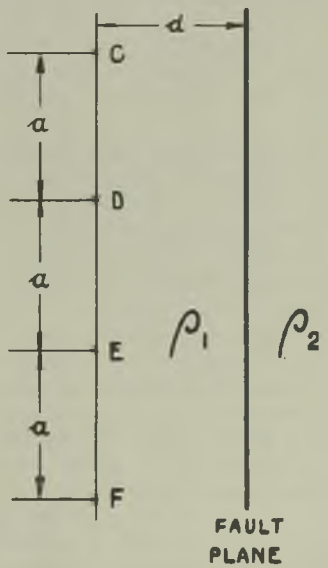


FIG. 10.

another the results obtained with three electrode intervals as described earlier (page 154). If the three sets of observations are consistent, it is highly probable that the structure being investigated is of the "horizontal stratum" type, but otherwise some formation such as the one just considered should be sought.

The extent to which results obtained theoretically can be of assistance in translating the observations obtained in the field must, of course, depend upon how closely the actual formations investigated approximate to the conditions assumed in the theoretical investigations. In cases where the practical conditions approximate fairly closely to those which have been considered above, the results of the theoretical treatment given should serve as a useful guide to the way in which the practical observations are to be interpreted.

In conclusion the author would like to express his thanks to Dr. H. Moore, the Assistant Director of the British Scientific Instrument Research Association, for his very considerable guidance and assistance.

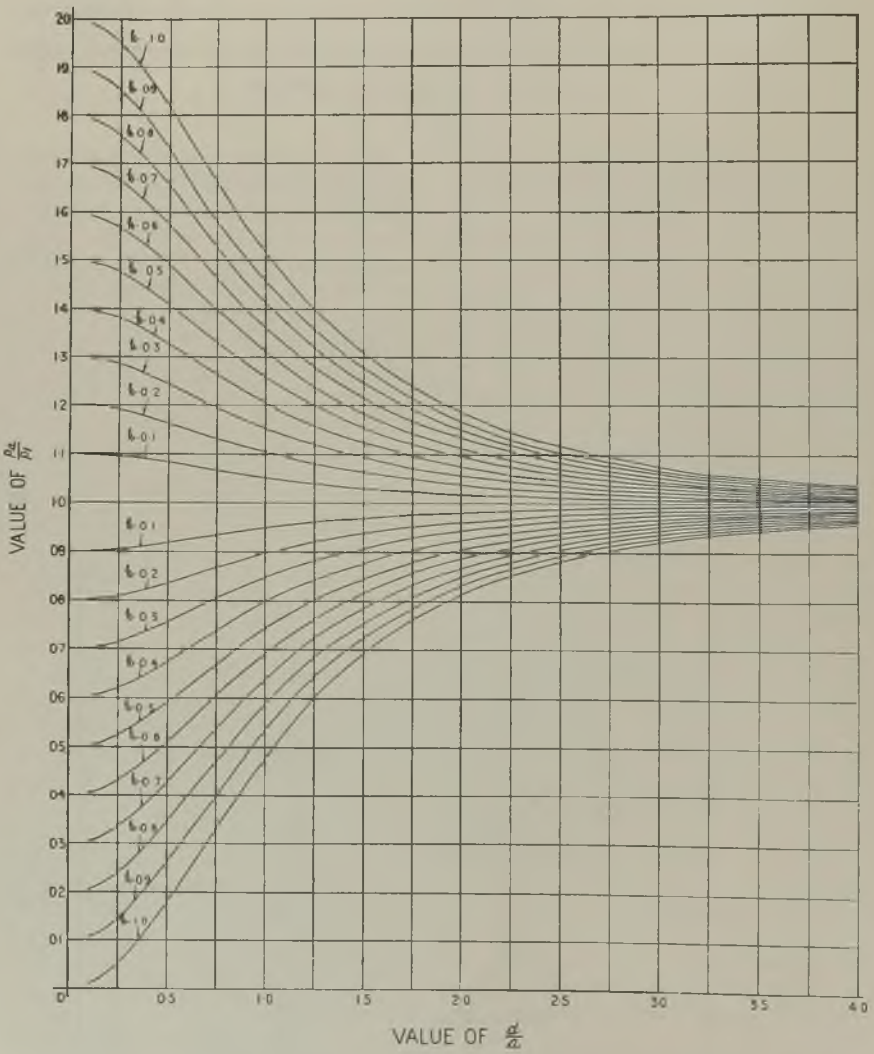


FIG. 11.

LETTER TO THE EDITOR

The Education of the Engineer

Sir,—As an old student and graduate of the Camborne School of Mines, and one who has gained experience with both British and American mining companies in various parts of the world, I have read with great interest your articles and the letters on "The Education of the Engineer" which have appeared in the MAGAZINE. While I am not in a position to say anything about the training received by students at the Royal School of Mines, I can certainly vouch for that of the students at the Camborne School of Mines.

Irrespective of the mining college or school at which a student receives his technical training, I do not think there is very much to choose between a British or American mining graduate on the threshold of his career, at least that has been my experience, and, therefore, I do not agree with the statement of Mr. Agnew "that there is something radically wrong in the training of the British engineer." I am of the opinion that it is during his professional career that the American, generally speaking, gains decided advantages over the British engineer which enable him in many cases to become a more competent manager and to gain more valuable experience than his British cousin. This is due to many causes. Firstly, in most mines in the United States it is possible for a young graduate to obtain a job on contract as a machine man or mucker and he can earn as much as another graduate who has been engaged, say, as a mine-surveyor or sampler. Consequently many young engineers after leaving college spend the first few years in working as ordinary miners, and so gain very valuable experience. Secondly, if a young engineer is engaged as a surveyor or sampler to commence with he is not kept in this job permanently but as opportunity offers he is moved about and may be appointed level-boss or shift-boss, depending on his abilities and sense of responsibility. He thus acquires a sound knowledge of the principles of underground administration, which after all forms the basis of sound management. Thirdly, most American mines conduct their mining operations on a much larger scale than British mines, excepting, of course, the gold mines of the Rand, etc., and as this usually indicates low-grade properties, where working costs are an important factor, the American engineer gains further advantages over the British engineer, as the ability to produce low costs is also an important item in sound management.

In many British-controlled mines shift-bossing and similar jobs are left either to miners or natives, whilst the technically trained graduate is solely employed as a surveyor or sampler. Surveying and sampling are without doubt of great importance, but it must be admitted that when one is employed in either surveying or sampling year after year it is apt to become monotonous, with the result that the young engineer looks upon this part of his career as a necessary evil, but one that must be endured until such time as he can attain to the management of a mine. When he finally does attain this position he finds that he is sadly lacking in his knowledge on a score of details connected with the management of a mine, details which the American engineer acquires in the first years of his career. The very fact that many British mining companies now give preference to British trained engineers with American experience strengthens this view.

I heartily agree with the remarks of Dr. C. Baring Horwood, in his letter in the June issue, to the effect that the young engineer should go underground as much as possible and "aim at ultimate promotion to assistant manager or manager through the jobs of shift-boss, mine captain, and underground manager," but in many cases this is not possible for the reasons stated above, namely, the young graduate is engaged as a mine-surveyor or sampler, while the shift-bossing is done by a "rough-neck" miner or by a native.

The remarks of Mr. Ernest R. Woakes in his letter, in the July issue, are also worthy of consideration, as he recommends the substitution of mechanical engineering, book-keeping, and accounting for advanced geology and kindred subjects, for it is certainly more essential for a mine manager to know something about mechanical and electrical engineering and book-keeping than it is for him to be an accomplished geologist. I admit that every mining engineer should have a practical working knowledge of geology for every day needs, but the study of the advanced forms of this science could be left to the specialist.

Mr. Leonard G. Brown in his letter, which also appears in the July issue, favours a

system which, in my opinion, would, if adopted, only aggravate the position. He appears to condemn the system of employing mining graduates as shift-bosses and states that " these positions should be occupied by those working miners who, by their experience and enterprise, have worked their way up from the ordinary class of miner and shown themselves to be fit for more responsible positions." Surely it is just as important for a mining graduate to obtain such experience, otherwise how can he expect to become a capable manager? In my opinion the two chief essentials of a capable manager are (1) a sound knowledge of and practical experience in underground administration and (2) his ability to handle labour, and these qualifications cannot be gained except by working up through the various stages from level-boss to manager. They certainly cannot be gained in the position of " assistant to the manager," as this job is more or less that of a glorified office-boy.

In conclusion, I would add that I do not hold the view or make any sweeping statement that all British or American companies work on the lines I have indicated. My statements are of a general character and are the outcome of my experience with both British and American mining companies.

S. V. GRIFFITH.

Santiago, Chile.
August 12.

BOOK REVIEW

The Mineral Industry of the Far East. By BORIS P. TORGASHEFF. Cloth, octavo, 510 pages, with 320 statistical tables and 14 maps. Price 40s. Shanghai: Chali Company, Ltd.

This is an extremely interesting publication, which gives detailed information of a portion of the globe about which the general public knows very little and concerning which it is extremely difficult to get authentic information. The author was sometime lecturer in the Pekin National University and Commercial Attaché in China and has previously written on certain branches of the subject in the MAGAZINE. The work has a preface by Dr. Wong Wen Hao, Director of the Geological Survey of China, and another by Dr. P. I. Polevoy, President of the Russian Far Eastern Geological Committee.

The author has supplemented the incomplete and casual nature of the existing general and official mining literature on the Far East by information collected from all the existing geological institutions and official mining bureaux of the territory embraced, and in this way has made the book as up-to-date and complete as is possible. The phraseology is in places somewhat un-English and the spelling at times a little startling, but in a book which furnishes valuable information about the Far East which is not readily obtainable elsewhere these can be overlooked and treated as of little importance. The main thing is the information and this appears to be very full and generous. Comparison is made throughout the book with the corresponding mineral industry of adjacent countries, and of the world in general, which enables one to get a true perspective of the matter discussed. It is a valuable addition to our records of the mineral industry of the world.

MURRAY STUART.

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

NEWS LETTERS

JOHANNESBURG

August 7.

Half Year's Gold Output.—For the first half of the current year the Transvaal's gold output is 5,263,045 fine oz., and exceeds the production for the corresponding period of 1929 by 79,030 oz. There is an advance of 189,154 tons in the tonnage milled and an improvement of a penny per ton in the working revenue, while working costs per ton at 19s. 9d. are twopence lower. The working profit for the six months ended June 30 last indicates an increase of £241,568, or 3d. per ton milled, and the dividends declared during the period total £8,283 more than for the first half of 1929.

Life of the Rand Gold Mining Industry.—Some striking facts concerning the " life " of the Witwatersrand gold mining industry are mentioned in the report of the Inter-Departmental Committee on the labour resources of the Union. The report considers that the mines will reach the peak of their native labour requirements at the end of the current year, after which they will experience

a gradual and progressive decrease in their needs until by the end of 1934 the requirements will total 186,000 or 19,000 less than in 1930. In 1930 about 3,000 natives will be released as the result of mines closing down, and in 1931, 8,700 will be released, but in the latter year new mines starting will require 5,000 natives, so that the total requirements at the end of the year will be 201,300. No new mines are expected to start in 1932, but 5,000 natives will be released as a result of mines closing down, and the requirements at the end of the year will be 196,300. Mines closing down in 1933 will cause 4,300 natives to be released, leaving the requirements at the end of the year at 192,000. In 1934 6,000 will be released, and the requirements at the end of the year will be 186,000.

World's Gold Supplies.—In the course of his Presidential address at the annual meeting of the Economic Society of South Africa, Dr. J. E. Holloway, who is Director of Census and Statistics, remarked that according to the Government Mining Engineer's latest estimate, the gold production of the Union will, roughly, maintain its present level until 1932. After that it will gradually decline until 1938, and from that year onward it will fall away rapidly. One of the factors on which the estimate is based is already in process of change, namely, the cost of production. As prices fall, this will go down, and, consequently, a larger body of low-grade ore will come within the region of payability. If the gold production requires an absolute increase from year to year, to keep pace with the world's needs, then prices will fall, and, to some extent, this will stimulate gold production, which will, in turn, exercise a restraining influence on the downward trend in prices. It is calculated that, if costs fall by 2s. a ton, there will be no appreciable diminution of output for the next eight or ten years. Similarly, if the available native labour supply is such as to render possible the working of all the mines to capacity, the effect will be the same. If, however, these conditions are granted, the Transvaal will not yet show an absolute increase in gold production from year to year. The production of the rest of the world has been relatively steady during the last half-dozen years. Even if full allowance is made for increased production, resulting from more favourable costs, it would yet seem that the world is moving forward to a period of the growing inadequacy of its gold supplies.

" Main Reef " in Orange Free State.—It is probable that another bore-hole will be put down in the Heilbron district of the Orange Free State, where prospecting operations have been proceeding for several years under the direction of Mr. A. R. Sawyer, with the object of proving the extension of the Witwatersrand Main Reef series. Mr. Sawyer believes that the proposed bore-hole should reveal a full and regularly bedded section of the Main Reef zone at a depth of between 1,200 ft. and 1,600 ft. The zone, about 100 ft. thick, was encountered in two previous bore-holes, but unfortunately a great deal of the core was lost, only a few remnants of typical banket being brought up at each pull. The New Rand Consolidated, Ltd., having been voluntarily liquidated, it is reported that a syndicate with a small capital is in course of being formed to buy the assets of the late company and to put down the bore-hole recommended by Mr. Sawyer. The two old companies put down 26 bore-holes and found the whole Witwatersrand system, it is said, as it occurs on the Rand, from the Hospital Hill slates to the Main Reef zone. The proposed syndicate, in which many of the shareholders of the old company are already interested, therefore hopes to reap the fruit of the extensive and systematic work done by the old companies. Mr. Sawyer will act as managing director and consulting engineer to the syndicate.

Bechuanaland's Minerals.—In view of the fact that Chief Tshekedi has given notice to terminate the British South Africa Company's mining concession in the Bechuanaland Protectorate and the Imperial Government is at present examining a draft proclamation to regulate mining in that territory, prospectors are wondering whether they will be invited to try their luck there. Those who know the Protectorate believe that fossicking will be difficult for the individual, and it seems that only companies with a sufficient capital available for prospecting are likely to accomplish anything of importance. It is hoped, however, that the proposed mining regulations will give facilities to the individual prospector, for there are probably more than one of this deserving class who are waiting an opportunity to peg off ground upon which they have " kept an eye " in the expectation of future opportunities. As far as actual mining has been done in the Protectorate, the " Union Year Book " states: " The only portion of the territory in which gold mining

has, so far, been carried on, is the Tati district. This has been done on a small scale for years. The output for the year 1927–28 was 2,063 oz. of gold and 157 oz. of silver (of a total value of £8,675), against 3,672 oz. of gold and 371 oz. of silver (valued at £15,469) in 1925–26, and 3,807 oz. of gold and 418 oz. of silver (of a total value of £16,020) in 1926–27. No other mining is referred to, and this record cannot be said to be encouraging. It is stated that the Chartered Company obtained their mineral concession, some 40 years ago, at a cost of £50,000, and that no attempt has been made to comply with the terms. Whatever the facts may be, it is probable that an effort will now be made to secure the opening up of the country where operations are not likely to conflict with native rights and privileges.

Postmasburg Manganese.—In a reference here last month to the market for the low-grade ore product of the Manganese Corporation a statement was made concerning a new steel-making process called the Thomas. The Thomas process, of course, is not new and the reference should have been to the use of low-grade ore as a desulphurizer in the blast-furnace reduction of certain iron ores.

BRISBANE

July 15.

Work at Mount Isa.—The total number of men now employed at the Mount Isa mines and works is 1,350. Rapid progress is being made in the construction of the mill, smelters, and power-house. The diamond-drill boring campaign is still being confined to the Black Star, the "show" mine of the Mount Isa Company. In four weeks on that lode a total of 996 ft. of diamond drilling was done in five bore-holes. In No. 9B hole, which has been deepened to 1,066 ft., the ore-body was cut at 822 ft. Assays to date show values as follow :—

	Lead %	Zinc %	Silver oz./ton.
From 927–952 ft.	8·8	10·7	2·8
From 967–992 ft.	7·0	7·0	5·0

In bore-hole 13A, deepened to 713 ft., available assay values to date have been :—

	Lead %	Zinc %	Silver oz./ton.
From 561–581 ft.	12·1	17·2	3·5
From 616–621 ft.	17·2	6·4	3·6

The drives and cross-cuts in the grizzly and haulage levels in the same mine were in May extended for an aggregate distance of 354 ft. In the Lawlor shaft, on the Rio Grande lode, sinking has been resumed, and at latest advices the depth reached here was 293 ft. The pipe-line from the Rifle Creek dam to Mount Isa, a distance of 20 miles, has been finished to the power-house. This dam, which is now full, has a capacity of 1,400,000,000 gallons—a water supply sufficient for three years' operations, even if no rain falls for that period. In order, however, to provide for future expansion and contingencies, the company has secured water rights over another storage basin, on the Leichhardt River, where there is a catchment area of 10,000 square miles, and where there is a permanent flow. There has, at the same time, been enough water of excellent quality for domestic purposes provided by bore-holes and this has been laid on the new buildings.

Cloncurry Copper.—In the Cloncurry field, the chief producer of copper in Queensland, the prevailing low price of that metal is having a depressing effect on output, which has been declining for the past two or three months. Since the beginning of the year the production has fallen by more than one-half. Two important mines—the Dobbyn and Orphan—are still being worked full-handed and producing the usual quantity of ore, but the low market value has considerably affected the payable limit of the ore mined. The tributer, however, who is working the rich Mount Oxide mine, owned by the Mount Elliott Company, is still carrying on as usual, having the ore carted by motor-lorries and horse-teams to the rail-head at Dobbyn, about 80 miles away. The Trekelano mine, near Duchess, is closed down. Over two-thirds of the ore raised on the field still goes for treatment to Port Kembla, New South Wales, the balance being forwarded to the State smelters at Chillagoe, North Queensland.

Mount Coolon Goldfield.—A large Lonhon corporation (the Austral Development Company) has lately taken a working option over the three principal mines on the Mount Coolon goldfield. The representative of the company in Australia is Mr. A. J. Jones, late Minister for Mines in this State. This field is situated between Clermont and Charters Towers, and is about 70 miles from the terminus of the railway from Bowen to the Bowen River coalfield. The mines worked have been small but consistent producers of gold for several years. Of the three that are

under option, the district inspector of mines reports that the work done on them during the past three years has improved their prospects. Over a length of 1,300 ft., the lode has been found to increase in size and value when passing into the sulphides. Ore worth £5 and £7 a ton has been raised from two shafts.

Proposed Gold Bonus.—For some time an intense campaign in favour of the granting by the Federal Government of a bonus on gold produced in Australia has been carried on throughout the Commonwealth. The proposal, which originated in West Australia, has met with much opposition, but has been supported by practically all the State Governments. As an outcome of the propaganda, the Prime Minister (Mr. J. A. Scullin) was a few days ago met by what is described as the most representative deputation that has yet assembled at Canberra, the new capital. Its object was to urge Mr. Scullin to concur in the payment by the Commonwealth of a bonus of £1 per oz. on all gold of standard value produced within the Commonwealth over a period of ten years. All that he was able to offer the deputation, however, was his sympathy, reminding the deputation that the Wiluna gold-mining company, in Western Australia, had introduced a new process for the treatment of low-grade ores, and that the Commonwealth Government had undertaken to back a guarantee of the Government of that State to the amount of £300,000 for the conduct of experiments with the process. In 1922 the annual production of gold in Australia was £3,545,000, while in 1928 it was £1,944,000.

Helping Gold Output.—In Queensland a patriotic scheme has been launched which it is hoped will increase the output of gold and at the same time reduce the number of unemployed in the State. The intention is to form a company, with a capital of £50,000 in 1,000,000 shares of 1s. each, for the purpose, firstly, of re-opening a well-known mine on an old northern goldfield (the Hodgkinson), and, secondly, of investigating other promising gold mines on the same field. The Government has granted a concession over four areas, totalling 660 acres, to the proposed company, free of rent, conditionally on its spending an amount of at least £2,200 a year on development work. The Central Australian Exploration Company, Ltd., is another company that has been formed in connexion with the search for gold. Its immediate purpose is to find a lost reef in the interior of Australia. A six-wheeled motor-truck, with valuable equipment, has already been despatched to Alice Springs, the terminus of the Northern Territory railway from Adelaide. Mr. H. R. Lassitter, who accompanies the party sent out, claims that he discovered the reef 30 years ago. Aeroplanes are to be used for surveying purposes.

The Late Coal Stoppage—The actual agreement under which the Northern Associated coal mines of New South Wales were re-opened included the following conditions: (1) The rates of all contract workers shall be reduced 12½%, and wages of all day-labour employees by 6d. per shift. (2) The federation agreed that the legal right of colliery managers to dismiss employees shall not be questioned. In the event of any dismissed employee feeling that he has been unfairly dealt with, a committee shall be appointed consisting of two proprietors' representatives and two representatives of the federation for the purpose of considering the case, and in no circumstances shall a stoppage take place while the matter is under consideration. (3) The federation undertakes not to place any restriction on output. (4) The federation agrees that it will take all steps possible to avoid petty stoppages. (5) The proprietors agree that the men shall be re-engaged in their order of seniority in the various classifications. (6) The term of agreement shall be for twelve months. Notwithstanding the fourth condition, up to a few days ago stoppages at different collieries on the northern field of New South Wales had occurred on an average of once a week since work was resumed at the associated pits five weeks previously. There is also a threat of trouble with the South Coast miners, owing to an expected reduction of their wages. The coal exported during June from Newcastle, however, for places outside the State, amounted to 137,000 tons—the largest quantity in any one month during the past fifteen years.

Broken Hill Mines.—In an effort to meet existing market and other conditions, the Broken Hill Proprietary, the Sulphide Corporation, and Block 14 companies a fortnight ago placed before the Barrier Industrial Council a suggested temporary arrangement to keep the mines open. In this arrangement the unions were asked to assist by consenting to a reduction of 17½% in wages. The result, however, was a definite refusal by the unions to co-operate in the

proposed arrangement. It is believed that this decision will result in the immediate closing of the Proprietary mine, and that this closure will be followed by that of Block 14, and the slackening of hands at the Central mine. The British Mine was closed at the end of June. About 1,000 men are already workless through the stoppage of mines that have already ceased work, and the closing of others that are to be shut down will result in 1,000 additional being added to the unemployed.

New Guinea Airway.—Guinea Airways, Ltd., having to meet greatly increased business, have ordered a new large three-engined Junker aeroplane, as well as another smaller Junker machine of a type similar to that of the one at present in use. The company is increasing its capital from £50,000 to £100,000. The Mining Trust, Ltd., has decided to make a tractor road to its mines, suitable for the transport of any heavy weight and for all other purposes.

VANCOUVER

August 9.

Mineral Production for First Half of 1930.—The Provincial Department of Mines has issued the following estimate of mineral production of British Columbia for the first half of this year: Gold 79,000 oz., silver 5,600,000 oz., copper 47,000,000 lb., lead 163,000,000 lb., zinc 120,000,000 lb., coal 959,885 long tons, structural materials and miscellaneous minerals and metals to the value of $2,305,000, The chief feature of this metal production is that, despite the marked decrease of metal prices, compared with the corresponding period of 1929 there was an increase in the production of all major metals with the exception of copper. This has been made possible by large production from a few mines in which the latest labour-saving devices in mining, transport, and treating the ores have been used on large ore-deposits. The bulk of the lead and zinc came from the Sullivan mine, the copper from the Britannia, Bonanza, Copper Mountain, and Hidden Creek mines, and the silver from the Sullivan and Premier mines. Important productions of lead and zinc came from the Monarch mine and of silver from the Prosperity, both new mines that were brought to production toward the close of last year. The falling off in copper production was due to curtailment of output by the Granby Consolidated Mining, Smelting and Power Company at all its mines in league with many United States copper producers with the hope of upholding the price of copper. The futility of this has been demonstrated and now Granby is again operating its properties at or near capacity. Owing to lack of demand and low prices no bismuth was produced and the cadmium production decreased 38% as compared with the first half of 1929. Both metals are by-products at the Tadanac smelter and residues from which they are obtained are being stored for a better market. The coal production fell away 18% as compared with the first half of last year. Owing to the deplorable condition of the coal mining industry and the large amount of unemployment at the collieries, the Hon. W. A. McKenzie, Minister of Mines, called a conference of representatives of the mine operators, miners, and consumers of coal, with a view to discovering what steps can be taken by any or all of those invited to the conference and the Government to improve the condition of the industry. The conference is in session at the time of this writing. The only base metal and silver mines now producing by company operation are those already mentioned, the group of high-grade silver mines on Wallace Mountain; the Porter-Idaho, which the Premier Gold Mining Company has recently brought to production, and the Planet, at Stump Lake, in the Nicola division. The last is able to continue owing to the gold content in the ore. Concentrate from the mine averages about $200 per ton, of which usually slightly more than half is in gold. A little ore is being produced from several mines by tributers, who, rather than be idle, are content to work for themselves, usually at appreciably below the normal wage rate. The slump in small-scale base-metal mining, too, has caused many miners to go into the hills in search of gold, and already some results are being obtained. Of five groups of lessees on O. K. Mountain, near Rossland, two have struck rich ore, one on the Midnight and the other on the Gold Dip claims. Both are sacking and shipping ore, which is the characteristic high-grade material that is found in narrow veins on the mountain. It is essentially a poor man's prospect, though several poor men have assured for themselves comfortable conditions for life from the ores on O. K. Mountain.

The Kootenays. — Reeves-McDonald Mines annual report, which was presented at the annual general meeting on July 31, must

have left the shareholders rather in a quandary as to the value of their holdings when the present unsatisfactory condition of the zinc market is considered. The report is for the fiscal year ended February 28, 1930. It shows that the company spent $141,019 on development during the year, which brought the total expenditure since formation up to $200,262. Pend Oreille Mines and Metals Corporation, which, according to the report, holds a controlling interest in Reeves-McDonald, advanced $103,920, which is to bear no interest, to enable development on a scale demanded by the policy of that company. Besides development $30,056 was spent on plant and equipment. The River-Level tunnel was advanced 3,545 ft., bringing the total length to 3,875 ft. and bringing it into the Reeves ore-body at a depth of 885 ft. on the dip of the lode below the Reeves tunnel and 1,185 ft. below the apex of the outcrop. Sampling over 1,300 sq. ft. of the Reeves ore-body gave an average of 1·1% of lead and 7·3% of zinc. Exploration by surface open-cuts, underground workings, or diamond drilling has indicated the existence of seven ore zones, on which, as yet, enough development has not yet been done to permit of an estimate of the ore reserve. The extension of the River tunnel 1,000 ft. may be expected to open the B. L. ore zone at a depth of 840 ft. on the lode and 2,000 ft. below outcrop, and the Norcross and O'Donnell ore zones at about 500 ft. All development has been suspended pending a more satisfactory condition of the zinc market.

Noble Five Mines report for the 17 months' period ended April 30, 1930, shows that the company made a net operating profit of $13,623. Between February, 1929, when the mill was started, and February, 1930, when mine and mill were closed because of low metal prices, 23,000 tons was milled and produced 214,076 oz. of silver, 1,987,934 lb. of lead, and 1,534,550 lb. of zinc, which brought a return of $185,216. When the mine was closed 30,000 tons of ore had been developed ready for stoping. The drive on the Deadman ore-shoot on the 1,800-ft. level has exposed a length of 450 ft. in ore. The shoot has been developed upward to the 1,700-ft. level and above is virgin ground to the 1,000-ft. level. The 800-ft. level on the Noble Five vein has been extended 1,000 ft. and a good shoot of ore has been exposed. The 700-ft. level was being advanced to pick up this shoot when the mine was closed. The mine and plant are in excellent condition and can be restarted directly metal prices warrant it.

Captain C. E. Hutton, of London, who represents the English shareholders in Reno Gold Mines, recently visited the mine, and expressed himself as being delighted with progress that has been made since his visit of last year. The mill was started on August 15,1929, and to the end of July has produced gold to the value of $112,500. According to Mr. O. C. Thompson, general manager for the company, the mine is developing better than was expected. Two ore-shoots, one 210 and the other 200 ft. long, have been opened on four levels on the main vein. A cross-cut from No. 3 level has opened a second vein at that depth. Five parallel veins have been exposed at the surface. Values are reported to be running from $120 to $170 per ton; 8,000 tons has been broken in the mine. The mill has a capacity of 30 tons daily and is recovering 97% of the gold content.

West Kootenay Power and Light Company is starting to develop another hydro-electric station on the Kootenay River at about two miles above its Upper Bonnington Falls station. The river at this point is expected to develop 30,000 h.p, and work will be pushed with the hope of bringing the station into service for the seasonal water shortage of the winter of 1931–1932. Engineering difficulties have developed in the Adams River plant, to the east of Kamloops, and it is feared that the plant will not be available until after the new plant on the Kootenay River. The company has filed its plans for the development of the Pend d'Oreille River, where it expects to develop 275,000 to 300,000 h.p., with the Provincial Water Board, which has reserved its decision. Reeves-McDonald Mines again made a protest against the plans.

Canadian National Railway Belt.—Dr. J. McIntosh Bell, who recently made an examination of Duthie Mines holdings for the Atlas Exploration Company, which owns 822,294 of the 1,822,294 outstanding shares in the company and holds an option on the whole of the treasury stock, has recommended that development work be restarted. He found that the extension of the Henderson vein into the Canary and Humming Bird groups, which the company has acquired, carries besides silver, lead, and zinc, important gold values over a workable width and he considers that this part of the property is worthy of further development. Some high

gold assays have been obtained from samples from the Glacier Gulch group, on Hudson Bay Mountain, near Smithers. The group attracted attention late in last fall because of the discovery of bismuth, but winter set in before much exploration could be done. A series of open-cuts have now been made on what appear to be two parallel veins separated by only a small width of rock, and the whole ranging from 3 to 11 ft. in width. The veins are well mineralized with a white mineral, the nature of which has not yet been wholly determined, but assays of selected samples run from 8 to 11% of bismuth and $260 to $400 in gold per ton.

Bridge River.—Two eastern Canadian development companies, the names of which have not been divulged, have been negotiating for the Pioneer mine which has been steadily producing gold for several years. Despite a water shortage which curtailed output, the mine produced gold to the value of $80,000 during the first half of this year, and the July brick is valued at approximately $25,000. The present owner, Pioneer Gold Mines, has opened the vein by drives on the 625-, 750-, 875-, and 1,000-ft. levels, the longest of which is 1,150 ft., on the 750-ft. level, which for most of its length is in ore. Additional water power recently has been developed and now 100 tons is being milled daily. The mine is one of the oldest lode gold mines, but until acquired by the present owner no attempt at systematic development seems to have been made. A second parallel vein has been cut by the shaft near the 1,000-ft. level and opened by a cross-cut from the bottom of the shaft.

TORONTO

August 19.

Porcupine.—During July the production of bullion in this field was valued at $1,467,220, from the treatment of 208,512 tons of ore as compared with $1,347,189, from 205,154 tons of ore in June. The Dome Mines, Ltd. is making satisfactory progress with the erection of its new 1,500 ton mill which is expected to be ready for operation by the first of October. Since the destruction of the mill by fire a year ago, development work was actively carried on and the opening up of new ore-bodies added considerably to the ore reserves. When production is resumed the mill can be kept steadily in operation on a good grade of ore for several months. The installation by the Hollinger Consolidated of mining, milling, and hoisting machinery designed to deal with 8,000 tons of ore per day has enabled the company considerably to reduce operating costs which are now substantially below $4 a ton, leaving a good margin for profit. Underground exploration which has been actively carried on for some time under the direction of Dr. Graton has been largely discontinued pending the consideration by the management of the recommendations contained in his special report. The management of the McIntyre Porcupine has finally decided on the erection of a new 2,000 ton mill and has placed orders for the necessary machinery and equipment. The mill will be located at the No. 11 shaft on the north side of the lake, where excavation work is now progressing and it is expected to be ready for operation by the end of March, 1931. Ore reserves are being steadily increased, and the outlook of the mine, particularly at the lower horizons, shows improvement. The mill is now treating about 700 tons of ore per day, which will shortly be increased by the addition of new equipment. The programme of mine development at the Vipond is proceeding favourably. Production has been somewhat increased and is now running about $85,000 per month and current rate can be easily maintained, reserves of ore being developed at a rate in excess of milling requirements. In order to enable exploration to be carried to lower horizons a winze will be sunk from the 1,250 ft. level to a depth of 2,200 ft. At the Canusa property the shaft which is down 300 ft. is being unwatered preparatory to resumption of operations.

Kirkland Lake.—The July output of the Kirkland Lake gold area was valued at $1,365,743 produced from 101,917 tons of ore, as compared with the production in June of $1,552,921, from 99,863 tons. At the Lake Shore, shaft sinking is under way from the 2,200 to the 2,600 ft. level. The old shaft is down 2,200 ft., and it is proposed to drive from the new shaft on the 2,600 ft. level and connect by a rise with the old shaft. The installation of machinery for the new mill addition is now approaching completion and part of this will be in operation in September. It is anticipated that the entire capacity of 2,000 tons will be reached before the end of the year. Production is being maintained at its former high level with some improvement in the value of the ore going through the mill. The Wright Hargreaves is

increasing its ore reserves through the development of its south vein system. The 2,125 and 2,250 ft. levels are being opened up across widths of 15 ft., showing ore lengths of approximately 700 ft., with values of from $12 to $15 to the ton. The mill is stated to be treating about 600 tons per day, of an average grade of $12. Excavations for the new mill of the Teck-Hughes which will bring the total milling capacity up to 1,250 tons per day have been completed. Sinking of the new south shaft is proceeding steadily, its objective being 3,600 ft. The new crusher adjacent to the south shaft is rapidly going up and the steel is practically all in place. The results of development at the lower levels are highly satisfactory, the values corresponding with those higher up, with widths greater than the average mine widths. The mill at the Kirkland Lake gold mine is handling an average of 150 tons of ore daily, with a recovery of close to $15 to the ton. The shaft has been completed to the 4,300 ft. level, and cross-cutting is in progress on the lower horizons. The Sylvanite has completed its new No. 4 shaft to a depth of 1,750 ft. Driving is under way at this level and good widths and values are being obtained. The mill is treating between 210 and 225 tons per day. The Barry Hollinger has completed the sinking of a winze to the 1,750 ft. level, which was in ore most of the way. A crosscut is being run to pick up the vein which dipped out of the winze. The mill is treating about 100 tons a day with mill heads running upwards of $10 to the ton.

Sudbury District.—With the completion of the plant of the Ontario Refining Company at Copper Cliff, International Nickel will be enabled to increase its output considerably. While the greater part of the matte to be treated will be provided by International Nickel, much will also be brought in from distant points, including shipments from Granby Consolidated in British Columbia and copper matte from the Sherritt-Gordon of Manitoba when that company goes into operation in about six months. A working force of about 800 men will be employed in the refinery branch of the industry, when fully in operation. The Falconbridge has prepared the foundations for an addition to the smelter, comprising a second blast furnace and a third converter. As definite arrangements cannot be made for the supply of power for some time, the installation of the machinery may be delayed until the spring. By means of this equipment the capacity of the smelter may be doubled. The smelter is operating at an average of about 285 tons of ore per day, and the ore has a value of $18 to $20 per ton. Mining operations are steadily adding to the tonnage of broken ore. Lateral work at the 1,000 ft. level has advanced about 2,500 ft., and about 80% of this is in ore showing an average width of about 10 ft.

Rouyn.—At the current rate of production, the output from the Noranda mine this year will be in the neighbourhood of 90,000,000 lb. of copper, an important increase over the output for 1929. The maximum performance has been the production of an average of 300,000 lb. of copper per day. The recent completion of the additional 500 tons of daily concentrating capacity and the new stack at the smelter will permit of an increase in production if desired. The ore continues to show around $3·50 per ton in gold, plus an average of over 6% in copper. About 70 rock drills are in operation. The Waite-Montgomery has discontinued the shipment of ore to the smelter until prices improve, and is carrying out a programme of exploration for the discovery of new ore-bodies at depth. The upper deposit is believed to contain about 170,000 tons of material carrying over 6% in copper. The lower deposits have not been developed to the same extent, but are apparently of much promise. During July Amulet produced 1,972 tons of copper concentrates averaging 19% copper, which was shipped to the Noranda smelter, and 2,875 tons of zinc concentrates averaging 53% zinc. A total of 5,159 tons of zinc concentrates were shipped to tidewater, and one cargo of 3,500 long tons has gone forward to Belgium. Development work is proceeding satisfactorily, and a large ore-body recently cut by diamond drilling showed values of 6·47% copper, and 24·1% zinc. The Mining Corporation of Canada has taken over the management of the Abana Mine as security for advances made to the company. The new mill will be ready for production in about three months, and at the outset the ore to be treated will be drawn from sections of the mine containing high values in copper, and comparatively little zinc. The mill at the Granada gold mine is handling about 40 tons of ore daily and giving every satisfaction.

Patricia District.—The only producing mine in this district is the Howey at Red Lake which during June yielded gold to the value of $52,000 from the treatment of 10,000 tons of ore.

CAMBORNE

September 5.

Wheal Kitty.—Active operations have been suspended as far as development and exploitation are concerned. The ore which had been broken in various stopes has been hoisted and sent to the mill and as soon as treatment has been completed all surface operations will also be stopped and the water allowed to rise in the mine. Underground the construction of dams between Wheal Kitty and Wheal Friendly setts, which are not owned by the same mineral lords, is being proceeded with as fast as possible. These dams are placed so that Wheal Friendly can be again unwatered without draining the workings in Wheal Kitty, or, if deemed necessary or advisable, both mines can be unwatered simultaneously. During the operations of the present company the dams previously constructed between West Kitty and Wheal Friendly have remained intact.

The company suspends operations with an indebtedness to the London Tin Corporation of about £113,000, there being no other debts. In other words, that corporation owns the property and will presumably figure largely if and when operations are resumed or the company undergoes reconstruction. During its brief existence the company has established the fact that the productive ore ground, so profitably mined by the old West Kitty cost-book company during the period 1880-1910, continues along the dip of the lode into Wheal Friendly to the deepest point yet reached in that sett, a point which is only about 500 ft. vertically below adit level. To pursue this productive lode to a greater depth arrangements for more adequate shaft accommodation are essential and in the event of a resumption of operations that is the first and most important matter to be undertaken. During the period mentioned, 1880-1910, the old West Kitty Company sold over 10,000 tons of black tin for about £665,000, but long before 1880 unrecorded sales from the various setts which were included in West Kitty were large and yielded substantial profits. Wheal Rock was a prominent example over a century ago.

Polhigey.—The position at present is very similar to that at Wheal Kitty. The mill has recently been crushing low-grade accumulations of ore left underground. Apart from this, active operations are already suspended and work will shortly be stopped altogether. No rich deposit has been discovered at Polhigey, but a considerable extent of low-grade ore, fairly uniform in quality, has been proved to exist. With tin metal at £200 to £250 per ton, operations can be carried on at a fair working profit. Here too, unfortunately, a heavy debt has accumulated and this must prove to be a serious burden in case another attempt is made to work the property.

With the suspension of Wheal Kitty and Polhigey the active operations of the Anglo-Oriental group in Cornish mines cease, as Wheal Vlow and Park-an-Chy were closed down previously.

Other Tin Mines.—There is no fresh development to report in relation to the other tin mines of the county. Their expenditure has been adjusted to meet as far as possible the requirements of the times, without a suspension of active operations, in the hope that by the aid of their existing financial resources or in a case or two by contracting a moderate loan they may "tide over" the period of depression, with the reasonable expectation of reaping a sufficient reward when the price of tin recovers its normal position.

Lambriggan.—Operations have been completely suspended owing chiefly to the continued low prices of lead and zinc, but partly to disappointing results experienced in the recent drivage on the lode at the deepest point yet reached, 400 ft. from surface. During the present working the engine shaft has been cleared and enlarged from surface and deepened by 115 ft. to the No. 3 level at 400 ft. Exploration at Nos. 1 and 2 levels disclosed the existence of two blocks of payable ore, one to the east and the other to the west of the shaft. At No. 3 level the enclosing rock evidences a change in structure, which may account for the comparative unproductiveness of the lode at that depth, although it maintains its size.

Under existing economic conditions it has been decided to suspend all operations, but the pitwork and, indeed, all the machinery have been left intact, so that should lead and zinc assume a sufficiently high price level it will be possible to minimise the expenditure required to again unwater the mine and carry the exploration of the lode to a greater depth. It is a fact that in the adjacent Chiverten district the richest deposits of lead were not discovered within 400 to 500 ft. from surface. It is to be regretted that it has been decided to abandon

—for a time at least—the idea of further sinking.

Labour.—The effects of the suspension of work in some of the mines upon unemployment are reflected in official lists. The numbers of unemployed in the mining districts of Camborne, Redruth, St. Just, and Perranzabuloe (including St. Agnes) further increased from 2,163 in July to 2,337 at the end of August. The depression in the tin industry unfortunately happens to coincide with the rather serious falling-off in the demand for Cornish china-clay since the beginning of the current year and as local stocks are considerable economy dictates a small reduction of hands.

PERSONAL

G. Keith Allen has left for Northern Rhodesia.

Sir Basil Blackett has joined the board of the De Beers Consolidated Mines, Ltd.

Cyril Bond has left for Spanish Morocco.

George Bottoms has left for Canada.

J. M. Callow has left for Australia.

G. W. Campion has left for West Africa.

Reginald Coward is returning from the Gold Coast.

J. B. Dennison has left for Spain.

J. V. N. Dorr is expected in London towards the end of the month.

Edward Hooper is home from Cape Colony.

J. M. Iles has left for Canada.

S. B. King, of the Sullivan Machinery Company, has been here from the United States.

R. F. St. J. Lethbridge has left for Jugoslavia.

Malcolm Maclaren has left for West Africa.

J. H. McLean passed through London on his way to New Jersey from Northern Rhodesia.

H. B. Milner has left for Czecho-Slovakia.

P. H. O'Nians is returning to England.

A. Otter is home from Nigeria.

C. E. E. Pargeter has left for East Africa.

T. P. Patterson has left for West Africa.

D. R. Pengilly is returning from Nigeria.

Francis J. Ryeland has left for Cyprus.

C. I. Snelling is home from Nigeria.

C. W. Thomas has left for South Africa.

James L. Thomson has left for Cyprus.

W. E. Thorne has gone to Colorado.

A. Travis has returned from the Balkans.

W. H. Trewartha-James has returned from Western Australia.

S. Dawson Ware is home from East Africa.

C. H. White is here from Northern Rhodesia.

Harley B. Wright is home from the Gold Coast.

The death occurred on August 17 of Sir William Walker, who from 1919 to 1920 was chief inspector of mines at the Home Office, having since 1914 been successively deputy chief inspector and acting chief inspector. He then moved to the Board of Trade as director of health and safety in mines. He was created C.B.E. in 1918 and knighted in 1922, and he retired from the Civil Service in 1921.

TRADE PARAGRAPHS

Head, Wrightson, and Co., Ltd., of Stockton on Tees, send us a booklet devoted to the Kirkless slurry separator as applied in coal washing practice.

International Geophysical Prospecting Co., Ltd., inform us that in future their offices are at 10-12 Copthall Avenue, London, E.C. 2, instead of 20, High Holborn. The new telephone number is Metropolitan 6363 and 6364 and telegraphic address Geoprosco, Stock, London.

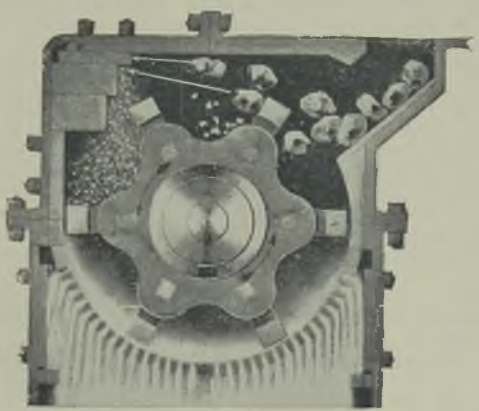
John Brown and Co., Ltd., of Atlas Works, Sheffield, send us a copy of the third edition of a bound booklet devoted to their alloy and tool steels. This covers some 100 pages, is fully illustrated, and contains much tabular matter and data setting out the heat and mechanical treatment necessary for these widely different steels.

The W. S. Tyler Company, of Cleveland, Ohio, has issued through their London agents, **Mining and Industrial Equipment, Ltd.,** of 11, Southampton Row, London, W.C. 1, a leaflet describing the Ro-Tap, which is already familiar to many as a mechanically operated laboratory outfit for size analysis with superimposed wire sieves of graded mesh.

The Bureau of Information on Nickel of the Mond Nickel Co., Ltd., of Imperial Chemical House, London, S.W. 1, in their *Nickel Bulletin* for August publish an article on the use of that metal in mining machinery exemplifying their observations by reference to various rock drill, air-compressor and haulage engine parts made by **Holman Bros., Ltd.** of Camborne.

Sullivan Machinery Company, of Salisbury House, London Wall, E.C. 2, send us the July issue of their *Engineering Graphic*, which contains the following articles of interest to mining men: Scraper Loading in British Longwall Mines, being a précis of a paper before the Midland Institute of Mining Engineers, Slushing Cuts Production Costs at Cerro de Pasco, and Surface Scraper Loading in France.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, send a catalogue of their K-B pulverizer, which is a mill of the revolving hammer type for crushing moderately hard material to a fineness depending on the adjustment of the six



Showing Interior of K-B Pulverizer while in Operation.

U-type hammers, the use of screens with various openings, varying the form of these openings, or regulating the speed of the machine. The hammers are suspended from discs mounted on the shaft. Hammers, screens and liner plates are made of manganese steel. A diagrammatic section to show the operation of the mill is reproduced here.

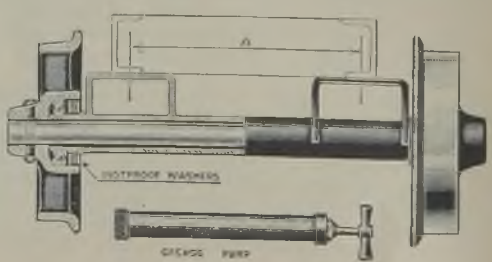
R. S. Patrick, of Duluth, Minnesota, U.S.A., issue an illustrated booklet about their carbons for diamond core drilling which, after describing the mining of the stones in Brazil, goes on to outline their physical characteristics and grading, their preparation for the drill—which includes a section on the artificial blunting of stones—and their application in the drill. Various examples of diamond drilling practice are cited, and the results obtained reviewed. Other booklets issued deal with diamond core drilling in oilfield practice, how to cut carbon costs, and the blunt-edge carbon.

The General Engineering Company, Inc., of Salt Lake City and Adelaide House, London, E.C. 3 have sent us a copy of their Bulletin No. 5 which is devoted to a description of the Geco pneumatic machine (MacIntosh type) the salient features of which were described in these columns in December, 1926 and September, 1927. A recent adoption on these machines are the " gland eliminators " at the discharge end or at both feed and discharge ends of the cells, which latter are recommended especially where gland water, free from foreign matter, is not available. Where a stuffing box and gland is used, the stuffing box is floated by means of a flexible rubber support. Thus it does not act as a bearing. Cutting of the rotor shaft has by these means been eliminated. In an article in the MAGAZINE for December last, J. M. Callow describes the installation of these machines in the Mount Isa mill, Queensland.

Westinghouse Electric International Co. of 2, Norfolk Street, London, W.C. 2 (Head Office: New York), has joined with a group of Spanish financiers and industrialists in the formation of a new company known as Constructora Nacional Maquinaria Electrica, and capitalized at 12 million pesetas, to manufacture electric generators, motors, transformers, and other electrical apparatus in Spain. Arrangements have been made whereby the new company will collaborate with both the Westinghouse Electric International Company and Le Materiel Electrique S-W, the French Company formed recently by Schneider-Creusot and Westinghouse interests. These arrangements secure for the Spanish company engineering, manufacturing, and research information, the granting of exclusive patent rights for Spain, and the technical guidance of the Westinghouse Company. The new company will be a national Spanish industrial enterprise in every respect, 75% of its stock having been subscribed for by a Spanish group. The new company has taken over the electrical business of the Electro Mecanicas organization (which, however, retains its extensive copper interests) and has acquired from " Naval " an existing plant in Cordoba and ground on which it will build a new factory in Reinosa.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, inform us of the following new orders for equipment: For England: One No. 00 Raymond pulverizer for yellow and red pigments at feeds of 1 in. to dust to yield 520 lb. per hour of the yellow and 200 lb. per hour of the red both 98% through 200 mesh; one 2 ft. by 4 ft., type 27, Hum-mer screen; one No. 00 Raymond pulverizer for arsenical compounds at feeds of 1 in. to 1½ in. maximum giving outputs of 1 ton per hour; one 3 ft. by 5 ft., type 39, Hum-mer screen for granite chips with separation at ¼ in. at an output of 10 tons per hour; one No. 00 Raymond pulverizer for Prussian Blue at a feed passing 1¼ in. ring, an output of 3½ cwt. per hour, and a fineness of 99% through 200 mesh; one R.L. 7 mill and air separation plant and one 3 ft. by 5 ft., type 31, Hum-mer screen all for split records at a feed of minus ½ in., output of 1,600 lb. per hour and fineness of 96% through 200 mesh; one No. 00 Raymond pulverizer for starch crystals at a feed of ⅛ in., output of 3 cwt. per hour and fineness of 99·9% through 140 mesh; one No. 00 Raymond pulverizer for magnesium carbonate; two 4 ft. by 5 ft., type 31, Hum-mer screens at a capacity of 8 tons per hour and separation at 0·5 mm.; and one No. 00 Raymond pulverizer for powdered lead at a feed of minus ½ in. to dust, output of 2 cwt. per hour and fineness of 99·9% through 250 mesh. For South Africa: 14 No. 70 and one No. 3 Impax pulverizers for Wankie coal respectively at 7,000 and 2,000 lb. per hour capacities; and one 4 ft. 6 in. by 16 in. Hardinge mill for unnamed duty. For Nigeria: One 3 ft. by 5 ft., 2-surface type 39, and one 4 ft., type 39 Hum-mer screens for tin ore at 150 tons per day of 16 hours, feed of 1 in. and separations at ½, ¼, ⅛, and 1/16 ins.

Robert Hudson, Ltd., of 38a Bond Street, Leeds, have devised, after much research and experiments spread over many years, a new type of wheel and axle which, it is claimed, only needs lubrication once a year. This affects a great saving in every way, for, apart from the cost of maintenance, there is the saving in man handling, and a longer life than the ordinary type. These wheels and axles have been subjected to practically every possible test over long periods, on various kinds of tracks, under all climatic and working conditions and from the data collected the firm claim that they effect a saving of 50% in haulage, 75% in starting effort and 85% in lubrication. A system of forced lubrication has been adopted utilizing a grease gun. This principle ensures that, should any foreign matter tend to enter the bearing, it is forced out the same way as it comes in by the application of the gun. This information should be of great interest to users of mining trucks and tip trucks of every description, especially those who have to contend with working under bad conditions where native labour, which cannot be relied upon, is employed. The wheels and axles are made of a high-tensile steel, which renders them practically unbreakable. They are fitted with ball bearings of the very best manufacture, and are made in two different types:—The " Cabo " type which has a continuous axle for ordinary use, and



the " Bako " type which has differential axles permitting the outside wheel on a curve to travel at a greater speed than the inside wheel, thus enabling them to nogotiate very sharp curves without any unduly increased tractive effort. Both the " Bako " and " Cabo " types are fitted with a grease-retaining system which enables the wheels to run without any attention beyond replenishing by means of a small charge of grease with a Hudson grease gun every 1,000 miles, this being about the average yearly mileage of a mining truck. The cost of labour alone saved by using practically frictionless bearings is considerable. Obviously, these wheels and axles cost a little more than the ordinary kind, but, in view of the greater efficiency in working in every respect it is considered that this extra cost is saved in the first year's working. As a proof of the makers' firm conviction in the superior qualities of these wheels and axles and the complete satisfaction they have given to users in every industry where trucks are used, they are prepared to send a sample set on six months' approval to firms who are large users of this class of light railway equipment.

METAL MARKETS

COPPER.—The tendency of copper prices during August was slightly easier, and Standard values in London were marked down a trifle, while in New York, although Copper Exporters Inc. continued to quote 11 cents per lb. for electrolytic, f.a.s., outsiders over there were prepared to offer metal for shipment at down to 10 87½ cents. The copper situation is still very far from brilliant, as, although makers have been endeavouring to curtail output, the huge transatlantic stocks have not yet been reduced to any substantial extent. Demand is comparatively quiet and if it does not revive during the autumn and winter there is a distinct possibility of the market exhibiting renewed weakness. The price of copper is now, however, so reasonable that the competitive power of aluminium and other rival metals is less serious than it was.

Average price of Cash Standard Copper: August, 1930, £47 11s. 4d.; July, 1930, £48 6s. 10d.; August, 1929, £73 16s. 8d.; July, 1929, £72 3s. 11d.

TIN.—This market kept comparatively steady during the past month. Sentiment was restrained, the " bears " being held in check by the possibility of the Tin Producers' Association's output-curtailment measures taking serious effect soon whilst the " bulls " were sobered by the still uncompromising statistical position. With fresh increases taking place in both the U.K. stocks and world " visible supplies " it is naturally difficult to take an optimistic view of the immediate prospects of market values, particularly as there is still no sign of a definite revival in the chief consuming industries. The price is now of course so low that there would appear to be very little scope for any further heavy fall, but on the other hand it is doubtful whether anything will occur to push it up in the near future.

Average price of Cash Standard Tin: August, 1930, £135 1s. 2d.; July, 1930, £134 11s. 10d.; August, 1929, £209 17s. 11d.; July, 1929, £209 11s. 6d.

LEAD.—This market was also characterized by considerable steadiness last month. Russia was a good buyer early in August, but demand from Germany was frankly poor. On the other hand, business with consumers in our own country is being well maintained. Thanks to the control which they exercise over surplus supplies, the Lead Producers' Association have been able to keep prices stable, but in view of the fact that these surplus stocks are very heavy it is obvious that the position is highly artificial. Prices ought to be rather lower than they are, but so long as the Association is in a position to keep metal off the market consumers will be forced to pay the quotations demanded. Arrivals of fresh lead have latterly been light, but they are likely to expand in the near future owing to heavier shipments from Australia. The control exercised by producers was demonstrated at the close of August when big premiums were temporarily obtained for metal for early delivery.

Average mean price of soft foreign lead, August, 1930, £18 4s. 8d.; July, 1930, £18 2s. 2d.; August, 1929, £23 4s. 5d.; July, 1929, £22 16s. 10d.

SPELTER.—Nothing very important transpired on this market last month. Values fluctuated, but on balance were virtually unaltered. Demand from consumers continued quiet, but on the other hand the hopes of sellers were buoyed up by anticipations of the definite establishment of the projected International Spelter Cartel during the autumn. However it is said some months will have to elapse yet before the organization can possibly be completed. It would not be surprising, meanwhile, if producers find themselves forced by economic necessity to cut down output further, whilst more of the higher-cost mines and works are likely to have to shut down entirely pending and improvement in the market. Prices in America, where stocks are still increasing, have been easy.

Average mean price of spelter: August, 1930, £16 4s. 2d.; July, 1930, £16 9s. 5d.; August, 1929, £25 0s. 7d.; July, 1929, £25 7s. 6d.

IRON AND STEEL.—The British iron and steel market remained dull during August, seasonal factors accentuating the already depressed state of trade. Cleveland pig-iron producers reduced their prices 4s. per ton, making No. 3 foundry G.M.B. 63s. 6d. minimum, but so far this move does not seem to have stimulated demand to any marked extent. In hematite, works continued to quote 71s. per ton for East Coast Mixed Numbers, but merchants were prepared to underquote this figure. The steelworks in this country continued under-employed, demand from both home and export markets being subdued except in the case of a few products. On the Continent the attempt to fix prices of semi-finished materials and joists has broken down, and works producing these materials are now scrambling for such business as can be secured. The general position of all the iron and steel markets is unsatisfactory and if an early improvement does not take place output is likely to be reduced further both on the Continent and in Britain.

IRON ORE.—There has been no business of any magnitude, and most works are overstocked and over-bought. Prices are nominally a little easier at 19s. per ton c.i.f. for best Bilbao rubio, but it is difficult to know the actual value in the absence of business.

ANTIMONY.—At the close of August English regulus was quoted between £38 and £46 10s. per ton. Chinese regulus on spot was quiet and irregular around £27 to £27 10s. ex warehouse, whilst for shipment from the East the value was approximately £25 10s. to £26 c.i.f.

LONDON DAILY METAL PRICES

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard.		Electro-lytic.	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	Forward.	
Aug.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
11	48 1 3	47 19 4½	51 10 0	—	136 6 3	138 1 3	16 2 6	18 5 0	19 15 0	16 7/16	16 7/16	84 11½
12	47 16 10½	47 19 4½	51 10 0	50 5 0	135 16 3	137 11 3	16 0 0	18 3 9	19 15 0	16 7/16	16 7/16	85 0½
13	47 10 7½	47 11 10½	51 10 0	—	134 13 9	136 11 3	15 17 6	18 1 3	19 10 0	16¼	16½	85 0½
14	47 6 10½	47 8 1½	51 10 0	—	134 7 6	136 5 0	15 16 3	18 5 0	19 10 0	16 5/16	16 5/16	85 0
15	47 6 3	47 6 3	51 0 0	50 0 0	134 3 9	135 18 9	15 17 6	18 3 9	19 10 0	16 7/16	16 7/16	85 0
18	47 8 1½	47 9 4½	51 0 0	—	134 17 6	136 7 6	16 1 3	18 6 3	19 10 0	16 13/16	16 13/16	85 0
19	47 5 7½	47 5 7½	51 0 0	50 0 0	135 1 3	136 11 3	16 2 6	18 7 6	19 15 0	16 13/16	16 13/16	84 11½
20	47 4 4½	47 6 10½	51 0 0	—	134 16 3	136 3 9	16 2 6	18 5 0	19 15 0	16 11/16	16 11/16	85 0
21	47 1 3	47 4 4½	51 0 0	—	134 13 9	136 6 3	15 15 0	18 6 3	19 15 0	16⅝	16¾	85 0
22	46 18 1½	47 0 7½	51 0 0	50 0 0	134 8 9	135 18 9	15 18 9	18 6 3	19 15 0	16 11/16	16 11/16	85 0
25	46 17 6	47 0 7½	51 0 0	—	134 1 3	135 11 3	15 15 0	18 5 0	19 15 0	16 7/16	16 7/16	85 0
26	46 17 6	46 19 4½	51 0 0	50 0 0	132 16 3	134 8 9	15 12 6	18 5 0	19 15 0	16¼	16¼	85 0½
27	46 16 10½	46 19 4½	51 0 0	—	133 8 9	134 18 9	15 17 6	18 5 0	19 15 0	16 7/16	16 7/16	85 0½
28	46 16 10½	47 1 3	51 0 0	—	135 13 9	137 3 9	15 17 6	18 7 6	19 15 0	16 5/16	16 5/16	85 0
29	47 7 6	47 7 6	51 0 0	50 0 0	134 13 9	136 6 3	16 1 3	18 13 9	19 15 0	16 7/16	16 7/16	85 0
Sept.												
1	47 14 4½	47 16 10½	51 0 0	—	133 13 9	135 3 9	16 1 3	18 5 0	19 15 0	16 7/16	16 7/16	85 0
2	47 11 10½	47 11 10½	51 0 0	50 0 0	133 13 9	135 8 9	16 2 6	18 5 0	19 15 0	16¼	16¼	85 0½
3	47 11 10½	47 11 10½	51 0 0	—	133 1 3	134 13 9	16 2 6	18 3 9	19 15 0	16 7/16	16 7/16	85 0½
4	47 6 3	47 8 1½	51 0 0	—	133 1 3	134 16 3	16 1 3	18 3 9	19 15 0	16 7/16	16 7/16	85 0½
5	46 19 4½	47 0 7½	51 0 0	50 0 0	133 7 6	135 2 6	15 18 9	18 3 9	19 15 0	16¼	16¼	85 0½
8	47 13 9	47 13 9	51 0 0	—	133 13 9	135 8 9	16 0 0	18 5 0	19 10 0	16⅜	16⅜	85 0½
9	47 8 9	47 11 3	51 0 0	50 0 0	133 13 9	135 8 9	15 18 9	18 5 0	19 10 0	16¼	16⅜	84 11½
10	47 8 1½	47 9 4½	51 0 0	—	133 16 3	135 11 3	15 18 9	18 3 9	19 10 0	16¼	16⅜	84 11½

ARSENIC.—The market keeps steady with 99% Cornish white around £15 15s. per ton f.o.r. mines.

BISMUTH.—Leading interests continue to quote 4s. per lb. for 5 cwt. lots and over.

CADMIUM.—Early last month prices developed a rather easier tendency, but at the lower levels more business was done, and a fair demand continues at about 3s. 3d. to 3s. 4d. per lb.

COBALT METAL.—Only a quiet business is passing, but the official price remains at 10s. per lb.

COBALT OXIDES.—There is no change in quotations, which stand at 8s. per lb. for black and 8s. 10d. for grey.

CHROMIUM.—About 2s. 6d. per lb. still represents the price of this metal.

TANTALUM.—The enquiry for wireless purposes has diminished and quotations are rather nominal at between £40 and £50 per lb.

PLATINUM.—The tentative agreement reached among producers for the stabilization of the price broke down two or three weeks ago, and with Russia offering freely, prices have declined sharply to the present level of £7 per oz. for refined metal.

PALLADIUM.—Quotations have eased somewhat in sympathy with platinum, current prices being £3 15s. to £4 per oz.

IRIDIUM.—Holders found it impracticable to maintain prices at the artificial level of £51 per oz., and sponge and powder have eased to about £40 to £42 per oz.

OSMIUM.—A fair enquiry is maintained for this metal, which is steadily priced at £15 10s. to £16 per oz.

TELLURIUM.—In the absence of business quotations are nominally unaltered at 12s. 6d. to 15s. per lb.

SELENIUM.—High grade black powder continues to realize 7s. 8d. to 7s. 9d. per lb., ex warehouse.

MANGANESE ORE.—Easiness in the freight markets has tended to lower quotations slightly, but there is no buying being done. Best Indian ore is somewhere about 1s. 1d. per unit c.i.f. with washed Caucasian about 1s. to 1s. 0½d. c.i.f.

ALUMINIUM.—Makers have decided not to reduce prices, at any rate this year, and demand has since improved somewhat. Consumption, however, lags behind that of 1929 and output has been curtailed fairly generally in Europe in order to stop stocks accumulating too rapidly. Prices remain at £95, less 2% delivered, for ingots.

SULPHATE OF COPPER.—Prices have been reduced in conformity with easier conditions in the copper market during the past month, and English material is now obtainable at about £22 10s. to £23 per ton, less 5%.

NICKEL.—Demand has been only moderate, but prices are fully maintained at £170 to £175 per ton for both home and export.

CHROME ORE.—A fair enquiry is maintained, but production is still tending to increase and there is certainly no scarcity of supplies. Rhodesian 48% material is worth about £4 to £4 5s. per ton c.i.f., with more obtainable for higher grade material.

QUICKSILVER.—Only a skeleton demand is in evidence, but prices are still pegged at £22 12s. 6d. to £22 15s. per bottle, full terms.

TUNGSTEN ORES.—Sellers in China have adopted a firmer attitude recently, partly on account of the difficulties in shipping. On the other hand demand has been trifling, and prices have been very indefinite. The current value of Chinese ore for forward shipment is about 18s. to 19s. per unit c.i.f.

MOLYBDENUM.—Quiet conditions still prevail in this market, prices being nominally unaltered at 32s. 6d. to 33s. per unit c.i.f. for 80 to 85% concentrates.

GRAPHITE.—The better grades of graphite are still called for at prices which keep remarkably steady. Madagascar 85 to 90% raw flake is about £25 to £27 per ton c.i.f. and Ceylon 90% lumps about £24 to £26 ci.if.

SILVER.—There has been a gradually improving tone in this market throughout August, mainly due to better conditions in China. Prices have moved within a moderate range, spot bars closing at 16d. on August 1, advancing to 16 5/16d. on August 15, to 16 7/16d. on August 21, and closing at 16¼d. on August 30.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
August, 1929	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
February	783,086	35,102	818,188
March	852,089	37,281	889,370
April	831,996	36,610	868,606
May	876,893	39,320	916,213
June	847,352	40,515	887,867
July	871,468	41,184	912,652
August	878,474	42,607	921,081

TRANSVAAL GOLD OUTPUTS.

	July.		August.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	88,500	£140,470	88,800	£141,516
City Deep	103,000	27,090	99,000	26,628
Cons. Main Reef	65,000	22,492	62,000	21,454
Crown Mines	247,000	80,058	255,000	80,752
D'rb'n Roodepoort Deep	45,800	15,070	46,000	14,923
East Rand P.M.	155,500	42,526	157,000	42,461
Geduld	86,000	27,632	86,000	27,513
Geldenhuis Deep	70,800	15,878	70,000	15,557
Glynn's Lydenburg	6,800	2,240	6,600	2,034
Government G.M. Areas	212,000	£409,233	207,000	£396,534
Kleinfontein	52,800	11,297	52,300	11,293
Langlaagte Estate	84,000	£119,639	80,000	£115,781
Luipaard's Vlei	30,000	7,579	30,000	7,653
Meyer and Charlton	18,400	£18,831	18,400	£18,358
Modderfontein New	161,000	73,069	159,000	71,784
Modderfontein B	71,500	25,147	71,500	25,166
Modderfontein Deep	45,900	23,833	44,200	23,034
Modderfontein East	72,500	20,738	71,000	20,525
New State Areas	80,000	£164,802	78,000	£162,538
Nourse	66,500	18,886	67,000	18,926
Randfontein	221,000	£239,048	223,000	£235,370
Robinson Deep	97,000	27,742	97,000	28,288
Rose Deep	62,500	13,675	64,500	13,528
Simmer and Jack	74,800	20,814	77,800	20,967
Springs	74,700	£152,379	72,000	£145,690
Sub Nigel	30,900	26,927	30,800	27,329
Transvaal G.M. Estates	15,400	4,524	15,000	5,401
Van Ryn	64,000	£106,313	42,500	£41,870
Van Ryn Deep	42,000	£42,145	82,000	£103,514
West Rand Consolidated	92,500	£104,764	93,000	£105,852
West Springs	70,600	£79,184	68,000	£75,735
Witw'tersr'nd (Knights)	56,000	£51,007	55,500	£51,577
Witwatersrand Deep	42,400	13,711	43,200	13,580

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
May, 1929	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	2,528,000	28 3	19 11	8 4	1,058,231
January, 1930	2,618,600	28 2	19 9	8 5	1,103,718
February	2,421,100	28 5	20 0	8 5	1,019,482
March	2,663,820	28 1	19 8	8 5	1,121,216
April	2,549,250	28 7	20 1	8 6	1,084,504
May	2,741,634	28 1	19 8	8 5	1,153,549
June	2,651,970	28 2	19 7	8 7	1,141,197
July	—	—	—	—	1,184,107

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
August 31, 1929	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
February 28	196,752	15,495	6,584	218,831
March 31	200,134	15,350	7,002	222,316
April 30	202,434	15,109	5,565	223,108
May, 31	202,182	15,028	5,340	222,550
June 30	201,324	14,943	5,126	221,393
July 31	201,111	14,670	5,490	221,271
August 31	202,257	14,788	5,754	222,799

PRODUCTION OF GOLD IN RHODESIA.

	1927	1928	1929	1930
	oz.	oz.	oz.	oz.
January	48,731	51,356	46,231	46,121
February	46,461	46,286	44,551	43,385
March	50,407	48,017	47,388	45,511
April	48,200	48,549	48,210	45,806
May	48,992	47,323	48,189	47,645
June	52,910	51,762	48,406	45,208
July	49,116	48,960	46,369	45,810
August	47,288	50,611	46,473	—
September	45,838	47,716	45,025	—
October	46,752	43,056	46,923	—
November	47,435	47,705	46,219	—
December	49,208	44,772	46,829	—

RHODESIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,600	10,512	24,600	10,647
Globe and Phœnix	6,167	6,038	6,065	5,330
Lonely Reef	5,700	3,859	5,300	3,831
Luiri Gold	1,738	2,718	—	—
Rezende	6,400	2,704	6,400	2,709
Sherwood Star	5,000	£13,469	5,000	£12,855
Wanderer Consolidated	14,600	3,655	15,900	4,081

WEST AFRICAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	—	—	—	—
Ashanti Goldfields	10,620	12,957	10,711	13,437
Taquah and Abosso	9,700	£15,546	9,950	£15,934

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
August, 1929	37,032	2,178	567
September	32,751	1,739	381
October	35,445	—	789
November	28,460	—	473
December	33,650	1,459	1,636
January, 1930	25,472	952	209
February	31,307	1,354	350
March	27,946	2,592	382
April	36,652	1,812	1,081
May	32,967	3,480	580
June	41,738	—	673
July	34,174	—	—
August	—	—	—

AUSTRALASIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Value £	Tons	Value £
Associated G.M. (W.A.)	5,482	8,334	5,229	7,656
Blackwater (N.Z.)	3,650	6,151	3,800	6,237
Boulder Persev'ce (W.A.)	7,390	16,588	6,696	13,054
Grt. Boulder Pro. (W.A.)	9,241	25,117	—	—
Lake View & Star (W.A.)	6,212	15,054	—	—
Sons of Gwalia (W.A.)	14,350	14,801	13,656	14,737
South Kalgurli (W.A.)	8,506	16,550	8,501	15,305
Waihi (N.Z.)	17,762	6,006 / 28,992	18,541‡	6,226* / 35,984†

* Oz. gold. † Oz. silver. ‡ To August 23.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	July.		August.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,300	1,563	3,700	1,957
Champion Reef	8,405	5,506	8,340	5,640
Mysore	17,249	8,402	17,959	9,596
Nundydroog	11,588	6,951	11,568	7,027
Ooregum	12,500	5,120	13,500	5,729

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	July.		August.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	10,260	14,529	9,760	12,380
Frontino & Bolivia (Colbia)	2,410	10,196	2,280	10,146
Lena (Siberia)	—	—	—	—
Lydenburg Plat. (Trans.)	4,180	858*p*	4,100	928*p*
Marmajito (Colombia)	960	4,869	940	4,535
Fresnillo	80,317	5,162*d*	—	—
Onverwacht Platinum	—	—	—	—
Oriental Cons. (Korea)	—	82,250*d*	17,484	82,792*d*
St. John del Rey (Brazil)	—	44,000	—	46,000
Santa Gertrudis (Mexico)	47,619	98,466*d*	—	—

d Dollars. *p* Oz. platinoids.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1930	6,128	July	5,525
February	4,768	August	4,153
March	5,763	September	—
April	5,407	October	—
May	6,043	November	—
June	5,590	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Aver Hitam	78½	65½	—
Batu Caves	28	—	—
Changkat	75	30	—
Chenderiang	—	—	—
Gopeng	65½	60	67
Hongkong Tin	71½	44½	23¾
Idris Hydraulic	29¾	31	—
Ipoh	52½	43¾	—
Jelapang	26	29½	29½
Kampar Malava	66	—	—
Kampong Lanjut	85	70	—
Kamunting	92	111	—
Kent (F.M.S.)	18	27	30
Kepong	37	33	—
Kinta	22½	20	13
Kinta Kellas	26¾	22½	—
Kuala Kampar	80	60	—
Kundang	30	38	—
Lahat	15	17	18
Larut Tinfields	35	—	—
Malaya Consolidated	82½	76¾	69½
Malayan Tin	119	131	—
Meru	18	12	18
Pahang	224½	225	225½
Penawat	119½	48½	78½
Pengkalen	53½	65½	71½
Petaling	158	149	149
Rahman	77½	59½	65½
Rambutan	10½	9	9
Rantau	36	—	—
Rawang	80	35	—
Rawang Concessions	40	65	27
Renong	96	80	—
Selayang	—	13	—
Southern Malayan	154¾	154¾	—
Southern Perak	84	83½	—
Southern Tronoh	71	51	—
Sungei Besi	45	37	—
Sungei Kinta	15	12	15½
Sungei Way	78½	65½	—
Taiping	41	—	—
Tanjong	35½	38¾	30
Teja Malaya	36½	26¼	30
Tekka	38½	33	32
Tekka-Taiping	65½	57	45
Temoh	29¼	29¾	—
Tronoh	68	60	—

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Amari	—	—	—
Anglo-Nigerian	83	65	51
Associated Tin Mines	170	130	—
Baba River	10	10	3
Batura Monguna	1½	1½	3½
Bisichi	65	65	65
Daffo	7½	10½	—
Ex-Lands	55	55	—
Filani	2½	4½	7½
Jantar	26	15	15
Jos	18	28½	—
Juga Valley	17	18	—
Junction	6	2	—
Kaduna Syndicate	39	20	—
Kaduna Prospectors	16	16	—
Kassa	19½	39	20½
London Tin	220	85	—
Lower Bisichi	8¾	8½	11
Naraguta	24¾	—	—
Naraguta Durumi	8¼	—	—
Naraguta Extended	16	—	—
Naraguta Karama	22	—	—
Naraguta Korot	11½	—	—
Nigerian Consolidated	18	14	14
Offin River	7	6¾	7½
Ribon Valley	16	21½	16½
South Bukeru Areas	9	—	—
Tin Fields	7¾	—	—
Tin Properties	8	6	—
United Tin Areas	35	33½	27
Yarde Kerri	8	10	9

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Anglo-Burma (Burma)	23	40	39½
Aramayo Mines (Bolivia)	207	199	203
Bangrin (Siam)	60	70½	84
Berenguela (Bolivia)	—	—	—
Consolidated Tin Mines (Burma)	96	210	200
East Pool (Cornwall)	82½	83	83
Fabulosa (Bolivia)	127	110	137
Geevor (Cornwall)	52	49	41
Jantar (Cornwall)	25½	23	—
Kagera (Uganda)	28	28	28
Northern Tavoy	40	—	—
Patino	1,289	1,329	—
Polhigey (Cornwall)	31	31	—
San Finx (Spain)	35*	33½	—
Siamese Tin (Siam)	131¼	159†	149
South Crofty (Cornwall)	65	66¾	65½
Tavoy Tin (Burma)	25	—	—
Theindaw (Burma)	8	—	—
Tongkah Harbour (Siam)	93	115	89
Toyo (Japan)	52½	48½	—
Wheal Kitty (Cornwall)	38½	40	—
Zaaiplaats	34½	35	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		July.	August.
Broken Hill South	Tons lead conc.	9,303‡	6,192
	Tons zinc conc.	7,559‡	—
Burma Corporation	Tons refined lead	6,420	6,420
	Oz. refined silver	580,000	580,000
Bwana M'Kubwa	Tons copper oxide	616	669
Electrolytic Zinc	Tons zinc	4,230*	4,216§
Indian Copper	Tons copper	206	223
Messina	Tons copper	630	656
Mount Lyell	Tons concentrates	4,183‡	—
Namaqua	Tons copper	—	—
North Broken Hill	Tons lead conc.	5,260	—
	Tons zinc conc.	2,540	—
Poderosa	Tons copper ore	784	588
Rhodesia Broken Hill	Tons lead	—	—
	Tons slab zinc	1,570	1,500
San Francisco Mexico	Tons lead conc.	4,445	4,295
	Tons zinc conc.	2,914	—
Sulphide Corporation	Tons lead conc.	2,192	2,065
	Tons zinc conc.	2,623	2,834
Tetiuhe	Tons lead conc.	1,020	—
	Tons zinc conc.	2,058	—
Union Minière	Tons copper	—	—
Zinc Corporation	Tons lead conc.	7,725†	—
	Tons zinc conc.	6,682†	—

* Four weeks to July 23. † Six weeks to Aug. 9.
‡ Four weeks to Aug. 13. § Four weeks to Aug. 20.

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

		June.	July.
Iron Ore	Tons	405,848	284,775
Manganese Ore	Tons	12,895	10,315
Iron and Steel	Tons	214,504	198,788
Copper and Iron Pyrites	Tons	30,196	31,844
Copper Ore, Matte, and Prec.	Tons	4,753	4,426
Copper Metal	Tons	17,672	17,491
Tin Concentrate	Tons	7,274	5,522
Tin Metal	Tons	850	1,655
Lead Pig and Sheet	Tons	27,916	20,642
Zinc (Spelter)	Tons	14,093	13,524
Zinc Sheets, etc.	Tons	2,085	2,073
Aluminium	Tons	1,285	1,375
Mercury	Lb.	68,703	183,455
Zinc Oxide	Tons	1,045	961
White Lead	Cwt.	13,498	15,280
Red and Orange Lead	Cwt.	7,727	7,965
Barytes, ground	Cwt.	54,501	55,077
Asbestos	Tons	1,642	2,280
Boron Minerals	Tons	620	267
Borax	Cwt.	12,950	17,200
Basic Slag	Tons	1,739	587
Superphosphates	Tons	3,342	890
Phosphate of Lime	Tons	47,973	45,500
Mica	Tons	207	264
Sulphur	Tons	6,758	6,339
Nitrate of Soda	Cwt.	18,531	41,220
Potash Salts	Cwt.	56,485	140,234
Petroleum: Crude	Gallons	42,974,679	43,867,683
Lamp Oil	Gallons	17,330,578	26,310,257
Motor Spirit	Gallons	95,304,527	95,135,673
Lubricating Oil	Gallons	8,375,641	7,122,499
Gas Oil	Gallons	9,539,927	23,198,376
Fuel Oil	Gallons	46,186,468	68,657,283
Asphalt and Bitumen	Tons	20,135	14,237
Paraffin Wax	Cwt.	118,428	93,491
Turpentine	Cwt.	43,827	49,879

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES

In Tons.

	June.	July.	August.
Anglo-Ecuadorian	16,127	16,818	17,017
Apex Trinidad	36,690	40,240	39,500
Attock	2,287	2,227	2,286
British Burmah	4,969	5,054	4,986
British Controlled	33,431	34,111	33,121
Kern Mex	667	724	752
Kern River (Cal.)	2,545	1,990	2,503
Kern Romana	2,663	2,421	2,420
Kern Trinidad	5,011	5,020	4,824
Lobitos	29,431	30,771	29,214
Phœnix	57,727	65,597	40,445
St. Helen's Petroleum	5,700	6,346	5,968
Steaua Romana	80,420	79,380	64,060
Tampico	2,942	3,011	3,053
Trinidad Leaseholds	28,200	25,600	28,400
Venezuelan Consolidated	1,583	1,384	—

QUOTATIONS OF OIL COMPANIES SHARES

Denomination of Shares £1 unless otherwise noted.

	Aug. 9, 1930.	Sept. 10, 1930.
	£ s. d.	£ s. d.
Anglo-Ecuadorian	15 0	13 10½
Anglo-Egyptian B.	2 3 0	2 3 9
Anglo-Persian 1st Pref.	1 8 3	1 7 6
,, ,, Ord.	4 1 6	3 13 9
Apex Trinidad (5s.)	18 9	18 0
Attock	1 5 6	1 5 6
British Burmah (8s.)	4 9	4 0
British Controlled (5s.)	2 0	2 0
Burmah Oil	4 5 0	4 2 6
Kern River, Cal. (10s.)	4 0	3 6
Lobitos, Peru	1 15 0	1 11 3
Mexican Eagle, Ord. (4 pesos)	12 6	11 0
,, ,, 8% Pref. (4 pesos)	12 0	10 9
Phœnix, Roumania	9 6	9 3
Royal Dutch (100 fl.)	32 10 0	30 5 0
Shell Transport, Ord.	4 14 6	4 8 9
,, ,, 5% Pref. (£10)	10 0 0	10 0 0
,, ,,	7 0	7 0
Steaua Romana	2 8 0	2 1 9
Trinidad Leaseholds	5 6	5 3
United British of Trinidad (6s. 8d.)	2 4 6	1 17 6
V.O.C. Holding		

PRICES OF CHEMICALS. Sept. 9.

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 3
,, Glacial	per ton	58 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	,,	16 0 0
,, Phosphate	,,	40 0 0
,, Sulphate, 20·6% N.	,,	8 17 0
Antimony, Tartar Emetic	per lb.	10½
,, Sulphide, Golden	,,	7
Arsenic, White	per ton	16 15 0
Barium, Carbonate, 94%	,,	4 10 0
,, Chloride	,,	10 0 0
,, Sulphate, 94%	,,	5 0 0
Benzol, standard motor	per gal.	1 6½
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 1
,, ,, crystallized, 40°	per lb.	6½
Carbon Disulphide	per ton	24 0 0
Citric Acid	per lb.	1 6
Copper Sulphate	per ton	22 0 0
Cresylic Acid, 97-99%	per gal.	10½
Creosote Oil (f.o.b. in Bulk)	,,	4½
Hydrofluoric Acid	per lb.	6
Iodine	per oz.	1 0
Iron, Nitrate 80° Tw.	per ton	6 0 0
,, Sulphate	,,	1 15 0
Lead, Acetate, white	,,	35 0 0
,, Nitrate	,,	29 10 0
,, Oxide, Litharge	,,	33 10 0
,, White	,,	42 0 0
Lime, Acetate, brown	,,	7 5 0
,, ,, grey, 80%	,,	14 10 0
Magnesite, Calcined	,,	9 10 0
Magnesium, Chloride	,,	6 15 0
,, Sulphate, comml.	,,	3 15 0
Methylated Spirit 64° Industrial	per gal.	1 9
Nitric Acid, 80° Tw.	per ton	21 0 0
Oxalic Acid	per cwt.	1 12 0
Phosphoric Acid	per ton	29 15 0
Pine Oil	,,	42 10 0
Potassium Bichromate	per lb.	4½
,, Carbonate	per ton	24 10 0
,, Chlorate	,,	25 15 0
,, Chloride 80%	,,	9 15 0
,, Ethyl Xanthate	per 1,016 kilos	55 15 0
,, Hydrate (Caustic) 90%	per ton	29 10 0
,, Nitrate, refined	,,	21 0 0
,, Permanganate	per lb.	5½
,, Prussiate, Yellow	,,	6½
,, ,, Red	,,	1 8
,, Sulphate, 90%	per ton	11 0 0
Sodium Acetate	,,	18 15 0
,, Arsenate, 45%	,,	26 0 0
,, Bicarbonate	,,	10 10 0
,, Bichromate	per lb.	3½
,, Carbonate (Soda Ash)	per ton	6 0 0
,, ,, (Crystals)	,,	5 5 0
,, Chlorate	,,	24 10 0
,, Cyanide, 100% NaCN basis	per lb.	7
,, Ethyl Xanthate	per 1,016 kilos	53 5 0
,, Hydrate, 76%	per ton	14 10 0
,, Hyposulphite	,,	9 0 0
,, Nitrate (ordinary)	,,	9 7 6
,, Phosphate, comml.	per cwt.	10 6
,, Prussiate	per lb.	4½
,, Silicate	per ton	9 10 0
,, ,, (liquid, 140° Tw.)	,,	8 10 0
,, Sulphate (Glauber's Salt)	,,	2 12 6
,, ,, (Salt-cake)	,,	2 15 0
,, Sulphide Conc., 60/65%	,,	8 10 0
,, Sulphite, pure	per cwt.	14 0
Sulphur, Flowers	per ton	11 10 0
,, Roll	,,	10 10 0
Sulphuric Acid, 168° Tw.	,,	4 16 6
,, ,, free from Arsenic, 144° Tw.	,,	4 0 0
Superphosphate of Lime, 33%	,,	3 9 0
Tartaric Acid	per lb.	1 0
Turpentine	per ton	39 0 0
Tin Crystals	per lb.	11¾
Titanous Chloride	,,	10
Zinc Chloride	per ton	9 10 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:	Aug. 9, 1930. £ s. d.	Sept. 10, 1930. £ s. d.
SOUTH AFRICA:		
Brakpan	2 14 6	2 14 6
City Deep	7 3	7 0
Consolidated Main Reef	17 6	16 6
Crown Mines (10s.)	3 15 0	3 12 6
Daggafontein	1 5 0	1 6 3
Durban Roodepoort Deep (10s.)	13 3	13 3
East Geduld	2 4 6	2 5 6
East Rand Proprietary (10s.)	10 9	10 9
Geduld	3 15 6	3 13 9
Geldhenhuis Deep	7 9	7 3
Glynn's Lydenburg	2 6	2 6
Government Gold Mining Areas (5s.)	1 15 0	1 12 0
Langlaagte Estate	1 4 6	1 3 6
Meyer & Charlton	13 9	13 9
Modderfontein New (10s.)	3 18 9	3 11 3
Modderfontein B (5s.)	14 0	12 3
Modderfontein Deep (5s.)	1 5 0	1 1 3
Modderfontein East	1 4 6	1 3 0
New State Areas	1 18 9	1 17 0
Nourse	10 0	10 3
Randfontein	10 3	13 3
Robinson Deep A (1s.)	16 3	15 0
" " B (7s. 6d.)	9 9	9 9
Rose Deep	4 9	5 3
Simmer & Jack (2s. 6d.)	2 6	2 9
Springs	3 6 3	3 2 0
Sub Nigel (10s.)	2 17 6	2 17 0
Van Ryn	7 9	7 6
Van Ryn Deep	1 11 3	1 7 0
Village Deep (14s.)	3 6	3 6
West Rand Consolidated (10s.)	7 0	8 0
West Springs	14 6	15 3
Witwatersrand (Knight's)	9 9	10 0
Witwatersrand Deep	4 6	4 3
RHODESIA:		
Cam and Motor	17 0	15 9
Gaika	3 9	3 9
Globe and Phœnix (5s.)	14 0	13 6
Lonely Reef	1 0 0	19 0
Mayfair	10 3	9 9
Rezende	1 1 9	1 1 9
Shamva	1 0	1 0
Sherwood Starr (5s.)	17 6	16 3
GOLD COAST.		
Ashanti (4s.)	1 9 6	1 9 9
Taquah and Abosso (5s.)	2 6	2 9
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	2 3	2 3
Great Boulder Propriet'y (2s.), W.A.	1 3	1 3
Lake View and Star (4s.), W.A.	11 0	10 3
Sons of Gwalia, W.A.	1 3	1 3
South Kalgurli (10s.), W.A.	12 6	12 6
Waihi (5s.), N.Z.	12 9	14 3
Wiluna Gold, W.A.	17 6	17 9
INDIA:		
Balaghat (10s.)	2 6	2 6
Champion Reef (10s.)	7 0	8 6
Mysore (10s.)	10 3	10 6
Nundydroog (10s.)	15 6	16 6
Ooregum (10s.)	5 0	4 9
AMERICA:		
Camp Bird (2s.), Colorado	6	6
Exploration (10s.)	4 0	4 3
Frontino and Bolivia, Colombia	11 6	11 6
Mexican Corporation, Mexico (10s.)	5 0	5 0
Mexico Mines of El Oro, Mexico	3 0	3 0
Panama Corporation	15 0	15 6
St. John del Rey, Brazil	16 6	17 3
Santa Gertrudis, Mexico	7 9	8 6
Selukwe (2s. 6d.), British Columbia	2 6	3 3
MISCELLANEOUS:		
Chosen, Korea	6 6	5 0
Lena Goldfields, Russia	3	6

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	12 3	13 0
Esperanza Copper, Spain	1 1 6	1 1 6
Indian (2s.)	1 6	1 6
Loangwa (5s.), Rhodesia	3 3	3 3
Luiri (5s.), Rhodesia	2 9	4 3
Messina (5s.), Transvaal	9 6	9 6
Mount Lyell, Tasmania	1 1 3	1 10 0
Namaqua (£2), Cape Province	7 6	7 6
N'Changa, Rhodesia	2 10 0	2 10 0
Rhodesia-Katanga	1 7 0	1 3 9
Rio Tinto (£5), Spain	35 0 0	36 2 6
Roan Antelope (5s.), Rhodesia	1 2 0	1 0 9
Tanganyika, Congo and Rhodesia	1 11 0	1 13 0
Tharsis (£2), Spain	3 19 0	4 0 0

LEAD-ZINC:	Aug. 9, 1930. £ s. d.	Sept. 10, 1930. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	8 0	8 0
Broken Hill Proprietary, N.S.W.	13 3	12 3
Broken Hill, North, N.S.W.	2 5 0	1 17 6
Broken Hill South, N.S.W.	1 13 9	1 8 9
Burma Corporation (10 rupees)	10 3	11 9
Electrolytic Zinc Pref., Tasmania	1 1 3	1 0 0
Mount Isa, Queensland	1 1 3	18 9
Rhodesia Broken Hill (5s.)	2 3	2 3
San Francisco (10s.), Mexico	15 0	17 0
Sulphide Corporation (15s.), N.S.W.	10 0	8 6
ditto, Pref.	16 3	14 6
Zinc Corporation (10s.), N.S.W.	1 1 3	18 3
ditto, Pref.	2 18 9	2 16 3

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

DIAMONDS:		
Consol. African Selection Trust (5s.)	1 3 9	1 2 6
Consolidated of S.W.A. (10s.)	7 3	6 6
De Beers Deferred (£2 10s.)	6 15 0	7 1 3
Jaggersfontein	1 7 0	1 8 9
Premier Preferred (5s.)	3 19 6	3 15 0

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

THE SHERRITT GORDON MINE

The mining and milling practice which it is proposed to employ on the Sherritt Gordon copper-zinc mine in northern Manitoba is outlined in a paper appearing in the *Canadian Mining and Metallurgical Bulletin* for August. This paper, which has been contributed by the staff of the property, covers the history, geology, and the preliminary work on the ore and on development, in addition to the mining and milling programme. An outline of the geology by E. L. Bruce was given in these pages in October last.

The ore minerals are pyrrhotite, pyrite, chalcopyrite, marmatite (sphalerite), and some chalmersite. Gold and silver are present in small quantities. Other metals, such as cadmium and lead, occur in minute amount, but can only be detected by analysis. Galena is frequently found in small quantities in cross fractures in the basic hanging-wall gneiss. Many rock inclusions are found in the massive sulphide ore. These range in size from small grains the size of a pea, up to pieces weighing several tons. The small inclusions are almost invariably quartz, but the larger ones are chiefly pegmatite and quartzite gneiss. These inclusions frequently show partial replacement, chiefly by chalcopyrite.

HEADFRAME AND CRUSHER HOUSE, NO. 3 SHAFT.

SUMMARY OF PILOT MILL RESULTS.—East ore treated in the pilot mill averaged: copper 2·30%, zinc 5·65%, gold $0.40, silver $0.35, iron 19·5%, insoluble 43·0%. A grind of 65 to 70% – 200 mesh yielded satisfactory results on this ore. Copper recoveries of 88–92%, with concentrate grades of 20–23%, were made. Zinc flotation yielded concentrates carrying 45–54% zinc and recoveries of 75–80% of this metal. Approximately 70% of the gold and silver values remained in the copper concentrate.

West ore treated at the test plant averaged higher copper and iron content and lower in zinc and insoluble: copper 2·95%, zinc 2·10%, gold $0.35, silver $0.45, iron 33·5%, insoluble 30·0%. Excellent copper results were obtained on West ore treated in the pilot mill. It was found necessary to clean the copper froth twice to ensure a concentrate grade of 20% and over. Zinc results, however, were not good. The comparatively low-grade zinc feed, the copper-zinc ratio (1·4 to 1), and the fast floating properties of the pyrite in West ore, have combined to form a difficult flotation problem. However, by triple-cleaning of zinc froth, and the elimination of middling products, commercial zinc concentrate was made, with low recoveries.

MINE DEVELOPMENT AND PRODUCTION PLANS.—The plan adopted for bringing the property to production embraces the development of the West ore-shoot to produce 1,200 tons per day, and the East ore-shoot to produce 600 tons per day.

For sinking No. 3 shaft and carrying on the development and also to supply power for the pilot mill, a third power plant was erected. This consisted of one 350 h.p., three-cylinder, Ingersoll-Rand Diesel, direct-connected to a 320 k.v.a., 2,200-volt generator, one 934 cu. ft. electric drive, Ingersoll-Rand air compressor, and one 608 cu. ft. Ingersoll-Rand air compressor direct-connected to a single cylinder, 110 h.p. Diesel engine. This last machine was moved from the No. 1 shaft. A double drum, electric-drive, Ingersoll-Rand hoist was used for sinking, and a temporary 60 ft. timber headframe erected. When power is received from Island Falls, the 350 h.p. Diesel will be retained as a standby, in case of trouble on the transmission line. The sinking hoist will be used as the permanent hoist at No. 1 shaft. In the operation of this Diesel-driven plant, further economies in power costs were made, the 350 h.p. Diesel being considerably more efficient

than the 110 h.p. units. The cost per h.p.-year was $112.85, after adding the freighting charges to the cost of the fuel-oil.

On the West ore-shoot, a main working shaft was sunk in the footwall at an angle of 51°. It has four compartments 5 ft. by 6 ft. and one 6 ft. by 6 ft., for two ore skips, two cages, and one pipe, cable, and ladderway. The first main haulage level was established at a depth of 500 ft. on the incline, and a haulage drive, 7 ft. by 9 ft., driven in the footwall about 25 ft. from the ore. This level is equipped with a 30 in. by 42 in. Buchanan crusher, skip loading hoppers, and ore and rock storage pockets. The ore will be trammed from standard platform chutes in the haulage drives, to the crusher, in 80 cu. ft., Granby cars. Haulage track is 24-inch gauge with 35 lb. rails. Storage battery locomotives will be used for haulage.

Proposed Stoping Method :—The sub-level system of stoping will be used, and a block, 1,000 ft. long and extending from the 500 ft. level to surface, is being developed at the present time. Service levels were opened from the shaft at 200 and 350 ft., respectively, on the dip, and 4 ft. by 6 ft. drives were driven in the ore from the stations to the end of the 1,000 ft. block.

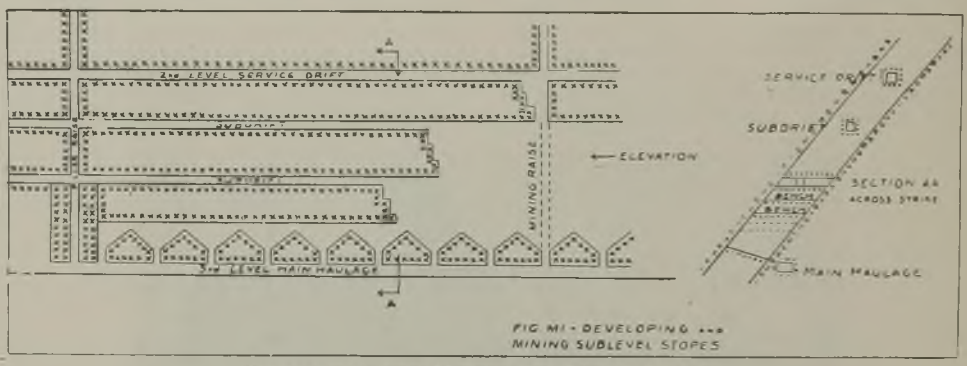
The first block to be stoped is being developed by rises driven in the ore from the main haulage level to surface. Three of these rises are located in pillars, one in the shaft pillar and one in each of the pillars at the ends of the block. Two intermediate rises will be driven. Sub-level drives are driven from the rises at vertical intervals of 40 ft. Box-hole rises will be driven up from the main haulage drive at 35 ft. intervals. Stoping will be started at the centre of the block. Beginning on the first sub-level at the intermediate rises, the drive is slashed to the foot- and hanging-walls, and the rise is benched out to the full width of the ore. A slab about 8 ft. thick, 10 ft. high, and extending from foot- and hanging-wall is then shot off the sub-level, retreating towards the manway rise. This forms a bench from which down holes may be drilled and blasted to form a second bench 10 ft. lower down. The operation is carried out in successive sub-levels, and is repeated until the last bench breaks through the back of the level below. The work on a lower level is kept far enough ahead of that on the level above, so that the men are always working under a solid back.

Small pillars to support the hanging-wall will be left wherever the ore-body is narrow and low-grade. The rib pillars at each end of the block will be removed when the blocks on both sides of them are stoped out. In this way no ore will be left tied up in rib pillars.

A contract system will be used on the stoping. The men will be paid, either for the footage drilled, or for the tonnage broken. Which of these will be most satisfactory can only be determined by a thorough trial.

Development.—All driving and rising is done on contract, the contractors supplying all machine and mucking labour and explosives. Payment is made on a sliding scale, per foot of advance, depending on the tramming distance to the shaft. The adoption of this contract system has resulted in a marked decrease in the cost of development as compared with the previous system of company wages and bonus, with the company supplying the explosives.

The lowest per-foot cost of development is obtained by working two shifts per day in each heading. The miners drill off and blast before going off shift, and the muckers muck out the headings on the following shift. From three to four hours is allowed between the shifts for blowing smoke.



Developing and Mining Sub-Level Stopes.

Drilling Equipment.—For all driving, the Waugh model 17 is used. For rising, the Ingersoll-Rand model R-51 stoper is used. In sinking all three shafts, Waugh model 7, equipped with spring handles, was used.

For all classes of development, steel of standard size is used, thus eliminating delays and confusion in the shop and underground. The steel used is Atlas 1 in. quarter-octagon.

Permanent Plant.—Excavation for the foundations of the various buildings of the permanent plant was started in the early summer of 1929, before the railway reached the mine. At the present time, the power house is in two parts, the new part being of hollow-tile construction with a gypsum slab roof. The old part is of timber construction covered with corrugated iron. The old part will be replaced by the same type of building as the new part. The power-house equipment consists of two Belliss and Morcom compressors of 2,500 cu. ft. capacity each, with room for the installation of a third unit. The equipment in the old part of the power house will all be removed except the 350 h.p. Diesel, which will be retained as a stand-by.

The head-frame, to which the crusher house is connected, is a steel structure, 127 ft. high, with one rock bin of 1,500 ton capacity and one ore bin divided into two sections of 1,200 and 600 tons capacity, respectively. The smaller section is for the ore from the East shoot, the terminal of the aerial tram being located over this part of the bin.

The shaft house, 50 ft. by 42 ft., is connected to the inclined part of the head-frame. The cage landing is 11 ft. below surface level and is connected to the change house by means of a tunnel.

The change house is a steel frame hollow-tile building, 119 ft. by 44 ft. Locker accommodation has been provided for 300 men. Hot air is forced up through the lockers, so that underground clothes will be properly dried. The usual washing facilities, showers, latrines, etc., are provided. The shops building, 170 ft. by 80 ft., is a steel frame building with sides and roof of two-inch fir decking, covered with J. M. housline with corrugated iron as the outside sheeting. Hollow-tile partition walls divide the building up into one bay 50 ft. by 80 ft. and three bays 40 ft. by 80 ft. for blacksmith shop, plate shop, machine shop, and electric shop. The warehouse, 122 ft. by 40 ft., is of the same construction as the shops building, except that a reinforced concrete floor was put in with the foundation.

No. 1 Shaft Layout.—The plant at No. 1 shaft is not yet erected, but it will consist of a steel head-frame, 70 ft. high, with ore storage bins and rock storage bin. Connected to this will be the loading terminal of the aerial tram to No. 3 shaft. The power house, 34 ft. by 76 ft., will be equipped with two 934 cu. ft. Ingersoll-Rand air compressors, and one double drum Ingersoll-Rand electric hoist. The building will be of steel frame construction with sides and roof of two-inch fir decking, covered with J. M. housline with corrugated iron as the outside sheeting.

Collar, No. 3 Shaft, on West Ore-Shoot.

Concentrator Equipment and Flow Sheet.—The two ore-bodies differ in zinc, iron, and insoluble content, and in the proportion of iron present as pyrite and pyrrhotite. The mill is being designed as three units of 600 tons capacity each. Two units will treat main shaft (West) ore, and the other will treat 600 tons per day from the east shaft. If at any time the Company decides to mix all ores for milling, the partitions in the coarse and fine ore bins can be removed. For the present, equipment to recover zinc from the West ore will not be installed. Floor space to house this equipment is allowed for.

Crushing.—East ore will be crushed underground by one 30 in. by 42 in. Buchanan crusher to – 5 in., hoisted to the surface, and carried to the main shaft head-frame bin by aerial tramway. West ore will be crushed underground by the same type of machine, hoisted in four-ton skips and dumped directly in the coarse-ore bin. A self-cleaning grizzly will remove – 2 in. material ahead of a 7 ft. Symons cone crusher. Symons crusher discharge will be conveyed to four 4 ft. by 6 ft. Hum-mer screens. Screen discharge will be reduced in one set of Traylor rolls, 72 in. by 24 in. Roll discharge joins the crusher product to be returned to the screening plant. Screen undersize will be conveyed to the fine-ore bin at the concentrator. The crushing and screening machinery is housed in a building approximately 44 ft. by 82 ft.

Grinding.—Ball-mill feed will be reduced in two stages to 75 or 80% — 200 mesh. The primary grinding plant includes three 8 ft. by 60 in. Hardinge mills direct-connected to 225 h.p. motors. Three 8 ft. Dorr standard classifiers will operate in partial closed circuit with these mills, overflowing a finished product and returning approximately one-third of the sands to the primary mills and discharging two-thirds to the secondary mills. Three 8 ft. by 72 in. Hardinge mills will take care of secondary grinding. Secondary mill discharge will be pumped to three 12 ft. by 26 ft. 8 in. Dorr rake classifiers above the ball-mill floor and sands return by gravity to the mill. Six-inch Wilfley sand pumps will perform this duty. Wilfley centrifugal pumps will be installed wherever pulps or froths must be elevated. Primary and secondary classifier overflows will be thickened in three 45 ft. Dorr traction-type thickeners to 35% solids before flotation.

Flotation.—Fahrenwald flotation machines will be installed. Comparison of machines in the test plant indicated that slightly higher grade concentrates, with the same recovery, were made with mechanical type machines. Sixteen-cell 24 in. machines will be installed for copper work and 12-cell 24 in. machines for the zinc. All machines, roughers and cleaners, will be double overflow type and equipped with 10 h.p. motors and dual tex-rope drive.

Reagents.—Soda ash, sodium cyanide, zinc sulphate, thiocarbanilide, and aerofloat will be fed to the primary mills. These reagents will be fed in the following amounts, which, of course, are approximate. The first three will be fed in solution. Thiocarbanilide will be fed dry. Additional frothing oil will be fed to the classifier overflow, or directly to the cells if needed.

	lb. per ton
Soda Ash	4·0
Sodium cyanide	0·1 to 0·2
Zinc sulphate	0·25 to 0·50
Thiocarbanilide	0·05 to 0·10
Aerofloat	0·04 to 0·10

Reagents for zinc flotation will be fed to the conditioners ahead of the zinc cells, 1 lb. of copper sulphate per ton of ore and small amounts of aerofloat, and either sodium xanthate or T.T. mixture being used. Additional soda is sometimes beneficial to zinc flotation.

Copper middlings, *i.e.*, middlings from the last copper roughers plus tailings from the first copper cleaner, will be pumped to a separate middlings classifier set at a flat slope and slow rake speed. The overflow from this classifier will join primary and secondary classifier overflows to the thickeners. The middlings classifier sand will be discharged to the secondary mills. Tailings from the second copper cleaning will join rougher froth to the first cleaner cells.

In the zinc flotation, middlings will be returned to the conditioner ahead of the rougher cells.

Dewatering.—Concentrates will be thickened in 12 ft. Genters. Each Genter thickener has a filtering area of 750 sq. ft. The Genter discharge will be filtered in six-leaf 6 ft. American filters. On account of the severe winter weather in the district, it will be necessary to work out a method to overcome freezing of concentrates. Final arrangements for handling the filter product have not been completed at this time. Three methods are being considered. Concentrates may be dried in either Ruggles-Cole or Lowden type driers to 4 or 5% moisture, or they may be shipped in specially constructed closed cars. Another method would be to ship concentrates from the filters in open cars and erect thawing sheds at the smelter.

General.—The concentrator proper will be housed in a steel structure approximately 160 ft. by 200 ft. Siding will consist of two-inch tongued and grooved lumber, a layer of insulation, and for the sides an outer covering of galvanized iron. For the roof, a heavy asphalt composition roofing will be used. Two fifty-thousand-gallon tanks will furnish storage for the mill. Fresh water will be pumped 3,500 ft. from Cold lake to one tank. Return water, including copper circuit overflow from primary thickeners and filtrate water from the Genter thickener and American filter, will be pumped to the second tank for storage. Final mill tailings will be pumped about one-quarter mile to a bay of Camp lake.

The concentrator at Sherritt Gordon has been designed as a complete differential plant to produce copper and zinc concentrates.

Smelting and Refining.—Copper concentrate will be shipped 80 miles to the Hudson Bay smelter at Flin Flon. Sherritt Gordon will endeavour to maintain the grade at 20% copper, or higher, and hold the zinc content under 7%. The blister copper will be shipped to Ontario Refiners at Copper Cliff, Ontario.

THE NORTH MOUNT FARRELL MILL, TASMANIA

Ore concentration at the North Mount Farrell Mine, West Tasmania, is described by J. C. Coldham in the *Chemical Engineering and Mining Review* of Melbourne for June 5. The author says that the North Mount Farrell silver-lead mine is situated near the township of Tullah, four miles west of Farrell Junction on the railway of the Emu Bay Co., which runs from Burnie to Zeehan. Access is by a 2-ft. gauge tram line, which also collects the timber fuel for the mine.

No geological investigation of the area has been made since 1908, but a genetic relationship with the Read-Rosebery mineral belt, about eight miles to the south-west, is obvious. Here, as at Rosebery, the ore-bearing rocks are overlaid by porphyry, but in this case the contact dips to the west at about 45°. A broad belt of altered porphyry masks the contact and Mr. A. McIntosh Reid, director of mines of Tasmania, shows a narrow belt of argillaceous schist overlying the ore-bearing slates. The present ore-bodies consist of a main body with subsidiary lenses. The main body has a maximum length of about 1,000 ft. and is part of an extended fault area in the slate. The strike is almost due N.S. and the dip 60 to 70° W. The subsidiary lenses which may be of considerable extent strike about N.N.E.-S.S.W. They are located in the hanging-wall and converge on the main lode in depth with approximately the same dip.

Structurally the lodes consist of a more or less central vein of high-grade ore with replacement zones of lower-grade, but millable, ore on either side. The central vein consists of a ground mass of almost clean galena and sphalerite. The crystals are small, but granular, and there is a distinctly schistose structure. Small inclusions of pyrite and large aggregates of clean cubical galena are present. The width of the vein varies from a few inches to 4 ft. and, as the zinc content is low, it is possible to pick a fair proportion of ore of shipping grade in the mine. A certain amount of gravity concentration is undoubtedly economical.

The ore in the replacement zones is finer-grained than in the vein. Aggregates of pyrite and carbonates occur, but cubical galena is absent. The structure on the whole is imperfect and the ore minerals frequently occur sprinkled through the gangue. On the foot-wall side the replacement dies out rather sharply and shows a definite foot-wall but on the western side no hanging-wall is present and the stoping width is determined by the diminishing ore values. The average width of the ore body is about 8 ft. with a maximum of 25 ft. at the junction of some of the subsidiary lenses. The gangue consists of slate, carbonates and quartz. The approximate composition of the ore mined is: lead, 10–12%; zinc, 8–10% ; silver, about 14 oz., and pyrite, 10%.

All the ore has been worked out above the main adit and the present supply is being raised to the adit through a blind shaft and hand trammed to the mill bins. In order to mine the lower levels of the ore body a new shaft is being sunk from the surface near the mouth of the adit, 500 ft. from the lode at the adit level.

Ore Dressing.—The ore-dressing mill started as a gravity lead concentrator with primary and secondary jigging and tabling, the zincy tailings, containing about 3% lead and 11% zinc, being dumped. The primary crushing and jig concentration section of the mill which has been retained is supposed to have a capacity of about 160 tons of ore per week when working on day shift. The

secondary section of the mill was reorganized in 1927 to include fine grinding and preferential flotation of the jig tailings and dump residues. It has a capacity of 1,400 tons per week on a three shift per day basis. The character of the ore makes it specially adapted for economic milling, but the lightness of broken ore, which is given as 23 cu. ft. to the ton, probably accounts for the low output of the various machines. The present process is shown in the accompanying flowsheet and the lay-out of the reorganized plant is largely the outcome of a necessary economy in capital cost. Under ordinary circumstances the gravity section is run on one shift and the flotation section on three shifts per day.

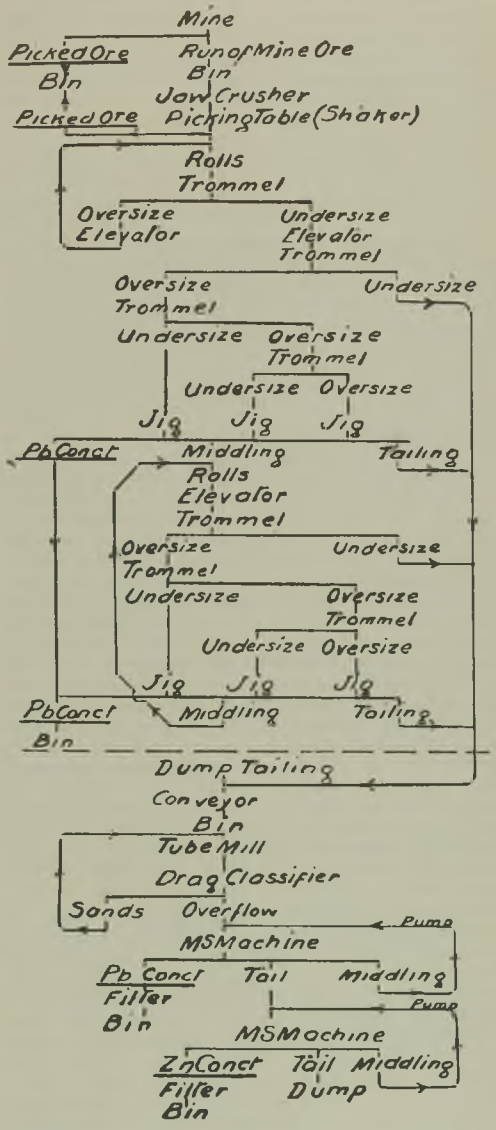
Gravity Section.—The picked ore from the mine is run direct to a shipping bin. The run of mine ore is crushed in a 20 in. by 10 in. Hadfield jaw breaker with a range of from 9 in. to 1½ in. The rolls are 30 in. diameter by 10 in. wide, close set, and running at 26 r.p.m. The primary trommels have a screen size of ⅜ in. Both series of jig head trommels give the same range of sizing, viz., — 3/32 in., + 3/32 in., — 3/16 in., + 3/16 in. — ¼ in., + ¼ in. — ⅜ in. These trommels are 5 ft. long by 27 in. diameter and run at 40 r.p.m. The — 3/32 in. product in each case together with the tailings from all jigs, runs direct to the dewatering bin for retreatment in the flotation section. The remaining trommel products are each fed to separate jigs of the Luhrig type. These are five-hutch machines with plunger and concentrating compartments 16 in. square and the plungers driven by eccentrics.

The ragging is high-grade ore of ¾ in. maximum diameter. Concentrate is taken from the first two hutches and middling from the remainder. The use of two-stage jigging is somewhat unusual nowadays, but no doubt it is justified by local conditions. The jig concentrate, averaging about 60% lead and 62 oz. silver, runs to a draining bin and the picked ore is trucked to the bin containing the prill ore from the mine. The ore and concentrate is bagged for shipment. The bagged concentrate contains 1·5% moisture and the cost of bagging is about 10s. per ton of concentrate. The labour employed is four men and one boy, the latter being employed on the picking table.

Zinc Section.—In this section dump residues are fed on to an inclined belt conveyor delivering into the tube-mill bin and current tailing is fed from the dewatering bin on top of the dry residues on the conveyor. From the bin the material is delivered to the tube-mill by roller feed. The tube mill is 10 ft. long by 5 ft. diameter and was built by C. Ruwolt and Co. It runs on trunnion bearings, carries a charge of nine tons of 2½ in. steel balls, and runs at 26 r.p.m. The ball wear is about 2 lb. per ton.

The drag classifier is 16 ft. long with 18 in. rakes of 2½ in. angle at 1 ft. spacing, the belt speed being 30 ft. per min. The sands from the classifier gravitate back to the tube-mill. The flotation units both consist of eight-cell Mineral Separation sub-aeration machines (Australian type) with 15 in. hard cast-iron impellers driven by horizontal belt at 590 r.p.m. In the lead unit concentrate is made in the first three cells and middling in the remainder, while in the zinc unit concentrate is made in the first three cells and middling in the remainder. The concentrates are pumped by 2 in. Dorrco pumps to a 6 ft. six-leaf American filter. The requirements of this mill, however, are satisfied by three leaves of the filter, one being used for lead and two for zinc concentrate and the pulp container has been partitioned for this purpose. The flotation feed is assumed to comprise 60% o — 200-mesh product.

The lead concentrate averages nearly 60% lead, 80 oz. silver and 5% zinc. The average of the zinc



Flow-Sheet of the North Mount Farrell Mill.

concentrate is 54% zinc, 13 oz. of silver, and 6% lead, while the assay of the tailings is approximately 2·5% zinc, 0·8% lead, and 1·5 oz. silver.

In regard to reagents, 4·5 lb. of soda ash and 0·25 lb. of cyanide per ton of feed are added in the tube-mill and 0·2 lb. of aerofloat (15% pentasulphide) is added by sight feed lubricator at the head of the lead machine. In the zinc circuit 0·2 lb.

of xanthate and 1·0 lb. of copper sulphate per ton are added in the launder at the head of the zinc machines. The cost of bagging the zinc concentrate is proportionately greater than for the lead concentrate. The filtered lead concentrate contains 10% of moisture and the liquor is returned to the zinc circuit.

GENERAL.—Owing to the slump in the price of the metal, zinc flotation was discontinued during the fortnight ending November 6 last, and on April 11 last lead flotation also was stopped and at present jig concentrate and prill ore only are being produced from a variable mine output up to 160 tons per week.

It is not possible to arrive at an accurate estimate of power consumed in the mill as mill power, underground power and lighting are all taken off the same line of shafting. The total power consumed previous to April 11 was approximately 700 h.p. taken from three engines as follows :—One 400 b.h.p Ruston-Hornsby super-Diesel engine, running a 300 h.p. ; one 350-h.p. National wood producer-gas engine running at 250 h.p., and one 200-h.p. engine of the previous type running at 150 h.p. The wood fuel consumption is given as 80 tons per week and the cost of Diesel oil at the works, 1s. per gal. Rail freight to Burnie is 25s. per ton of concentrate.

CYANIDATION OF CUPRIFEROUS GOLD ORES

A summarized report on the results of an investigation into the cyanidation of cupriferous gold ores by W. G. Clarke and B. H. Moore, of the School of Mines of Western Australia, Kalgoorlie, is published in the *Chemical Engineering and Mining Review* of Melbourne for July 5. The authors say that it is well known that the cyanidation of gold ores containing the basic carbonates of copper, malachite and azurite, presents serious difficulties owing to the readiness with which these minerals are attacked by dilute solutions of alkali cyanides, with the formation of soluble complex double cyanides of the alkali metals and copper. Apparently, in working cyanide solutions of ordinary concentration, the solvent action of the cyanide solution on the copper carbonates is more rapid than on the gold, so that the free cyanide is more or less completely converted into complex double cyanides of copper and the alkali metals before it is able to dissolve the gold in appreciable quantities. Hence the extraction of gold is usually small and at the same time the solutions become so charged with copper that serious difficulties are introduced in the precipitation of the gold by means of zinc. Comparatively few successful attempts have been made to cyanide this class of ore ; in fact, the authors are acquainted with only one instance in which a commercial success has been achieved, this being the cyanidation of cupriferous tailings at Rothsay on the Yalgoo goldfield, Western Australia, by V. T. Edquist, who used very weak cyanide solutions—0·002% KCN—the extraction obtained being 66·7%. Consequently there have been numerous cases in Western Australia where the association of malachite and azurite with gold has caused the abandonment of properties in which the gold content of the ore-bodies would have made them profitable if a satisfactory method of treatment had been available.

To this class of ore belongs the dumps of residues on the Tumbulgum, Tumbulgum South, and Mountain View leases at Gabanitha, near Meekatharra, W.A., which resulted from the treatment of the ores by battery amalgamation. These dumps are held by Caddy Bros., of Meekatharra, who, during 1929, made an application to the mines department of Western Australia to have the treatment of these dumps investigated in the metallurgical laboratory of the School of Mines at Kalgoorlie, as previous attempts of various investigators to treat these dumps had proved unsuccessful. With the approval of the hon. minister for mines, this investigation was commenced during 1929 and has recently been completed and a report has been furnished in which, as a result of the laboratory investigation, a method of treatment has been recommended which promises to be successful, and which, so far as the authors are aware, is entirely new in connexion with the cyanidation of ores of this character.

The laboratory investigation has shown that roasting or calcination of the ore at a comparatively low temperature to convert the copper carbonates to oxide, followed by fine grinding, amalgamation, and leaching with weak cyanide solution yields consistently high gold extractions with a low cyanide consumption and the solution of insufficient copper to cause fouling of the cyanide solution. Apparently, copper oxide produced by calcining the carbonates is much less readily attacked by weak cyanide solution than the carbonates, and the cyanide solution acts selectively, dissolving the gold before appreciably attacking the copper oxide. The following analysis of a sample from the Mountain View dump is typical of the composition of the oxidised ores of these leases :—Insoluble, 65·79% ; copper, 2·30% ; ferric oxide and alumina, 19·90% ; lime, 1·20% ; magnesia, 3·04%.

The approximate tonnages and the gold and copper contents of the dumps are as follows :—

Dump.	Tonnage (2,000 lb.)	Gold, dwt. per ton (2,000 lb.)	Copper, %
Tumbulgum South	1,700	9·8	2·54
Tumbulgum	25,000	4·9	1·60
Mountain View ..	6,500	9·0	2·30

A grading analysis of a composite sample prepared by mixing the samples from the three dumps in the proportions represented by the tonnages existing in the dumps is as follows :—

I.M.M. Screen.	%
+ 30	10·3
+ 40	10·4
+ 60	7·3
+ 80	5·8
+ 100	9·9
+ 150	5·3
+ 200	21·0
− 200	30·0

On account of the highly basic nature of the gangue, as shown in the above analysis, preliminary treatment of the ore with sulphuric acid for removal of the copper before cyanidation was not likely to be commercially possible. This was confirmed by some sulphuric acid extraction tests in which the

consumption of acid was over 100 lb. per ton of ore, and it was found that in order to reduce the resultant acidity of the pulp within reasonable limits for cyanidation, the washing time was so prolonged and the quantity of water required was so great as to make this method impracticable.

Concentration of the dump material by gravity and flotation methods failed to yield a satisfactory extraction, either of the gold or the copper.

Amalgamation of the composite sample mentioned above during fine grinding in a Wheeler pan yielded an extraction of 37·5% of the gold, leaving a tailing containing 4 dwt. gold per ton. The product of this fine grinding contained 93·6% – 200 mesh. Cyanidation by agitation of this pan tailing with a 0·071% KCN solution for seven hours gave a maximum extraction of 45% of the gold, with a total consumption of the cyanide. Agitation of the same pan tailing with a weak cyanide solution —0·002 to 0·008% KCN—for periods varying from 27 to 117 hours gave practically the same extraction and total consumption of cyanide.

Some previous experiments conducted by the present workers on the cyanidation of similar ores had indicated that the rate of solution in cyanide solutions of copper oxide produced by calcining malachite and azurite was less than that of the carbonates themselves, and this indication was therefore followed up in order to determine whether cyanide solutions would act selectively in the case of a cupriferous gold ore so treated, i.e. would dissolve the gold in preference to the copper. A series of preliminary tests under varying conditions of roasting and cyanidation established the following facts :—

(1) The maximum roasting period required was 1½ hours from cold to the finishing temperature of 600° C.

(2) Fine grinding after roasting, and amalgamation during fine grinding were necessary to liberate the gold and to remove the coarse, amalgamable gold before cyanidation.

(3) Although addition of 1 lb. of lime per ton of ore produced a slight alkalinity in the pulp, due to magnesium hydroxide, better extractions were obtained when sufficient lime was added to precipitate all the soluble magnesium compounds as magnesium hydroxide and to leave a slight lime alkalinity in the solution.

(4) The maximum time of contact of the roasted ore with a 0·07% KCN solution required for satisfactory gold extraction was seven hours.

(5) In this treatment period the copper dissolved is insufficient to cause subsequent difficulties in precipitation of the gold by means of zinc.

(6) After roasting, this ore, which filters extremely slowly in the raw state, filters so rapidly that treatment by percolation is practicable, even though the product contains 93% of – 200 mesh.

(7) Cyanidation under these conditions in a 1 : 1 pulp results in a consumption of cyanide not exceeding 1½ lb. per ton of ore, with a total extraction by amalgamation and cyanidation of 90% and over.

These fundamental principles of the method of treatment having been fully demonstrated and established, samples of tailings from the three dumps were treated under the stated conditions with satisfactory results, the average total extraction by amalgamation and cyanidation being 90%. The details of the treatment of the composite sample from the three dumps are shown in the table below.

These results lead to the conclusion that in the case of this sample, after roasting and amalagamation, agitation for seven hours in a 1 : 1 pulp with 0·07% cyanide solution is the most satisfactory from an economic aspect.

Although the authors have not had occasion to apply this modified method to the treatment of other gold ores containing copper carbonates, the uniformly successful results obtained point strongly to the probability that the method should be equally applicable to ores of this class, provided always that before cyanidation steps are taken to remove coarse free gold by amalgamation of the roasted product, such coarse gold being necessarily slow in dissolving and therefore time being allowed for the cyanide solution to attack the copper oxide to a serious extent.

ROASTING, AMALGAMATION, AND CYANIDATION OF COMPOSITE SAMPLE.

Treatment conditions : Roasting period, 1½ hours from cold to 600° C. Barren cyanide solution, 0·072% KCN. CaO added, 10 lb. per ton. Grading of amalgamation residue, 90% — 200 mesh.

Assay Values.						*Consumption, lb. per ton.*			*Extraction by cyanidation (on amalgamation residue).*		*Percentage extraction of gold (on roasted ore).*		
Raw Head		After roasting	After amalgamation, dwt.	Pulp ratio solid : soln.	Agitation period, hours.			Cyanidation residue, dwt. Au per ton.		Cu, lb. per ton of roasted ore.	By amalgamation.	By cyanidation.	Total.
Au, dwt. per ton.	Cu. %	dwt. Au per ton.	Au per ton.			KCN	CaO		Au, %				
6·4	1·78	6·5	2·8	1 : 1	7	1·38	9·92	0·55	80·4	0·30	56·9	34·6	91·5
6·4	1·78	6·5	2·8	1 : 2	7	2·56	9·72	0·50	82·1	0·76	56·9	35·4	92·3
6·4	1·78	6·5	2·8	1 : 2	16	2·64	9·72	0·40	85·7	0·72	56·9	36·9	93·8
6·4	1·78	6·5	2·8	1 : 2	24	2·72	9·84	0·35	87·5	0·80	56·9	37·7	94·6

Tin, Lithium, and Beryllium in Manitoba.— In October last an abstract was given in these pages of an article by Dr. J. S. Delury on the tin occurrences in Manitoba. Further information of these deposits is now available as J. F. Wright, of the Geological Survey of Canada, writes in the *Canadian Mining Journal* for May 30 on the tin, lithium and beryllium deposits of south-east Manitoba. The author says that during the past six years, and especially during the past year, the pegmatites of south-east Manitoba have attracted attention as a possible source of tin, lithium, and beryllium ores. The deposits attracting most attention are in that part of Oiseau River area along Winnipeg River east of Pointe du Bois and north to Shatford and Bernic Lakes. Tin and lithium-

bearing minerals have also been discovered near West Hawk Lake, south of Ingolf on the Canadian Pacific Railway, and lithium-bearing minerals in pegmatites near Cat Lake, some 18 miles by trail north-east of Bird River Post Office. Bodies of pegmatite are numerous in these areas, and also farther north along Manigotagan valley from Turtle to Tooth Lakes, but only a few of the pegmatites are known to carry spodumene, beryl, cassiterite and other minerals at present commercially valuable.

General Geology.—The bedrock of the prospecting areas mentioned in the foregoing paragraph is Pre-Cambrian in age, and comprises a series of volcanic and sedimentary strata and intrusives ranging in mineral composition from peridotite to granite. The volcanic rocks include flows of basalt, andesite, and rhyolite and associated tuffaceous and pyroclastic beds. Quartzose sediments of varying texture are interlayered with the lavas. Some of the sediments, however, appear to be older than the lavas and locally sediments overlie the lavas, although no structural unconformity has been recognized between the different members of the series. A few thin beds of sediment carry red garnet, locally estimated to form two-thirds of the rock, and schistose phases of such beds carry small quantities of pyrrhotite, pyrite, and chalcopyrite. Garnet schist carrying veinlets of quartz was reported to assay a trace of tin, consequently the garnet beds were explored carefully for possible commercial deposits of copper-tin ore. The garnet is almandite. It is fractured and also carries bits of quartz and other minerals, hence probably the garnet would be suitable only for a powdered abrasive.

Intrusive rocks are widespread in the district and the pegmatites are considered to represent the closing phase of the period of intrusion. A large lens-shaped body of porphyritic rock between Bernic and Shatford Lakes varies from granodiorite to granite in mineral composition. The white felspar phenocrysts, averaging near a quarter inch in length, sharply contrast with the fine-grained greenish-grey weathering groundmass. Areas containing quartz lenses up to 1½ ft. in length are locally present within this intrusive mass and these may have resulted from a local differentiation of the magma. This feature of this body of porphyritic rock suggests that it is a roof phase of a magma that presently gave rise to the more extensive granite masses exposed nearby. If this be the case, erosion has not reached a level below the cupolas of some of the granite masses. Many lode tin deposits of the world are within or adjacent to the smaller granite bodies which perhaps represent domes on the surface of large granite batholiths.

General Features of the Pegmatites.—The most abundant type of pegmatite is a pink microline-quartz type, carrying few accessory minerals and occurring in small bodies of irregular shape. This type of pegmatite is abundant in the lavas and sediments along the margin of some of the large granite areas. A few bodies of a pinkish-white albite-pegmatite are also present in the same areas with the microline-pegmatite, and the pegmatites carrying abundant albite in addition to microline and quartz, contain the lithium- and tin-bearing minerals and other accessory minerals characteristic of pegmatites. The albite-pegmatites are of variable texture ranging from a fine aplitic rock through pegmatitic granite to a pegmatite with crystals a foot or more across. Some of the pegmatite bodies have the form of dykes, either paralleling or cutting the bedding and schistosity of the older rocks, whereas others appear to be nearly horizontal sheet-like layers formed along joint planes and other structures of the rocks. The deposits of cassiterite and lithium-bearing minerals are localized in lenses and irregular-shaped masses within the albite-bearing pegmatites.

Tin Deposits.—Cassiterite was discovered in 1924 in a pegmatite out-cropping on a small island near the east end of Shatford Lake. The original outcrop is small and is near the water-level of the lake. The island is less than 50 ft. wide, and pillow lava outcrops along the south shore and a garnet bed on the north side. The pegmatite apparently is along the contact between these two types of rock and cannot be over 12 ft. wide. Specimens on the dump are of a pinkish albite and a quartz-muscovite pegmatite. The cassiterite is in the quartz-muscovite phase of the pegmatite as small grains and crystals up to ¼ in. long distributed either along the borders of veinlets of quartz or between large crystals of quartz and felspar. Purplish fluorite is also present in small irregular areas between large felspar and quartz grains. Tourmaline, beryl, and other accessory minerals of nearby pegmatites are absent. Judging from the general appearance of the rock, the tin content across widths of 4 ft. or more would be low, although certain specimens would assay several per cent. tin. The size of the body of quartz-muscovite tin-bearing pegmatite is unknown.

Lithium Deposits.—The lithium and tin deposits are similar in their general features and lithium-bearing minerals occur sparingly in the tin-bearing pegmatites. The Silver Leaf lithium deposit, located south of Winnipeg River and 8 miles east of Pointe du Bois, has been developed by the Silver Leaf Mining Syndicate, and three carloads of lithium ore have been shipped for test purposes. Lepidolite and spodumene are the abundant lithium minerals; amblygonite and montebrasite occur only sparingly. The accessory minerals include tourmaline, beryl, tantalite, topaz and various micas carrying a trace of lithium. The pegmatite mass is about 400 ft. long and 80 ft. wide at one point. The west two-thirds of the body is under a swamp. The outer margin is pegmatitic albite-granite passing inward into a coarse irregular-grained type carrying the lithium minerals. The deposit has not been explored to depth, but a small tonnage of lithia ore is exposed in the open-cut.

Beryllium Deposits.—Beryl, a beryllium aluminium silicate containing from 11 to 14% beryllium oxide, occurs sparingly in a number of pegmatites of the district. Two occurrences on the points along the south shore of Shatford Lake, 3,500 ft. from the east end, had been opened up by Manitoba Tin Company. In one of these pegmatites, beryl crystals up to 2 ft. in length and 2 in. diameter are present. The body of pegmatite carrying large crystals is small, not over 2½ ft. across as exposed in a prospect pit. At the other nearby locality small beryl crystals form about half the rock across a width of 2 ft. Pinkish albite, muscovite, and quartz are the only minerals noted in addition to beryl. The pegmatites were exposed for only a few feet along their strike. The beryl is apparently limited to a small part of the pegmatite body.

Leaching of Chalcocite.—Technical Paper 473 of the United States Bureau of Mines by J. D. Sullivan covers work done at the Southwest Experiment Station of the United States Bureau of Mines in co-operation with the Department of Mining and Metallurgy of the University of Arizona on various fundamental factors involved in the leaching of copper ores. The author points out that four factors are essential to the successful leaching of any copper-bearing ore: (1) A solution that will attack the copper minerals must get into the body of the ore particles; (2) the copper minerals must be dissolved by chemical action of that solvent; (3) the solution containing the dissolved copper must find its way out of the voids of the ore into the main solution stream; and (4) the copper in solution must be recovered by some means of precipitation. The present paper presents experimental data on the solution of chalcocite, Cu_2S, in various common solvents.

Investigators have long realized that ferric sulphate is an active reagent for chalcocite. Siemens and Halske introduced a process about 1890 in which finely ground ore was first roasted to oxidize the iron almost completely while the copper remained principally as Cu_2S and then leached with a hot solution of ferric sulphate containing a small amount of sulphuric acid. The copper was precipitated electrolytically, using carbon rods as anodes. At Cananea concentrator, tailing-sands and flue dust were leached with ferric sulphate, and the solvent was regenerated by forcing heated air through the solutions. In 1905 experiments were conducted at Ray, Ariz., using ferric sulphate as the leaching reagent. The plant of the New Cornelia Copper Co., Ajo, Ariz., was completed on May 1, 1917, and the first charge of ore was finished on May 17. The ores treated at Ajo, although primarily oxidized, always contained a small quantity of copper as sulphide, and in recent years the sulphide content has been increasing. Part of the copper in the sulphide minerals has always been extracted, probably through the action of ferric sulphate in the leaching solution. The Inspiration leaching plant was put in operation on October 3, 1926, and its leaching solution carries a high ferric iron content and leaches mixed oxidized and sulphide ores. The metallurgical report for June, 1927, gives the percentage of total copper in the feed to the leaching plant as 1·195, of which 0·754 was oxidized copper and 0·441 sulphide. For July of the same year the percentages of total, oxidized, and sulphide copper were 1·132, 0·785, and 0·347 respectively.

Although experimental work was done on the leaching of sulphide copper ores with ferric sulphate as long ago as 1890 and although large plants are now using ferric sulphate to attack certain of the sulphide minerals (mainly chalcocite), very little of the chemistry of ferric sulphate leaching of chalcocite is definitely known.

Investigations were made on as pure minerals as could be obtained, most of the work being done on a very pure sample of chalcocite from Kennecott, Alaska. Other experiments were made on a sample of chalcocite from Bisbee, Ariz., which was not so pure as that from Kennecott, and a few preliminary experiments were made on a sample from an unknown source.

The following conclusions were formed. Chalcolite can be leached with ferric sulphate and the sulphide converted into the soluble sulphate. Simultaneously with the solution of the copper, the ferric iron is reduced to ferrous iron. About 1·7 to 1·8 parts of ferric iron are reduced to the ferrous condition for each part of copper extracted. Commercial leaching requires that by some means the ferrous iron be reoxidized to the ferric condition so that it will again be an active reagent for the solution of further chalcocite. Ferrous sulphate does not attack chalcocite. Various schemes have been suggested for the reoxidation of the iron. The Inspiration Consolidated Copper Co. brings about the reoxidation by electrolysis, which takes place simultaneously with the precipitation of the copper.

The experiments described in the report show that the rate of solution of chalcocite is independent of the strength of ferric sulphate if enough reagent is present. As ferric salts reduce current efficiency and necessitate higher current densities in electrolytic precipitation, it is desirable to keep their concentration as low as possible. A low ferric iron content is also desirable in plants making cement copper because of the consumption of iron by ferric salts.

The rate of solution of chalcocite is independent of the acid strength of the solution if the ferric iron concentration remains constant. Experiments with solutions containing 1% of ferric iron and sulphuric acid in strengths of 0·25 to 10% showed practically identical rates of solution. Oxidized copper minerals are dissolved by ferric sulphate, but in being dissolved the ferric sulphate is decomposed and converted into the oxide, hydroxide, or basic sulphate. The presence of sulphuric acid is desirable therefore in leaching mixed ores or ores carrying acid-consuming components. The precipitation of oxides or basic sulphates of iron has the dual bad effect of consuming a relatively expensive reagent and of endangering the solution passage-ways with plugging by these salts. A basic sulphate of iron is rather difficult to get into solution, especially if weakly acidic solutions are employed. However, an excess of sulphuric acid is unnecessary for the decomposition of chalcocite and has no advantage over a solution of lower concentration.

The work done on sizes of chalcocite from 10 to − 200 mesh showed the remarkable fact that the rate of solution in ferric sulphate is independent of size of particles, provided the particles are free so that the solution can attack them. Although there is a great difference in surface per unit weight for 10-mesh and 200-mesh particles, their rates of solution are practically identical. Ores suitable for leaching are usually of the disseminated type, and particles larger than 10 mesh would rarely be found. Also, the large pieces do not crumble in leaching but hold practically their original form. This shell is composed of sulphur, insoluble matter, and pyrite if present. As soon as the residue comes in contact with carbon bisulphide it falls apart and the sulphur dissolves, leaving a powder of insoluble material. Particles as large as 2 to 3 mesh dissolve at a slightly slower rate than smaller ones.

It has been shown that air with water alone cannot dissolve chalcocite. Sulphuric acid plus air will attack the mineral more slowly than ferric sulphate solutions. Sulphuric acid in the absence of oxygen has very little effect upon the mineral. Ferric sulphate is a much better leaching reagent for chalcocite than sulphuric acid and air. The rate of solution of chalcocite is markedly affected by

temperature. When — 100 + 200 mesh chalcocite was leached with a solution containing 0·5% of iron as ferric sulphate plus 0·5% of sulphuric acid, 73% of the copper was in a soluble condition in 1 day at 50° C., in 5 days at 35° C., and in 15 days at 23° C. The rate of solution of chalcocite is greatly accelerated at boiling temperatures. The products of the reaction, ferrous sulphate and cupric sulphate, do not interfere with the reaction in the quantities produced when the pure mineral is leached with pure reagents. When a large excess of ferrous sulphate is present, the rate of solution is slightly retarded.

Tests in ferric chloride showed that the rate of solution of chalcocite at 35° C. was practically identical with the rate in ferric sulphate. At boiling temperatures the solution of chalcocite in ferric chloride was more rapid than in ferric sulphate.

Chalcocite is dissolved when the ferric sulphate comes in contact with the mineral particles by open-drainage trickle leaching, but its rate of solution is a little slower than that by flood leaching in revolving bottles. When chalcocite is dissolved by ferric sulphate the reaction takes place in two stages, which may be written:

$$Cu_2S + Fe_2(SO_4)_3 = CuSO_4 + 2FeSO_4 + CuS$$
$$CuS + Fe_2(SO_4)_3 = CuSO_4 + 2FeSO_4 + S$$

The first of the two reactions is much more rapid than the second. The quantity of ferric iron reduced to the ferrous condition and the quantity of free sulphur produced show that the reactions are probably as written above.

When chalcocite is leached with ferric sulphate one-half of the copper dissolves rapidly, and the residue has the approximate formula, CuS. This CuS does not remain constant but continually undergoes a change as more copper is dissolved until the atomic ratio of Cu : S becomes 0·9 or less. The residue after 50 % of the copper has been dissolved has properties that are different from the mineral covellite.

Although these experiments were made on nearly pure minerals, the data are applicable to any leachable ore containing chalcocite. The rate of dissolving chalcocite in various ores may, of course, vary because of differences in mineralogical associations, as of pyrite and chalcocite, in the rate at which solutions penetrate the particles of ore, and in the acid-consuming constituents present, etc. The mineral particles in leaching ores are usually not large, and enrichments are frequently along cleavage planes where easy contact between mineral and solution is obtained.

Treatment of Graphite.—The treatment of graphite in Madagascar is dealt with by W. Thompson in an article which appears in *Engineering and Mining World* for August. The author states that in this island the graphite is found in gneiss in the same formation as mica, while in Siberia it occurs in granulites, and in Bohemia in gneiss, mica schists, or crystalline limestone. When masses of graphite are found before complete decomposition, the mineral can be exploited much easier and more economically than when diffused in the rock, as it is more generally mined. In the United States, where deposits are found in Georgia, Pennsylvania, and New York, graphite occurs in two forms: dry crystals and in an amorphous state. The same is true of the Canadian and Ceylon deposits. Each has its distinct uses. Only the crystalline is indigenous to Madagascar.

The Malgache crystals of Madagascar are principally utilized in making metallurgical crucibles. They are found at a uniform depth occurring in reddish earth produced by the decomposition of the gneiss. After the clearing of the forest and removing the surface soil, the graphitic earth is taken to the wash sheds, where the first operation, called *debourbage*, or cleaning, takes place. Usually the mass does not yield more than 10% of graphite mixed with decomposed felspar, sand, crystals of mica, and particles of iron. The mass is shovelled into the cleaning basin, from which it passes through a series of wooden troughs, which separate first the sand, then the crystals, and finally other residue. The last troughs are covered with metallic nettings, the mesh being of various sizes. These successive siftings, made under primitive sheds which protect the blacks from the sun and rain, result in yielding graphite of 45 to 60% carbon. To secure a grade of 80% it is necessary to eliminate other impurities such as iron, mica, and lime.

From the wash sheds the mineral mass contains sand, graphite, and about 4 or 5% of mica. To remove the sand it is delivered to the winnowers. The crystals fall in a vat from the winnow of the Maigache worker. In the Suberbie plant, and the establishments of the "Society of General Stores and Depots of Madagascar," these operations are performed mechanically. After cleaning, the graphite is dried, sorted by agitating sieves, and put through winnowing machines analogous to those employed in cleaning wheat. Since 1917 the exporters, by preference, have bought the mineral washed by the natives, and it is refined either at Tananarive, the capital of Madagascar, or in France. According to the character of the soil, three or four tons of washed graphite produce a ton of the commercial product.

As the mechanical sifting does not eliminate the mica when the sizes of the crystals equal those of the graphite, the elimination of this impurity becomes a problem for the chemist. Although the laboratories which treat the graphitic mineral chemically guard their secret, de Pritzbner, who is familiar with the industry, states that the use of petroleum or other grease is necessary. The unrefined graphite, mixed with petroleum under certain conditions, detaches itself from the impurities by floating. The first graphite shipped from Madagascar to Europe contained a large percentage of mica, which proved destructive to the crucibles. Of late, Madagascar has been producing a very high grade of graphite.

Graphitic minerals having 85 to 94% carbon contain iron, and until recently it was not possible to eliminate it. The elimination of this impurity was also made with the aid of petroleum, but it is very expensive. There is also an electrical treatment.

Some refiners in Germany, after soaking unrefined graphite in oil, subject it to a bath of boiling water. Following the boiling process the impurities fall to the bottom of the vat, the crystals remaining on the surface. This method was formerly employed at Nurnberg, Germany, but, being costly, it has been abandoned.

The greasy graphites have more important and more varied uses than the crystals. They are used in the manufacture of pencils, lubricants, and moulds for foundries and glassworks, and are also employed in electrical equipment. Canadian and Mexican greasy graphites can be used as they

exist in nature, as they require very little preparation, containing 92% and even more carbon, but most graphitic deposits are not so rich and the product must be purified. Methods of refining amorphous graphites are not perfected sufficiently to enable low-grade deposits to compete with natural deposits containing high percentage of carbon. In Bohemia, amorphous graphite of high density is obtained from low-grade deposits by treatment with carbonate of soda and heat. This chemical method, when tried in Madagascar, furnished an inferior product and has not been applied industrially in this French colony.

Acheson artificial graphite is manufactured by submitting anthracite to the high temperature of an electric furnace. In the years immediately preceding the War, this product was employed as a lubricant, and also in the electric industry because of its conductibility. Being prepared by heating with electricity anthracite containing no other impurities than silica and traces of alumina. The high temperature secures the partial disappearance of the silica and finally results in a pulverized mass of exceptional fineness containing 95% of carbon. Although regarded as slightly inferior to the Ceylon, Acheson graphite is a formidable competitor for most uses, as the price is so much lower. Experiments have been fairly successful in creating a good and cheap graphite lubricant.

Malgache exporters do not fear competition from these substitutes. In the Madagascar deposits there are vast layers of crystalline graphite which can be easily extracted and can compete, in almost all the markets of Europe, with the mines of Ceylon. The World War stimulated the development of this industry in France's large African island. During the first year of the War 6,314,000 kg. was produced. The maximum production during the War was 15,015,050 kg. After the War the maximum output reached totalled 4,049,888 kg.

Until 1914, France bought the Malgache graphites after they were purified in the United States, or Frankfort, Germany. The producers of Madagascar complained of the methods employed by certain foreign houses which bought the graphite directly from the exploiters and resold it in Europe. For example, first quality Malgache graphite, containing 90% or more carbon, was sometimes sold under the name of "Ceylon graphite," reserving the Malgache label for an inferior quality which had been badly refined. French industrialists and merchants now buy from the producer, or demand a certificate of origin.

World Silver Production.—Economic Paper 8 of the United States Bureau of Mines, by C. W. Merrill and others, calculates that the world production of silver for the entire period from 1493 to 1927, inclusive, has been over 14,000,000,000 oz., or about fourteen times the weight of gold produced in the same period. This amount of silver would make a cube measuring 114½ ft. on an edge.

The rate of world silver production has increased steadily since 1493. During the 108-year period 1493 to 1600 the production was 747,000,000 oz., less than the production for 1925, 1926, and 1927. For the century 1601 to 1700, 1,272,000,000 oz. was produced, and for the century 1701 to 1800 the production was 1,833,000,000 oz. The total world production from 1493 to 1800, a period of 308 years, was 3,852,000,000 oz., or less than the production from 1909 to 1927, a period of 19 years. Since 1888 more silver has been produced in the world than in the period 1493 to 1887; in other words, the production of 396 years has been exceeded by the production of the last 39 years.

In spite of the greater relative increase in the production of gold than that of silver, the price of silver has declined. This decline in the price of silver has been the result of a lessening demand rather than an abnormally increasing supply. The lessening demand has been due very largely to demonetizing of silver during the latter part of the nineteenth century by the principal nations of the world. This became possible through the enormous increase in gold production that followed invention of the cyanide process in 1887 and development of the goldfields of South Africa, yet a number of countries still retain the silver-gold standard. Most orientals use silver as a medium of exchange almost to the exclusion of gold. Silver may thus be regarded as a second line of defence for the maintenance of the metallic foundation of monetary systems, but the future of its production will be influenced largely by the course of gold production.

In the 108 years from 1493 to 1600 Bolivia produced 48% of the world's silver, followed in turn by 13% from Peru and 12% each from Mexico and Austria. During the next century, 1601 to 1700, the New World established its supremacy as a silver producer more firmly, accounting for over 77% of the world total. Both Peru and Mexico almost quadrupled their production and doubled their proportion of the world total. Bolivia continued as the leading producer, with 36% of the world total.

Mexico increased its production very rapidly, so that in the eighteenth century over 1,000,000,000 oz.—57% of the world's silver—was mined in this one country; Peru remained in second place with a production of 360,000,000 oz., or 20% of the world total. The production of Bolivia dropped to 214,000,000 oz., less than one-half of that in the preceding century.

In the decade 1801 to 1810, the Spanish colonies produced over 91% of the total world silver of 287,000,000 oz. With the close of this decade a revolution started which was to drive the Spanish governors from every capital of continental America within 20 years. Silver mining declined greatly for the two decades of revolution and reconstruction, but before the end of the half century production had reached new heights. Mexico, with 605,000,000 oz., or 57% of the world total, continued to lead the world. Peru was second and Bolivia third with productions and percentages of 159,000,000 oz., 15%, and 101,000,000 oz., 10%, respectively.

During the next half century the production of the United States rose from a negligible amount to first place among the countries of the world. This period witnessed the development of the Western States. After the discovery of the Comstock lode in 1859, a year seldom passed without discovery of a great silver deposit. For the half century 1851 to 1900, the world production nearly quadrupled, attaining a total of over 4,000,000,000 oz. The United States produced one and one-third billion oz., or 33%; Mexico one and one-quarter billion oz., or 31%; and Bolivia one-third of a billion oz., or 8% of the world total.

The United States, producing 1,534,000,000 oz., or 31% of the world total, was unable to hold the first place during the first quarter of the twentieth century, being surpassed by Mexico, which produced 1,615,000,000 oz., or 33%. Canada was third with

464,000,000 oz., or 9% of the world total, and Australia fourth with 284,000,000 oz., or 6%. In 1926 and 1927 the proportion showed an increase for Mexico to 40% of the world total, the United States dropped to 24%, Canada remained at 9%, and Australia dropped to 3½%.

In early times the proportion of silver extracted from silver ore was much higher than it is now. Slowly the silver and the silver-gold deposits have become less important, and the silver-lead, silver-copper, silver-zinc, silver-lead-zinc, and other silver-bearing deposits have arisen in silver-producing importance. Silver production is becoming more and more dependent on the production of these base metals and gold. This trend will probably continue and the future of silver production should therefore follow the expanding production of these other metals. The silver content of base-metal deposits usually becomes smaller with depth, so it is probable that future silver production, though generally upward, will increase at a lower rate than the rates indicated for copper, lead, and zinc.

Beneficiation of Low-Grade Chromite Ores.—In view of the dependence of the United States on foreign countries for chromite, a study of methods for beneficiating domestic low-grade ores is being conducted by the United States Bureau of Mines, Department of Commerce, and Report of Investigations 2999, by H. A. Doerner, is the first of a series dealing with an investigation of chemical methods of treating chromite, and the possible application of these methods to the utilization of low-grade ores.

In a recent year the United States consumed 60% of the world's production of chromite and produced none. The uses of chromium are rapidly expanding, and a dependable supply is essential to American industries. Since the political and commercial control of the supply of chromite is now in other hands it is deemed prudent to determine how the United States can best prepare to supply its need for chromium if imports were cut off or restricted and whether it is now possible and desirable to stimulate production of chromium from domestic deposits. The United States has only small amounts of chrome-ore of high enough grade to meet present trade requirements.

Chromite is the only commercial source of chromium. For refractories, a minimum of 40% chromite and a low silica content is usually specified. In most instances bricks or lumps having a physical structure that will not crack when heated are required. The only way an inferior ore could be adapted to this use would be to concentrate it and develop a satisfactory binder to make bricks out of the concentrates. For making ferrochrome the requirements are a minimum of 45% chromite and an iron content not exceeding one-third of the chromic oxide. On some low-grade ores gravity concentration will give a product meeting these requirements; other ores yield concentrates containing too much iron or other impurities to be saleable.

The chemical trade demands an ore containing 50 to 55% chromite; silica, alumina, and magnesia are considered undesirable, but unavoidable impurities. Ore from New Caledonia is preferred and commands a higher price. Current quotations on various grades of chrome ore range between $21·00 and $25·00 per ton f.o.b. Atlantic ports.

Chromite is smelted in the electric furnace to produce ferrochrome, which in turn is used to alloy steels and castings. "Pure" chromium, required for special alloys of low iron and carbon content, was formerly made by thermit reduction of chromic oxide, but at present much of it is also being made in the electric furnace. Nearly all other uses (except refractories) involve the production of chromates by a chemical treatment of the ore. The usual treatment involves roasting the ore with lime and soda ash and leaching sodium chromate from the calcine. The sodium chromate is converted to sodium or potassium dichromate, chromic oxide, chromic acid, and various other salts and pigments. The rapid development of chrome plating has caused a substantial increase in the consumption of chromic acid.

A study of methods by which low-grade chromite can be converted to chromates, chromic acid, and chromic oxide should be of value in the utilization of domestic ores in the United States and may also bring about improvements in the metallurgical treatment of imported ores.

The present series of reports will include a study of methods of roasting chromite to obtain chromates; leaching the calcine; purification of chromate liquors; conversion of chromates to other compounds, particularly chromic oxide and chromic acid.

The paper here reviewed deals with the reactions involved in the roasting and leaching operations with reference to the effect of various common impurities, reagents employed, and conditions during roasting and leaching.

Origin of Mesothermal Pyritic Copper Deposits.—*Abstracts* of Scientific and Technical publications from the Massachusetts Institute of Technology contains the following summary of a paper by J. E. A. Kania presented for the degree of Doctor of Philosophy. With a view to determining whether or not colloids, in the role of double sulphide solutions and sols of Na_2S with the heavy metal sulphides as well as Na_2S combined with SiO_2, would be able to account for the type of mineralization characteristic of the mesothermal pyritic copper deposits, the problem was attacked in an experimental way. A number of melts were prepared mixing in molecular proportions fused powdered Na_2S with powdered pyrite, chalcopyrite, sphalerite, galena, and silica respectively. The cooled melts were finely crushed, extracted with distilled water, filtered and the filtrate used in the experiments.

The behaviour of these solutions (varying the concentrations) was observed at 25° C., 32° C., 95° C. and cooled to 32° C., and at 90° C. continuously, in contact with various rocks such as marble, lime, mud rock, syenite porphyry, argillaceous quartzite and carbonaceous shale and with or without CO_2 and (or) H_2S gas. Though the formation of crystals was not the main object of this thesis, which deals mainly with the stability of the sols and solutions in various environments. pyrite, marcasite and chalcopyrite crystals formed in some of the tubes. Marcasite formed from FeS_2 sols with very little Na_2S present (neutral or acid, cold or hot). Pyrite from Na_2S–FeS_2 solutions under similar conditions as well as in alkaline solutions and chalcopyrite from a hot alkaline sol as replacement in crystalline limestone. The solutions and sols prepared with hot water were found to be more stable at lower temperatures than those prepared with cold water. Calcium bicarbonate was found to be the most powerful coagulant in all the experiments performed, especially if H_2S had an

opportunity to escape, which it does mainly due to the presence of excess CO_2.

It was found that Na_2S–SiO_2 solution coagulated FeS_2 sol, which in turn coagulated $CuFeS_2$ and ZnS sols. From this it was reasoned that the most easily soluble of suspended substance ascended first from the magma chamber, the order therefore being (1) silica, (2) pyrite, and (3) sphalerite and chalcopyrite.

It is postulated that the Na_2S in combination with these substances is carried off to the surface, along with CO_2 and H_2S, as the carbonate and acid carbonate, which is also a reason for thinking that these solutions, due to the presence of excess CO_2, are acid throughout the mineralizing process and not alkaline.

The Geology of the Iron Deposits of the Sierra de Imataca, Venezuela.—*Abstracts* of Scientific and Technical Publications from the Massachusetts Institute of Technology also summarizes a paper by G. Zuloaga, presented for the degree of Doctor of Philosophy. The author says that the iron deposits of the Imataca range of Venezuela occur along the Orinoco River, in the Northern border of the Guayana Highlands. Many deposits occur in the area, some of slight economic importance; others which may rate with the largest masses of high grade iron ore of the world.

The geology, as well as the character of the ores, seems to be remarkably similar to that of the iron deposits of Brazil, which are the largest known. The similarity is so evident that it has been the hope of the writer to find a theory of origin for the Venezuela deposits which would apply to the Brazilian ores. Both occurrences are characterized by the presence of sedimentary iron formations or "itabirites" in which the iron minerals are found. The iron ore-bodies are concentrations in the mass of these iron formations.

In the investigation of the Venezuelan deposits a definite relationship has been found between the mineralization of the large ore-bodies and igneous intrusions, specially norites and granites. This seems contradictory to the geology of the Brazilian deposits where apparently no such intrusives occur, therefore a generalization of one theory to both areas has to be postponed till more data are available. The Venezuelan deposits have been found to be of two classes: (*a*) Deposits in the Imataca quartzite, with recognizable sedimentary characteristics; and (*b*) deposits in much metamorphosed rocks, very probably of the Imataca Series, but with decided igneous affiliations. The deposits of class (*a*) are small; they consist of small veins and masses of high-grade ore in the mass of the itabirite, which is intruded by a granite. The deposits of class (*b*) are large and economically important; they are in rocks which have been intruded by a granite and a norite.

The theory of origin that has been developed for the Venezuelan ores is as follows: The Imataca sandstone was laid, probably as a shore deposit, being highly ferruginous to start with. Whether this original iron was brought in solution or in suspension there are, as yet, no data to decide. The lack of chert or other form of silica deposited from colloidal solutions would rather favour the latter view. An intrusion of granite caused migration of the iron in the sediments, re-depositing it in fractures and places of easy circulation of solutions, in this way producing small bodies of iron ore such as found at Becerro, Piacoa, etc.

At Pao and Imataca, deposits of class (*b*), shortly after the intrusion of the granite, there followed an intrusion of norite which caused further changes and solutions coming from the norite mass became loaded with iron dissolved from the mass of the ferruginous quartzite which replaced in favourable places the ferruginous quartzite, in this way producing the ore-bodies.

Uses of Zinc.—A recent report of the United States Bureau of Mines by E. W. Pehrson reviews the uses of zinc. The author states that zinc ore may be used for the manufacture of slab zinc, zinc dust, pigments, and salts. The three chief uses of slab zinc are in the manufacture of zinc-coated (galvanized) products, in brass making, and in the manufacture of sheet zinc. Other minor uses are in the manufacture of French oxide, atomized zinc dust, die castings, and slush castings, and for desilverization of lead.

The galvanizing industry is the largest user of slab zinc and has accounted for approximately 47% of the total zinc used in the United States during the past several years. Brass making provides the second largest use of slab zinc and has accounted for about 29% of the total consumption during the past five or six years. The use of zinc in brass has not, however, kept pace with the general increase in consumption of zinc during the past few years. The use of zinc in the manufacture of rolled products has recently decreased to some extent. This phase of zinc consumption has been adversely affected by the decreased use of dry cells in radio receiving sets.

Another important use of zinc, and one that presents a promising future, is as the essential constituent of die-casting alloys. During the last three or four years the use of zinc for this purpose has nearly doubled. Articles now being die cast from zinc-base alloys include loud-speaker cases, radio-instrument dials, many automobile parts, including hub caps and intricate carburettor parts, soda-water dispensers, pencil-sharpener bodies, and smoking stands. Other miscellaneous uses account for about 9% of the total production of zinc. Approximately two-thirds of this miscellaneous consumption is due to the manufacture of French process zinc oxide. Probably several thousand tons of zinc are used annually in the Parkes process for desilverizing lead.

Possible new uses for zinc are suggested by research upon zinc of exceptional purity produced by the Tainton process. This metal contains 99·99% zinc and has properties that promise to expand the utilization of zinc into new fields. It is about two-thirds as hard as ordinary high-grade zinc and very much more ductile, and it can be drawn into 0·008 wire, rolled into foil, and rolled into strip and ribbon without annealing. Collapsible and drawn tubes have been made successfully. Differences in impurities, although slight, have a tremendous effect on the physical qualities of the metal. It is being used now principally in the brass and die-casting industries.

A new timber preservative, zinc-meta-arsenite, has been developed recently. It is claimed that this compound has toxic properties equal to copper arsenite and greater than zinc chloride, that it is quite permanent and inexpensive, and that it is practically non-corrosive to iron. It is applied by the ordinary pressure methods.

Murdoch Copper Extraction Process.—The Murdoch process for the extraction of Copper from

oxidized ores is protected under Australian patent No. 1687824, and an outline of the methods and principles involved is given in the *Chemical Engineering and Mining Review* of Melbourne for June 5. The claims of the specification read as follows: "A leaching and precipitation process of recovering copper from cupriferous material in which the copper is in oxidized condition, which includes subjecting the material to the action of an aqueous leaching solution comprising calcium chloride, common salt and sulphurous acid to convert the copper content to cuprous chloride in solution, and adding lime to the cuprous chloride, for the purpose of precipitating copper and reforming calcium chloride."

The reactions of solution and precipitation respectively are expressed by the following equations:—

(1) $2CuO + CaCl_2 + SO_2 = CaSO_4 + 2CuCl$.

(2) $2CuCl + CaO = Cu_2O + CaCl_2$.

In the application of the process, the ore is crushed to a degree of fineness that is determined by experiment, usually from $\frac{1}{4}$ in. to $\frac{1}{8}$ in. mesh being suitable, and, if a sulphide, the ore is roasted to the oxidized condition. It is then charged into vats and a liquor applied containing a quantity of calcium chloride and sulphur dioxide adjusted as closely as possible to be equivalent to the copper present. A proportion of common salt may also be present to help to retain the cuprous chloride in solution, but which does not otherwise take part in the reaction. In most cases it will be found convenient to work with solutions containing about 1% copper, 1% calcium chloride and 5% salt.

The copper-bearing solution, having been removed by percolation (or decantation), is treated with milk of lime which precipitates the copper as a fairly dense brown precipitate of cuprous oxide which settles and filters well. This is washed, dried and smelted to copper, being of such a degree of purity as to permit of refining in the first operation.

The filtrate from the copper precipitate is returned to a percolating tower and being impregnated with sulphur dioxide from the roasters is ready for fresh batches of ore. No cumulative fouling of the solution is possible, everything being cleaned out each cycle by the lime.

Assuming a daily tonnage of 100 tons of 4% ore, the following are the items to be considered in making up an estimate of working costs:— Crushing; roasting (if a sulphide); leaching and disposal of residues; precipitation; smelting precipitate, or, alternatively, marketing in that form. Apart from the disposal of residues the leaching will require the attention of two men for three shifts, one being an engine driver, while the precipitation will require two men on day shift only to attend filter presses and drying of precipitate.

The materials required for the above ore would be sulphur dioxide, obtainable from about three tons of pyritic ore (or from the roaster if the ore to be treated were a sulphide), two tons of lime for precipitation, and about £2 worth of salt and calcium chloride to replace mechanical loss.

SHORT NOTICES

Mining Methods and Systems.—Mining terminology is discussed by T. T. Read in *Mining and Metallurgy* for July.

Drilling at Mount Hope.—F. M. Radel describes a new method of drilling adopted at the Mount Hope Mine, New Jersey, in the *Engineering and Mining World* for August.

Effects of Rock-Strata Gases on Mining.—Rock-strata gases of the Cripple Creek District, Colorado, and their effect on mining, form the subject of Bulletin 317 of the U.S. Bureau of Mines by E. H. Denny, K. L. Marshall, A. C. Fieldner, A. H. Emery, W. P. Yant, and W. A. Selvig.

Quarrying with the Wire Saw.—O. Bowles describes the use of the wire saw in slate quarrying in the United States in Technical Paper 469 of the U.S. Bureau of Mines.

Wire Ropes.—The manufacture, use, and abuse of wire ropes as applied to mining operations are discussed by G. C. Hodgson in the *Canadian Mining Journal* for August 1.

Compressed Air and Electricity in Coal Mines.—A paper by H. N. Eavenson and G. Bright on compressed air *versus* electricity in the coal mines of America, read before the Second World Power Conference at Berlin is summarized in *The Iron and Coal Trades Review* for August 1.

Mine Air.—*Engineering* for August 8 contains an article by A. L. Egan on the reconditioning of mine air.

Scrap Tin Plate.—W. W. Scott and N. E. Davis describe the detinning of scrap tin plate in *Industrial and Engineering Chemistry* for August.

Copper Leaching.—Bulletin 321 of the U.S. Bureau of Mines by H. E. Keyes discusses innovations in copper leaching employing ferric sulphate—sulphuric acid.

Assaying.—*Industrial and Engineering Chemistry* for July 15 contains the following papers: Evaluation of Stibnite, II.—Determination of Antimony, by W. M. McNabb and E. C. Wagner; Short Method for Complete Analysis of Magnesium-Aluminium Alloys, by S. S. Singer; Determination of Lithium, by M. H. Brown and J. H. Reedy.

Detection of Tin.—A new method for the detection of tin, as described by H. Meissner in *Z. anal. Chem.*, 1930, **80**, 247–252, is discussed in the *Analyst* for July.

Leached Outcrops.—O. B. Gwillam discusses the application of the principles of Locke to leached outcrops in Northern Manitoba in the *Canadian Mining and Metallurgical Bulletin* for August.

Geophysical Prospecting.—Technical Publication No. 338 of the American Institute of Mining and Metallurgical Engineers, by H. Shaw, deals with the interpretation of gravitational anomalies, while electrical methods for sub-soil investigation are discussed by S. F. Kelly in the *Proceedings* of the Brooklyn Engineers' Club for April.

Cobalt, Ontario.—Part 1 of a qualitative and quantitative determination of the ores of Cobalt, Ontario, appears in the August issue of *Economic Geology*.

Platinum and Chromite in South Africa.—An article by Dr. R. Stappenbeck in *Metall und Erz*, 1 Augustheft, deals with the platinum and chromite deposits of the Union.

Oil-Shale Distillation.—Bulletin 315 of the U.S. Bureau of Mines, by M. J. Gavin and J. S. Desmond, deals with the construction and operation of the Bureau of Mines experimental oil-shale plant, 1925–1927.

Perak River Hydro-Electric Power.—The *Engineer* for August 22 contains the first part of an article on the Perak River hydro-electric power scheme.

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 patents.

1,298 of 1929 (330,876). Oil Finding Corporation, New York. Currents of relatively high frequency are used to locate deposits of a high dielectric nature, such as oil or gas.

1,934 of 1929 (330,933). W. J. Luff, L. Logan, and O. W. Lusby, Baltimore. Sulphur bearing impurities in combustible gases are removed by passing the gas over masses consisting of oxides and metals of, say, copper and chromium, or copper, chromium and uranium, at a temperature of 250° C. The revivification of the mass is completed by following the gas flow with a purging flow of a non-combustible oxygen-free gas.

3,779 of 1929 (331,892). W. B. Hamilton and T. A. Evans, Lancs. Metals and alloys are produced in high frequency induction furnaces by exothemic reactions, a typical mixture for reduction being chromite ore and ferro-silicon.

10,440 of 1929 (331,552). Sir Douglas Mawson, Adelaide. Mineral complexes containing sulphur, having more than one sulphur atom within the complex, such as the mineral Alunite, are used in the fixation of ammonia, whereby metallic hydrates are freed together with the alkali metals present.

11,248 of 1929 (331,886). Soc. Minière et Métallurgique de Penarroya, Paris. The purification of zinc sulphate solutions.

12,062 of 1929 (309,957). F. Jourdan, Rome. Leucitic rocks are treated with nitric acid vapour for the recovery of the potash content.

19,688 of 1929 (318,232). Metallgesellschaft A.-G., Frankfort-on-Main. Cupriferous and zinciferous ores, particularly chloridized roasted pyrites, are partially leached in such a manner that the bulk of the zinc present enters the first liquor fraction and the copper the remaining liquor, the individual fractions being then separately treated.

24,643 of 1929 (318,149). K. W. Palmaer, Stockholm. A metal of the iron group may be removed from solutions containing one or more of such metals by electrolysis, using a cathode of mercury which is kept in motion.

31,246 of 1929 (332,147). S. G. Watson, D. M. Henshaw, and W. C. Holmes and Co., Huddersfield. Sulphur is removed from fuel gases by passing the impure gas through suspensions or solutions of metallic oxides in alkalis.

4,002 of 1930 (331,259). J. E. Hackford, London. Apparatus for the heat treatment of minerals and other solids, in which the heat is usefully conserved and manual labour reduced to a minimum.

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.

The Principles of Coal Property Valuation. By A. W. Hesse. Limp cloth, octavo, 183 pages, illustrated. Price 15s. London: Chapman and Hall.

The Iron Ores of Lake Superior. Seventh Edition. Cloth, octavo, viii + 332 pages, illustrated, with maps. Cleveland, Ohio; Crowell and Murray, Mining Engineers, Chemists and Metallurgists.

Outlines of Physical Geology. Prepared from the third edition of Part 1 of a Textbook of Geology by the late L. V. Pirsson, C. Schuchert. By C. R. Longwell. Cloth, octavo, 376 pages, illustrated. Price 15s. London: Chapman and Hall.

The Modern Dowser. By Le Vicomte H. de France. Cloth, octavo, 135 pages, illustrated. Price 3s. 6d. London: G. Bell and Sons.

8th Annual Report of the Safety in Mines Research Board, including a report by the Health Advisory Committee, 1929. Paper covers, 62 pages, illustrated. Price 1s. London: H.M. Stationery Office.

Flame-Proof Electrical Apparatus for Use in Coal Mines. Safety in Mines Research Board Paper No. 60. Summarizing Report by I. C. F. Statham and R. V. Wheeler. Paper backs, 62 pages, illustrated. Price 6d. London: H.M. Stationery Office.

Catalogue of Plans of Abandoned Mines. Supplement to Vols. I, II and III. Paper backs, 36 pages. Price 6d. London: H.M. Stationery Office.

Canada; Investigations of Mineral Resources and the Mining Industry, 1928. Paper backs, 57 pages, illustrated. Publication No. 710, Ottawa: Department of Mines.

Canadian Metallurgy; Investigations in Ore Dressing and Metallurgy, 1928. Paper backs, 166 pages. Publication No. 711, Ottawa: Department of Mines.

British Columbia; Report of Minister of Mines, 1929. Cloth, octavo, 532 pages, illustrated. Victoria, B.C.; Bureau of Mines.

South Australia; Mining Review for the Half-Year ended December 31, 1929, No. 51. Paper backs, 100 pages, illustrated. Adelaide: Department of Mines.

Sierra Leone; Report of the Geological Department for the year 1929. Paper folio, 12 pages. Price 2s. 6d. Freetown: The Geological Department.

Tanganyika Territory; Mines Department Annual Report, 1929. Paper backs, 24 pages. Price 2s. Dar Es Salaam: Mines Department.

Revision of the Lower Eocene Wilcox Flora of the Southeastern States. United States Geological Survey Professional Paper 156. Paper backs, quarto, 196 pages, illustrated. Price 75 cents. Washington: Superintendent of Documents.

Mines Handbook. Vol. XVIII. Price $20. New York: Mines Information Bureau, Inc.

The Canadian Mining Book, 1930. Cloth, octavo, 411 pages. Price 10s. Montreal: Thomas Skinner of Canada.

COMPANY REPORTS

Leeuwpoort Tin Mines.—This company, which belongs to the Bailey group, was formed in 1912 to work lode tin deposits in the Waterberg district of the Transvaal. The report for the year 1929 shows that 79,200 tons of ore was milled, which is a record tonnage for the mine, being 5,800 tons more than in 1928. Concentrates produced, however, were 6 tons less than in the previous year, amounting to 660 tons, containing 63·19% metallic tin. The year's working resulted in a loss of £3,867 and, development having been greatly reduced about the middle of the year, the ore reserves were reduced by 46,476 tons to 64,018 tons. Operations were continued into the current year, but, with conditions becoming worse, the mine was closed down in March last.

Tavoy Tin Dredging.—This company was formed in 1923 to work alluvial tin properties in the Tavoy district of Lower Burma. The report for the year 1929 shows that 1,216,043 cu. yd. of ground was treated by the dredges and gravel pump and 567½ tons of tin concentrates recovered, as compared with 1,114,341 cu. yd. and 514 tons in 1928. The working profit for the year was £38,248 to which must be added £8,876 from other sources, making a gross profit of £47,125. Of this amount, after charging overhead expenses and crediting sums to general reserve and taxation accounts, a balance of £16,748 remained and this was carried forward. The future of this company is bound up in its amalgamation with Northern Tavoy Tin Dredging, Theindaw, and Thingandon Tin, which was announced last month.

Tetiuhe Mining.—This company was formed in 1925 and works the Tetiuhe lead-zinc-silver mines in Siberia. The report for the year ended September 30, 1929, shows that 50,487 tons of ore, assaying 15·06% zinc and 10·49% lead, was sent to the mill, where 13,923 tons of zinc concentrates, assaying 45·06% zinc, and 6,335 tons of lead concentrates, assaying 74·47% lead and 58·35 oz. silver per ton, were produced. Ore reserves at the end of the period under review were estimated to be 910,754 tons averaging 12·95% zinc, 10·33% lead and 7·74 oz. silver per ton. A second mill unit was brought into operation on October 1, 1929, the total crushing capacity now being 400 tons per day. The year's working resulted in a loss and the debit balance now totals £69,747.

DIVIDENDS DECLARED

Amalgamated Zinc.—4%, less tax, payable October 10.

Anglo-Oriental Mining.—Pref. 9d., less tax, payable Sept. 1.

Central Provinces Manganese.—1s. 6d., free of tax, payable Oct. 1.

Consolidated Tin Smelters.—Pref. 7%, less tax, payable September 30.

Imperial Smelting.—Ord., 5%, less tax.

Kramat Pulai.—6d., less tax, payable September 18.

Malayan Tin Dredging.—3d., less tax, payable September 19.

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

Nundydroog.—9d., less tax, payable October 6.

Renong.—7½%, less tax, payable October 11.

Selection Trust.—1s. 4½d., less tax, payable September 22.

Tekka.—3d., less tax, payable September 4.

Witbank Colliery.—1s., less tax, payable October 3.

NEW COMPANIES REGISTERED

Amisk Gold Syndicate.—Registered as a private company August 13. Nominal Capital: £8,000 in £100 shares (50 Preference and 30 Deferred). Objects: To acquire concessions, to prospect for, work and develop gold, lead, silver and other mines, etc.

British Titan Products Co.—Registered as a private company July 26. Nominal Capital: £25,000 in £1 shares. Objects: To promote the production and use of titanium, zinc, lead and other metals or their compounds, derivatives and alloys, in particular titanium pigments, composite and all other pigments; to carry an all kinds of research work incident or relating to the production and use of titanium, zinc, lead and other metals and their alloys and compounds; to carry on all kinds of metallurgical operations; to carry on the business of manufacturing chemists, manufacturers and producers of and dealers in sulphuric and other acids, alkalis, chemicals and chemical substances, etc. Office: 95 Gresham Street, E.C.

Consolidated Mines and Minerals Development Corporation.—Registered August 15. Nominal Capital: £100,000 in 5s. shares. Objects: To acquire the business of Uroz, Ltd. (in liquidation), and to carry on the business of miners of asbestos, metals, minerals and precious stones, etc. Directors: G. W. Andrews, W. Blount and G. A. Stockfield. Office: 20 Copthall Avenue, E.C. 2.

Empire Geophysical Research.—Particulars filed August 7. Capital: £13,000 in £1 shares (5,000 "A" and 8,000 "B"). Objects: The company was incorporated in Guernsey on July 5, 1930, to adopt an agreement with G. L. Scott, A. W. Sharman, and Sir Horace W. Kirby for the acquisition of certain inventions and rights relating thereto; to carry on research and experiments in geophysics, radiation, etc., the exploration and refining of metals, the location of treasure and things of value, and in the application of inventions and scientific methods to horticulture and agriculture, etc. Directors: G. L. Scott, Sir Horace W. Kirby, and F. J. Nettlefold.

Oranjeville Goldfields Syndicate.—Registered August 21. Nominal Capital: £15,000 in £1 shares. Objects: To adopt an agreement with New Rand Consolidated, Ltd., and L. Wood, the liquidator thereof, to develop and turn to account the property and assets described therein, and to carry on the business of miners, smelters, dealers in precious and other stones, gold and other metals, etc. Directors: S. Martineau, P. A. Barendt, A. R. Sawyer. Office: 105 St. Clements House, Clements Lane, E.C. 4.

P. R. H. E. Exploration.—Registered as a private company August 8. Nominal capital: £5,000 in £10 shares. Objects: To prospect, explore, and investigate the industrial and electric power supply of the Gold Coast Colony of West Africa and elsewhere, and to carry on the business of electricians, technical engineers, etc. Directors: Sir James MacKenna, Major W. A. Wills, and J. Tunley.

Rhodesia Border Mining Corporation.—Particulars filed August 1. The company was incorporated in Southern Rhodesia. Directors: J. Hill, H. Brignell, A. Fraser and S. A. Redrup. Office: 80a Coleman Street, E.C. 2.

Santiago Development Company.—Registered as a private company August 20. Nominal Capital: £500 in 1s. shares. Objects: To acquire the mines known as Sheilita, Concepcion, Angostura, Gold Bars, and Timbire, in the Province of Esmeraldas, Republic of Ecuador, to adopt an agreement with C. K. J. Underhill, and to develop and turn to account the said mines. Directors: Sir Arthur T. Dawson, Major R. H. Thomas, F. L. Hallam. Office: Sentinel House, Southampton Row, W.C. 2.

Tubara Deferred Interests.—Registered August 29. Nominal capital: £100 in 6d. shares. Objects: To acquire any petroleum or oil-bearing lands in any part of the world; or any interest therein; or any rights of or connecting with the searching for, getting or winning of any natural gas, petroleum or other oil, bitumen, asphalt or other similar substances, to sink wells, and to carry on the business of mine owners, merchants, carriers, ship and barge owners, etc. Office: 16 Charles Street, Haymarket.

COMPANY MEETINGS AND REPORTS SECTION

SELECTION TRUST, LTD.

Directors : A. Chester Beatty (*Chairman and Managing Director*), C. W. Boise, H. Micklem, Lt.-Col. R. Micklem, Maj.-Gen. H. L. Reed, W. Selkirk. *Secretary :* R. D. Peters. *Office :* Selection Trust Building, Mason's Avenue, Coleman Street, London, E.C.2. *Formed* 1926. *Capital issued :* £200,000 preference shares of £1 each and £700,000 in 5s. ordinary shares.

Business : Finance and development of mining properties in various parts of the world.

The fourth ordinary general meeting of members of Selection Trust, Ltd., was held on September 1, 1930, at the registered offices of the company, Selection Trust Building, Mason's Avenue, E.C., Mr. A. Chester Beatty (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31 last, said : The profit and loss account shows a profit for the year of £307,325, which represents a substantial increase over the corresponding amount for the preceding year. As shown by the appropriation account, various amounts have been written off, totalling £19,642, and, after transferring £15,000 to income-tax reserve, £20,000 to premises reserve and £25,000 to contingencies reserve, deducting dividends paid and bringing in the balance of profit from the previous year, there remains a net amount of £233,071 available for further distribution. The directors recommend for your approval a final dividend of 27½%. After payment of this dividend there will remain a balance of £40,571 17s. 5d. to be carried forward to next year.

The main item on the balance-sheet is the figure of £1,518,683, representing our investments at or under cost. This figure compares with an amount of £905,539, representing the value of investments at March 31, 1929. At the date of the balance-sheet now under review approximately 90% of the total book value of the investments represented investments dealt in on the Stock Exchange, and I am glad to be able to report that the aggregate market value of those investments at March 31, 1930, was, and continues at the present time to be, very considerably in excess of the book value shown on the balance-sheet.

Consolidated African Selection Trust.—This company is interested in diamond production and its principal subsidiary, the African Selection Trust, in which it holds practically the entire share capital, has once more had a prosperous year. In view of the very large reserves of diamonds known to exist in the subsidiary company's concessions on the Gold Coast, West Africa, there is every reason to anticipate a long and successful life for the mines.

Roan Antelope Copper Mines.—Our company is also substantially interested in the Roan Antelope Copper Mines, Ltd., which will be the first of the large mines in the Northern Rhodesian copper belt to come into production. Over 100,000,000 short tons of sulphide ore are now indicated on the property, and this enormous tonnage is more than sufficient without further drilling to supply for many years without even allowing for an increase of the present plant, which will have a capacity of about 2,000,000 short tons of ore per annum.

Rhodesian Selection Trust.—We have maintained our very large interest in Rhodesian Selection Trust, one of the principal companies engaged in the development of the Northern Rhodesian copper belt. Under its agreements with the British South Africa Company and the Bwana M'Kubwa Company, the Rhodesian Selection Trust was able to select and take up within the N'Kana concession a total of approximately 149,700 acres of ground, in which the sedimentary copper-bearing beds are known to exist. Within this area deposits of great potential value have been discovered at Mufulira, Chambishi, and Baluba.

Tetiuhe Mining Corporation.—In Asia we have maintained our interest in the Tetiuhe Mining Corporation, Ltd., which operates lead-zinc-silver mines near Vladivostock under a concession from the Government of the U.S.S.R. The installation of a second milling unit was completed last autumn, increasing the capacity from 200 to 450 tons of ore per day. A lead smelter is under construction, and should be in operation very shortly.

Yugoslavian Business.—During the current year our operations in Yugoslavia have continued to develop along successful lines. In this sphere mining concessions and prospecting rights within areas totalling some 2,000 square miles have been examined, and, in view of the promising results obtained, a further large territory is being examined. We have formed and are maintaining a substantial interest in five companies at present carrying out development and exploration of lead-zinc properties, namely, Trepca Mines, Ltd., Novo Brdo Mines, Ltd., Zletovo Mines, Ltd., Kopaonik Mines, Ltd., Belasica Mines, Ltd.

Trepca Mines.—During the past year Trepca Mines, Ltd., has been engaged in a programme of development work and plant construction, and you will be pleased to hear that about ten days ago milling commenced at the Stantrg mine and concentrates are now being produced.

This will no doubt be the last occasion on which I shall have the pleasure to preside at an annual general meeting of this company, because shareholders will be asked at an early date to pass a resolution to liquidate the company. A company was incorporated in Canada with the intention of acquiring, if practicable, all the Ordinary shares in our company, and we learn that their efforts have been successful, all the holders of Ordinary shares in the company having agreed to exchange their holdings for shares in the Canadian company. Simultaneously arrangements were made to safeguard fully the interest of the holders of debenture stock and Preference shares in the company.

Major-Gen. H. L. Reed seconded the motion, which was carried unanimously.

TAVOY TIN DREDGING CORPORATION, LTD.

Directors : Sir William D. Henry, W. H. Edwards, D. L. H. Dautresme, Lt.-Gen. Sir E. Locke Elliot, Louis Hardy, Louis Pasquet. *Managers in the East :* Anglo-Oriental (Malaya) Ltd. *Technical Managers :* Anglo-Oriental Mining Corporation, Ltd. *Secretaries :* Anglo-Oriental and General Investment Trust, Ltd. *Office :* 31 and 33, Bishopsgate, London, E.C.2. *Formed* 1923. *Capital :* £250,000 in 4s. shares.

Business : Operates alluvial tin properties in Lower Burma.

The annual general meeting of Tavoy Tin Dredging Corporation, Ltd., was held on August 26, 1930, at the Cannon Street Hotel, E.C., Mr. Louis Hardy presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1929, first apologized for the absence of Sir William Henry and then said : Although the results of the year's working are disappointing from the point of view of the actual profits earned, a close study of the report reveals many encouraging features, and indeed enables us to look forward with every confidence to the future of the corporation. During the year, approximately 49½ acres in all were treated by the three dredges and the gravel pump, which compares with 44 acres so treated in 1928 ; but of this area of 49½ acres as much as 28 acres had been previously dredged. The original extent of the Heindu Chaung Concessions was 979·09 acres, and the total ground treated to December 31, 1929, including that dredged by previous owners, amounted to 379·84 acres. The important fact to note, however, is that the area of the blocks which have been added from time to time still remains well in excess of the acreage worked out, so that, after six years of profitable working, we still possess a larger area than we owned when the corporation was formed early in 1924. During the year a comprehensive programme of prospecting and boring was carried out on the sectional areas with satisfactory results.

With tin at under £140 a ton, only a ridiculously small percentage of the world's producers can make both ends meet, and figures quite recently published show the largest individual producer in the world to have been operating at a definite loss with the price £15 a ton higher. The production of tin oxide under such conditions is an idle pursuit ; indeed, a number of the leaders of the alluvial tin industry have said that the depletion of the world's vanishing resources at uneconomical levels carries with it a grave responsibility for which those in charge will have in due course to answer. Your corporation was an original member of the Tin Producers' Association ; it has loyally and conscientiously supported each of the several recommendations of the Council of that association.

Reverting to our own prospecting, boring operations were confined entirely to our original Heindu Chaung concession, on which the three dredges are at present working. The ground ahead of the dredges, as well as practically the whole of the area already dredged, has now been rebored. The reboring of the tailings, besides proving the existence of payable reserves which will extend very considerably the working life of the dredges in the Heindu Chaung, has also enabled our engineers to map out a course for each dredge, which should produce the maximum results at the minimum outlay. 1,216,043 cubic yards were excavated in 1929, a very notable improvement on the 1,114,341 cubic yards treated in 1928. As the value of the content was unchanged at 1·03 lb. per cubic yard, the output of tin concentrate at 567½ tons showed an increase on the previous year of 53½ tons.

Operating results would have been even better had we not been seriously handicapped by the fouling of the water supply by neighbouring operators. Apart from this misfortune, the road to No. 1 dredge was badly damaged, necessitating extensive repairs, the No. 3 dredge temporarily driven out of its proper course into high and barren tailings, and the smooth working of the gravel pump very much impeded. I am glad to be able to report that the Courts of Burma have recognized our claim to have this state of affairs put right, and the matter of damages is now being determined.

The 567½ tons of concentrate produced were sold for £78,969 15s. 6d., which is equal to an average price of £139 2s. 10d. per ton of concentrate, and, after deducting working costs, a gross working profit of £38,248 8s. 9d. was realized. The net working profit for the year is £16,194 0s. 7d.

Immediately following this meeting we shall proceed with the extra-ordinary meeting which has been convened for the purpose of increasing the capital of the corporation to enable the proposed amalgamation with Northern Tavoy Tin Dredging, Ltd., Theindaw Tin Dredging Company, Ltd., and Thingandon Tin Dredging Company, Ltd., to be effected.

The resolution was seconded by Lt.-Gen. Sir E. Locke Elliot and carried unanimously.

The Chairman, in addressing the extra-ordinary general meeting which followed, said : For some months past the technical managers of the Anglo-Oriental group of tin companies operating in Burma have been investigating the technical position and the prospects of the several areas and their respective plants. This investigation has been directed specifically towards the submission of a practicable scheme enabling those dredges which are the least economical to operate to be suspended forthwith, and work to be concentrated for the present entirely upon the areas where operating costs can be reduced and maintained at the lowest possible level. The technical managers have satisfied the directors that such an arrangement is both practicable and desirable and have recommended that the only satisfactory method of achieving this consolidation of interest is the complete fusion of the four companies concerned.

On the completion of the amalgamation the authorised capital of the corporation will be £500,000, but only £359,031 will be issued. An offer has been received from London Tin Corporation to subscribe for the whole of the £125,000 of debenture stock at par, free of cost to Tavoy Tin Dredging Corporation, Ltd. But it was the view of your Board that the prior right to subscribe must be reserved for shareholders of this company and its three affiliates.

The Chairman concluded by moving the necessary resolutions, which were seconded by Mr. W. H. Edwards and carried unanimously.

BWANA M'KUBWA COPPER MINING CO., LTD.

Directors : Sir Edmund Davis (*Chairman and Managing Director*), Sir E. Oppenheimer (*Deputy Chairman*), A. Chester Beatty, E. Birkenruth, J. G. Lawn, D. O. Malcolm, E. E. Marshall, J. C. Moulden, L. A. Pollak, Lieut.-Col. C. H. Villiers. *Consulting Engineers :* Rhodesian Anglo American Ltd. *General Manager :* C. W. Dowsett. *Secretary :* A. H. Watts. *Office :* 19, St. Swithin's Lane, London, E.C.4. *Formed :* 1922. *Capital Issued :* £2,175,916 12s. 6d.

Business : Operates copper mines in Northern Rhodesia.

The ordinary general meeting of the members of the Bwana M'Kubwa Copper Mining Company, Ltd., was held on August 13, 1930, at Cannon Street Hotel, E.C., Sir Edmund Davis (Chairman and Managing Director of the Company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31 last, said : The profit for the year under review was £60,250, which it is proposed to carry forward. It is gratifying to be able to report that mining operations for the year under review have resulted in a profit.

At our last ordinary general meeting reference was made to alterations in the plant to treat the oxidized ores at Bwana, and since then the additional plant has been erected in a satisfactory manner and given the results expected when it was installed, and though we were making profits they are now materially affected by the very serious drop in the price of the metal. We are advised that with certain further additions to the plant which are being made and the improvement in the grade which is taking place through ore now being treated assaying nearer the value of the reserves, we may expect to make a satisfactory profit in spite of the very low prices now ruling for metal. The result of the work carried out on the Bwana mine leads us to conclude that mining and treatment operations should be carried on on the present scale of that mine until N'Kana is producing on the basis of about 70,000 tons of copper per annum. When this is the case we may, perhaps, have to take into consideration the advisability of increasing the output on our N'Kana property, where far larger profits would be made, instead of continuing to treat oxidized ores at the Bwana mine.

Reference was made at our last meeting to the work which had been carried on at N'Kana, when we stated that on one section we had proved the existence of an ore body 5,000 ft. long with both ends open, and on another section 7,900 ft, with an intervening space between the two of about 3,300 ft, which, if it also contained the ore-body at depth, would make a length of about 16,200 ft. The result of the drilling which has taken place since then has indicated the existence of the ore-body over a total length of about 50,000 ft, and the result of the drilling has indicated ore reserves amounting to 80,000,000 tons of 3·9 % copper ore. This tonnage could be greatly increased if the drilling programme were continued, but as the first unit of plant to be erected is to treat 5,000 tons of ore per day, the tonnage just referred to will alone be sufficient to cover a supply for 40 years. Sufficient work has already been done to indicate about 3,120,000 tons of metallic copper. We are erecting on the property the most up-to-date plant on the lines of that used on some of the large American-owned copper propositions in other parts of the world.

The developments at N'Kana have far exceeded any expectations we ever had, as you will have gathered from my remark that, though we have devoted our attention to the drilling on one limb of the syncline, we have already proved the existence of an ore body over a length of about 40,000 ft. and there is no reason why further drilling on the toe and the opposite limb should not give us satisfactory results, though, of course, it is impossible at the moment to suggest any length on the southern limb.

The great development to date has naturally necessitated the expenditure of far more capital than ever contemplated, and we are proposing a resolution to-day to increase the capital by the creation of an additional 1,000,000 shares of 5s. each.

N'Kana is practically in the centre of the present known copper field in Northern Rhodesia. A townsite has been laid out and buildings have already been erected ; those of our consulting engineers, the Rhodesian Anglo American, Ltd., will be on a substantial and useful scale. The white population at N'Kana already amounts to about 700 men, and the native population amounts to about 4,800 men.

What is of great importance to the company is the date from which production at N'Kana will commence, which should be early in 1932. There is another matter to which I should refer, and that is the question of refinery. Negotiations are now taking place between the various groups for the formation of a company to erect a large refinery in England, which is a matter of national importance, and which we feel sure should meet with the approval and support of the Government.

At the Mufulira mine, ore reserves as at December, 1929, were 45,000,000 tons, averaging 4·68 % copper. The branch railway from Mokambo to Mufulira was completed in September last, and rapid progress has been made in town site construction, plant construction and underground work. The initial plant is being designed to deal with 2,000,000 tons of crude ore per annum, which should produce 75,000 short tons of copper.

I now come to the Rhodesian Selection Trust, which previous to December 1, 1929, selected 21 special grants. On one of the grants, at Chambishi, a large deposit of suphide ore has been proved, where about 25,000,000 tons, averaging about 3·8 % copper, is already indicated. On another of the grants, Baluba, has been proved approximately 25,000,000 tons of approximately 3·22 % ore. Drilling is being done at Luansobe.

Mr. A. Chester Beatty seconded the resolution, which was carried unanimously.

The Chairman next moved : "That the capital of the company be increased to £3,750,000 by the creation of 1,000,000 new shares of 5s. each, ranking pari passu with the existing shares in the company's capital."

Mr. J. G. Lawn seconded the resolution, which was unanimously adopted.

RHODESIA BROKEN HILL DEVELOPMENT CO., LTD.

Directors : Sir Edmund Davis (*Chairman and Managing Director*), Sir E. Oppenheimer, E. Birkenruth, Sir A. S. T. Griffith-Boscawen, C. Hely-Hutchinson, Cromwell Hockley, L. A. Pollak, Lieut.-Col. C. H. Villiers. *Consulting Engineers :* Rhodesian Anglo American Ltd. *General Manager :* R. H. Stevens. *Secretary :* A. H. Watts. *Office :* 19, St. Swithin's Lane, London, E.C. 4. *Formed :* 1910. *Capital issued :* £2,261,283 3s. in 5s. shares.

Business : Operates lead-zinc deposits in Northern Rhodesia.

The ordinary general meeting of the members of the Rhodesia Broken Hill Development Company, Ltd., was held on August 11, 1930, at Cannon Street Hotel, E.C., Sir Edmund Davis (Chairman and Managing Director of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1929, said : As far as the production of zinc is concerned, we are now producing on the basis of about 20,000 tons per annum, which is in accordance with our forecast of August last, when I stated that the zinc production was 1,081 tons in July, but that a further monthly increase should take place. Our estimate of about 1,500 tons per month has, as you will no doubt be pleased to note, been exceeded for every month of the present year with the exception of February, when it was 1,461 tons, and, although this was the case, the average for the first seven months of 1930 works out at 1,580 tons per month. In the report we have made particular reference to the credit which is due to Mr. R. H. Stevens and his staff for the improved operating results of the plant and to the fact that the production costs are in accord with Mr. Stevens' original estimates. I consider that this is a great achievement in the initial stages of the production of zinc by means of a very elaborate process. It is interesting to note that the zinc extraction for the first five months of the current year was 79·95 %, an improvement of 7·78 % over last year. Another satisfactory feature is the consumption of acid compared with the slab zinc production. In our estimates it was assumed that a production of 2·5 tons of zinc could be obtained for each ton of acid consumed, whereas, during the first five months of the current year the production per ton of acid consumed averaged 2·69 tons of zinc, while in April and May last the ratio averaged just on three tons of zinc to the ton of acid. Structural alterations are now being made with a view if possible to obtaining this production permanently.

In connexion with the recovery of vanadium from our mixed minerals, we shall produce this metal in the form of a fused oxide, which is convenient for shipment and an excellent basis for the manufacturer not only of ferro-vanadium but of all vanadium products. As it will become necessary to have a supply of vanadium-bearing zinc-ore for the vanadium production when the erection of the plant is complete, it was intended last month to start mining ore above the ground level from No. 3 kopje, it being the aim of the management to have available at least one year's supply of ore in dumps on the surface, which is a safe policy, as in some months native labour is very plentiful for the purpose of obtaining additional tonnages, whereas in others, owing to the shortage of labour, a curtailment of mining naturally takes place.

As far as the mine is concerned, the management is satisfied that there are now known, but not blocked out, reserves above the 225 ft. level for over 14 years' supply of ore for the existing plant, and, say, within the next three to four years, when mining operations will have penetrated the various known ore occurrences, the opportunity should then be more advantageous for conducting development work to keep reserves ahead of the ore consumption. During the year under review we have completed the prospecting of Nos. 5 and 6 kopjes ore-body, which has resulted in adding 350,000 tons of good quality zinc-lead sulphide ore to the reserves between the 225 ft. and 800 ft. levels, with every indication that the ore-body extends to still greater depths.

The power installation at Mulungushi has been operating satisfactorily. We have expended a large amount, roughly £60,000 to date, on completing the new canal, and on creating additional diversion embankments and storm channels on the escarpment above the power generating station for the purpose of giving added protection to the building and equipment during heavy rains.

In conclusion, I wish to state that we are making various improvements in the plant, which should lead to a reduction in the cost of production of zinc, and though such reductions may only be slight, they are evidence of the care which is being taken by Mr. Stevens and his staff to reduce cost wherever possible. We are producing zinc at a cost within our estimates, and when the vanadium plant is at work this cost should be again reduced and add to the profits which are being made notwithstanding the extraordinarily low figures now ruling for metals, no doubt due to world overproduction. As our zinc is sold at a satisfactory premium, with an increase in the price of spelter and the sale of fused vanadic acid, satisfactory profits should be made.

We should like to convey, not only on behalf of the Board but from all of you, our thanks to Mr. Stevens and his staff for having erected and accomplished the successful running at Broken Hill in Northern Rhodesia of such a complicated plant, an achievement more satisfactory than we ever expected to obtain.

I think you will have noticed by the names of the members who are on the Board that most of us have visited the property, and it was with great pleasure that we learned that Sir Arthur Griffith-Boscawen, also one of the directors of the company, was able to visit Broken Hill during the current year, and all the information he has brought back has been of a most satisfactory nature. At present six of the members of the Board have visited the property, which is of great use to the Board as a whole when considering any subject which may have to be dealt with and any recommendations made from the other side.

Mr. Cromwell Hockley seconded the resolution, which was carried unanimously.

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