The Mining Magazine

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Published on the 15th of each month by Mining Publications, Limited, at Salisbury House, London, E.C. 2.

Telephone : *Metropolitan* 8938. Telegraphic Address : *Oligoclase.* Codes: *McNeill,* both Editions, *& Bentley.*

Branch Offices { New York : Amer. Inst. M. & M.E. / Chicago : 360, N. Michigan Blvd.

Subscription { 12s. per annum, including postage. / U.S.A., $3 per annum, including postage.

Vol. XLVII. No. 4. LONDON, OCTOBER, 1932. PRICE ONE SHILLING

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EDITORIAL

THIS year's recipient of the Redwood Medal of the Institution of Petroleum Technologists is Dr. Edeleanu, to whom it has been awarded in recognition of his discovery and development of a process of extracting mineral oils by means of liquid sulphur dioxide.

DR. HAROLD MOORE, for many years Director of Metallurgical Research at Woolwich, has been appointed Director of the British Non-Ferrous Metals Research Association in succession to Dr. R. S. Hutton, who has proceeded to Cambridge to take up the newly-created Goldsmiths' Professorship of Metallurgy.

MEXICO'S reputation as a silver-producing country is already widely known, but perhaps it is not so well realized that it has potentialities as a producer of gold. In this issue Mr. Lynwood Garrison, who will be well known to many of our readers, examines Mexico's position as a precious metal producer and puts forward a plea for the reintroduction of a bimetallic monetary standard.

A NEW session at the Sir John Cass Technical Institute was inaugurated on October 6, when the customary address was given by Viscount Burnham. After the ceremony the several departments were thrown open for inspection. The institute makes a specialty of evening classes for those who are engaged in business during the day and affords facilities for education in chemistry, metallurgy, geology, and oil technology.

THE likelihood that new taxation would be imposed in Kenya was discussed in the August issue of the MAGAZINE in the course of a review of the report of Lord Moyne. The recent imposition of a so-called non-native poll tax in Tanganyika has aroused the fears of the white population of the other East African colonies, where it is suggested that organized opposition may be set up to delay the imposition of further taxation until governmental costs have been considerably reduced.

MINERAL production in the United States during 1931, as shown by an advance summary issued by the Bureau of Mines, declined in value by 33 per cent. when compared with that for the previous year, the output of metallic minerals falling by as much as 42 per cent. in value. Silver, copper, lead, zinc, and iron all showed substantial declines in quantity as well as in value, but increases were recorded by gold, tungsten, and chromium, mercury exhibiting a rise in quantity, but a fall in value.

REFERENCE was made in the MAGAZINE for August to a proposed aerial survey of the Rand. We learn from the *South African Engineering and Mining Journal* that this is not correct, but our contemporary adds that, although the project has not been seriously considered, " as regards the eastern and western extremities of the Rand, an aerial survey would probably be of value from a mining point of view." The statement of our Johannesburg correspondent may, therefore, only be an intelligent anticipation of events.

IN 1928 the publication of " A Sketch of Malayan Mining " gave mining men a glimpse of Mr. J. B. Scrivenor, until lately the geologist to the Federated Malay States Government, in a lighter mood and served to reveal his undoubted talent as a writer to a wider public. That Mr. Scrivenor is taking his retirement seriously is evidenced by the appearance of " Brigade Signals," [1] in which he describes some of his war experiences. The book makes entertaining reading and Mr. Scrivenor's many friends will welcome a work which not only deals with the activities of the Royal Engineers in war time, but admirably illustrates the author's character.

AN inquiry into the cause of an accident at the Witwatersrand Gold Mining Company's mine on June 11, when two Europeans and five natives lost their lives, is said to have disclosed features not previously encountered on the Rand and

[1] " Brigade Signals." By J. B. Scrivenor. Oxford: Basil Blackwell. Price 6s.

in order to examine the possible existence of a new mining hazard on the field a fresh inquiry has been ordered. The men involved were members of a party drilling into old workings of the Knights Central Mine in search of water. When the last hole was drilled a flow of water, estimated at 18,000 gallons an hour, resulted, but the workers were overcome by fumes which, it is suspected, were given off by the water and the nature of which it will be the business of the second inquiry to ascertain.

Sir Ronald Ross

By the death of Sir Ronald Ross the world has lost the most widely-known of the pioneers responsible for the advance of modern knowledge in the field of tropical medicine. His name will always be associated with the remarkable discoveries which proved conclusively that malaria was conveyed to human beings by the anopheles mosquito, thereby immediately revolutionizing the views of the medical world of his time and indicating directly the means by which the dread disease might most effectively be fought. The effect of his work on the spread of modern civilization is so great as to be almost immeasurable. The building of the Panama Canal was, for example, a project made easy of fulfilment when the fever-infested region to be penetrated had been made safer for the white man. Certain it is that Sir Ronald's work served to show, more clearly than anything achieved before, the benefits that might accrue to mankind by the application of the results of careful scientific research and his discoveries must have meant the saving of millions of human lives.

Ronald Ross was born in India, the son of an Indian Army officer, and, after training at St. Bartholomew's Hospital, he entered the Indian Medical Service in 1881. His routine work in connexion with the Service left him little time for private investigations, but served nevertheless to bring him closely in contact with the ravages of malaria and to arouse in him a desire to discover how the disease was spread. The contemporary notions of an impalpable miasma pervading the marshy regions of the tropics seemed insufficient to explain the transmission of the disease to the blood of a healthy human being and, with the knowledge that the fever was caused by the presence of a parasite in the blood, his work became centred on the discovery of the agent responsible for carrying the parasite from infected to healthy patient. At this stage in his career he received great stimulus from the privilege of consultation with another of the great pioneers of tropical medicine, Sir Patrick Manson, and the line of work then suggested to him was ultimately destined to prove extremely fruitful. Working on the idea that the mosquito might prove to be the carrier, it was still long before the final discovery was made that a certain type of mosquito—the anopheles—was alone responsible. Once this important fact had been discovered the first step in malaria control had been taken, since it became one with the control of the anopheles mosquito, the chief use of quinine from this time on being that of a prophylactic. Although the discovery had been made, the world had yet to be convinced, and it was many years before he was able to clear Ismailia of the disease and free the Suez Canal. His work in Egypt, however, was not long in being recognized and he subsequently went to Panama as adviser in malarial control, a work which was carried out with conspicuous success by the co-operation of the United States medical authorities. Leaving the Indian Medical Service in 1899, Sir Ronald joined the Liverpool School of Tropical Medicine and was largely responsible for its growing prestige in the early years of the present century. His subsequent work during the War and at the Institute bearing his name, founded at Putney in 1926, received but belated recognition and his financial worries were only relieved shortly before his death, by the aid of voluntary subscriptions willingly forthcoming, in recognition of the inestimable value of his life-work to humanity.

The burden that malaria has added to the load of the white worker in the tropics is enormous and the rapid advance of white colonization in various parts of the world can only be said to have commenced with the discovery of the causes of malaria. The reputation of the west coast of Africa, for example, as the "White Man's Grave" rapidly disappeared as the country grew to be a thriving colony when once the nature of malaria and the manner in which it could be controlled were fully understood. The white pioneer has still to go into places where malaria cannot be brought under control—as, for instance, during prospecting and exploration work—but once a project has

been located the site can be cleared and made safe for all time by the methods made known to the medical world in the discoveries of Sir Ronald Ross. His name, therefore, can be linked with mining in many parts of the world where healthy camps are now established and it was, indeed, fitting that an expedition from the Ross Institute, under Sir Malcolm Watson, should have been given the task of clearing the Northern Rhodesian mines of this disease. Truly he deserved well of his generation.

Metalliferous Mining in Britain

Extensive reference to the prospects of metalliferous mining in this country and to the directions in which assistance from public funds might be most profitably applied for its resuscitation was made in the August issue of the MAGAZINE in the course of a review of the report of the Advisory Committee for the Metalliferous Mining and Quarrying Industry for 1932. The opportunity to return to the subject is occasioned by the appearance of the report of the Mines Department [1] on Metalliferous Mines and Quarries for 1931, which not only deals with the health and safety of the workers, but contains, in addition, a great deal of general statistical information as to the size and nature of the mineral workings.

The quarrying industry occupies first place in the report and certain developments clearly show how the depressed conditions at present prevailing are being countered. The demand for extensive supplies of crushed material for road and building work has encouraged large-scale quarry operations and the adoption of mechanical appliances. Since the pre-war period, it is stated, the output of mineral from the quarries of this country has increased by three-sevenths and, although the number of quarries at work has declined by one-fifth, the average output of each quarry has increased by three-fourths. The reports of the various divisional inspectors continue to emphasize the manner in which steam is being displaced by electrical power, which is not only used for the operation of crushing and grinding plant, but also for that of cranes and mechanical excavators, and it is estimated that nearly three times as much electricity was consumed in the quarrying industry in 1930 as in 1924. Employment during the year under review was considered to be fairly good, and was much as in the previous year, 266 days having been worked. It is gratifying to note that except for the years 1921 and 1922 the fatal accident rate in quarries has never been so low as it was in 1931 and it is felt that the good effects of the safety-first campaign are still being experienced. Altogether it can be accepted that the position of the industry is such that it could hardly fail to profit by any improvement in general trading conditions.

Activity at the mines coming under the Metalliferous Mines Regulation Acts was much curtailed during 1931, the continued and serious decline in the price of non-ferrous metals having a marked effect on employment, in spite of the beneficial effect of the departure from the gold standard in September of the year under review. For the year there were 277 mines at work, as compared with 310 in 1930, the aggregate value of the mineral raised falling by £1,096,000 to £2,136,000, while the average number of men employed fell from 13,417 to 9,773. These figures apply to most sections of the industry, the output of iron ore, for example, being over 40% lower than in 1930, while work on non-ferrous mines was much curtailed, although a notable exception to the general decline was furnished by the increased production of dressed lead ore, chiefly in Derbyshire. In addition, the production of minerals associated with non-ferrous ores, such as barytes and fluorspar, was substantially less than in 1930, as was the output of other products, such as potter's clay, rock salt, slate, and gypsum. In dealing with the health of the workers in the metalliferous mines it is recorded that the position with regard to dust prevention notably improved during the year. In the slate mines dust traps of an improved type are now extensively employed for use with power drills and means have also been found to collect the dust made in the course of sawing and splitting operations, while in the dressing sheds good results have been obtained by insistence on periodical sweeping of the working places and the plentiful use of water. In the northern mining division dust traps or respirators are now in use at the smaller mines where the installation of water is not practicable. Speaking generally, it may be said that mine managers are paying increased attention to ventilation and have

[1] Reports of H.M. Inspectors of Mines and Quarries: Metalliferous Mines and Quarries: H.M. Stationery Office. Price 9d.

successfully introduced the use of auxiliary fans in mine workings, headings, and confined places. As with the quarrying industry, there is evidence that all-round efficiency of operation at the larger undertakings continues to improve and the industry only awaits the return of better prices for its output.

Gold in Canada

To the gold of the Rand and of other parts of Africa attention has frequently been directed in the MAGAZINE, while last month, in the course of a review of mining in British Columbia, some account was given of the gold-mining activities in that province. Canada as a whole, however, now claims notice by reason of the appearance of a bulletin [1] issued by the Department of Mines which is devoted to the gold-mining industry of the Dominion. The importance of gold at the present time has on several occasions been emphasized in these columns, yet the department concerned in the production of the present bulletin has chosen such a commendably opportune moment for its publication as to deserve some notice, the importance of the subject-matter being sufficiently obvious when it is remembered that Canada as a gold producer is second only to South Africa.

In the introduction to the bulletin Mr. John McLeish, Director of the Mines Branch, describes it as an attempt to present in brief form such a picture and description of the industry as will show the extent of mining and production operations now in progress at the principal mines. The records and descriptions are prefaced by short discussions of such topics as the properties of gold and its mode of occurrence in nature, the history of its use in the arts and commerce, the history of world production, the types of ore from which it is recovered, and the history of its production in Canada. The value of the book has been increased by the simultaneous production by the Geological Survey of a companion volume descriptive of the gold occurrences of the Dominion. Gold was first discovered in Canada early last century and up to 1895 the greater part of the metal produced came from the British Columbian placers, although there was substantial production from the Nova Scotian mines and the placers of Quebec. In 1896 the discovery of rich placers on the Klondike River in the Yukon initiated a second period of intensive gold production, which was at its peak in 1900, when the Canadian output reached 1,350,057 oz. From this period to 1909 the industry showed a continuous decline, but with the discovery of the Porcupine field the country then entered its third and most important period of gold-mining activity, which has yet to reach its zenith. The success attending the developments of the Porcupine and Kirkland Lake areas served to intensify the search for gold and in 1924 the Rouyn field was discovered, which resulted in Quebec becoming the second largest producer of gold in the Dominion, while discoveries in Manitoba have made the output of that province almost equal to that of British Columbia. Examination of the statistics of production show that during 1930 auriferous quartz mines contributed 84·8% of the total production, Canadian smelters in base bullion and blister copper recovered 8·2%, gold in ore treated abroad amounted to 5%, while the alluvial deposits contributed only 2%, the total output for the year being 2,102,068 oz., a figure which in 1931 had grown to 2,695,209 oz.

An examination of the statistics available for 1930 shows that in that year the Union of South Africa contributed about 53·5% of the world's output of gold, Canada 10·43%, the United States 10·42%, Russia 6·5%, and Australia 2·3%, and there is at the moment no indication that this position is likely to undergo much change. It may be many years before the Rand output begins seriously to decline—especially if the low-grade ore is dealt with—while the Canadian output, if it does not show any considerable increase on its present figure, should be maintained for some time to come. The Porcupine and Kirkland Lake fields, which in 1931 produced 74·7% of the total output, are expected to continue to be the predominating factors, and it is worth noting that the increase in their production in 1931 over that of 1930 was practically equal to half the total output of all the other gold-producing mines in Canada in the former year. An industry built up on the pertinacity of courageous explorers may be held to be deserving of success and the important gold-mining industry of the North American Dominion is a worthy monument to the old-time pioneers.

[1] Gold in Canada. By A. H. A. Robinson, Canadian Department of Mines Publication No. 730. Price 20 cents.

REVIEW OF MINING

Introduction.—The publication of the satisfactory final results of the War Loan Conversion scheme and the partial lifting of the Treasury embargo on new capital issues have served somewhat to clear the air and indications that public confidence in the future of industrial investments is growing are not lacking. There is still uneasiness, however, over the continued depressed condition of world trade and much is hoped from the world conference on monetary policies which is to be held in London this autumn.

Transvaal.—The output of gold on the Rand for September was 912,870 oz. and in outside districts 48,631 oz., making a total of 961,501 oz., as compared with 991,322 oz. in August. The number of natives employed in the gold mines at the end of the month totalled 216,398, as compared with 217,658 at the end of August.

The report of the Sub Nigel, Ltd., for the year to June 30 last shows a profit of £831,964, which, added to the sum of £46,869 brought in, gives an available total of £878,833. Of this amount £562,500 has been distributed as dividends, equal to 7s. 6d. per share, £69,954 spent on equipment and shaft sinking, £141,048 set apart for taxes, £61,332 paid to the Government as participation in profits, and £1,481 paid on miners' phthisis account, leaving a balance of £42,518 to be carried forward. The ore milled during the year amounted to 435,700 tons, against 378,000 tons for 1930–31, the yield falling from 17·648 dwt. to 17·207 dwt. per ton. The ore reserves at June 30 last were estimated to be 1,320,000 tons, of an average value of 17·6 dwt. over a stoping width of 29 in., as compared with 1,206,000 tons, averaging 17·3 dwt. over 27 in., at June 30, 1931.

The New Modderfontein company during the year to June 30 last showed a profit of £1,851,615, making, with the balance of £242,082 brought in and other items, an available total of £2,094,572. Of this amount £1,505,000 was distributed as dividends, equal to 107½%, and, after making allowances for taxation and other purposes, there was an unappropriated balance of £220,246 to be carried forward. The tonnage milled during the year reached 2,000,000, against 1,934,000 in the previous year, the yield falling, however, from 8·667 dwt. to 7·881 dwt. per ton. The available ore reserves at the end of the year showed a further shrinkage, being estimated at 6,009,500 tons, averaging 7·7 dwt., as compared with 6,789,000 tons, averaging 8·0 dwt., at June 30, 1931.

The report of Modderfontein East, Ltd., for the year ended June 30 last shows a total profit of £197,868, making, with the sum of £167,428 brought in, an available total of £365,296. Of this amount dividends equal to 20% absorbed £186,161 and, after making allowances for taxation and other items, there remained a balance of £148,316 to be carried forward. During the year 880,000 tons was milled, as compared with 850,800 tons the previous year, the yield falling from 5·87 dwt. to 5·855 dwt. per ton. The available ore reserves at June 30 last were estimated at 1,997,000 tons, averaging 6·0 dwt., as against 1,985,600 tons, averaging 5·9 dwt., at the end of the previous year.

The accounts of Nourse Mines, Ltd., for the year to June 30 last show a profit of £84,135, which, added to the £80,800 brought in, gave an available total of £164,935. Dividends equal to 7½% were paid, absorbing £58,775, while £33,455 was spent on capital account. After accounting for taxation and other items, there remained a balance of £65,974 to be carried forward. During the year 841,500 tons of ore was milled, against 805,400 tons in the year to June 30, 1931, the yield rising from 5·906 dwt. to 5·974 dwt. per ton. The available ore reserves at the end of the year were estimated to be 1,501,900 tons, averaging 6·1 dwt., as compared with 1,413,500 tons of the same value at the end of the previous year.

During the year ended June 30 last the Consolidated Main Reef Mines and Estate, Ltd., made a profit of £187,144, which, added to the sum of £128,585 brought in, gave an available total of £315,729. Dividends equal to 12½% were paid during the year, absorbing £151,542, and, after allowing for Government taxation and other items, there remained a balance of £125,707 to be carried forward. During the year 820,100 tons of ore was milled, as compared with 773,800 tons for 1930–31, the working profit increasing from £173,706 to £180,639. The available ore reserves at June 30 last were estimated to be 1,793,740 tons, averaging 6·8 dwt., as compared with 1,936,560 tons, averaging 6·9 dwt., at the end of the previous year.

Accidents at two of the Rand mines were

reported last month. At the Rose Deep a pressure burst in No. 1 vertical shaft did such damage as was likely to put the shaft out of commission for at least two weeks, although, fortunately, no one was injured. At the Simmer and Jack mine, however, a runaway truck on the Milner main incline was responsible for the death of three natives and for injuries to three others, while timber was extensively damaged. It was expected that repairs to the incline would take about a week.

The accounts of the Johannesburg Consolidated Investment Co., Ltd., for the year ended June 30 last show a profit of £359,675, so that, with the sum of £166,685 brought in, there was an available total of £526,360. A dividend equal to 1s. 6d. per share was paid during the year, absorbing £220,706, while £150,000 has been placed to a special currency reserve account, leaving £155,654 to be carried forward.

Diamonds.—At a conference of diamond producers held in Brussels last month it was stated that an agreement on sales policy had been arrived at, an announcement which has restored a certain amount of confidence to the diamond market.

Southern Rhodesia.—The output of gold from Southern Rhodesia during August was 49,254 oz., as compared with 47,331 oz. for the previous month and 43,292 oz. for August, 1931. Other outputs for August last were : Silver, 8,245 oz. ; coal, 35,744 tons ; chrome ore, 764 tons ; asbestos, 1,044 tons.

During the year ended June 30 last the Sherwood Starr company made a profit of £26,711, which, added to the sum of £16,084 brought in, gave an available total of £42,795. Of this amount £30,000 was distributed as dividends, equal to 30%, leaving a balance of £12,795 to be carried forward. The tonnage milled during the year was 56,800, against 56,000 in the previous year, the revenue per ton falling from 45s. 11d. to 36s., owing to the treatment of ore of a lower grade. The reserves at the end of the year were estimated to be 246,000 tons, valued at 44·5s. per ton, as compared with 151,300 tons, valued at 46·6s. per ton, at the end of 1930–31. During the period under review No. 1 shaft was sunk a further 383 ft. in depth, while No. 2 shaft was deepened by 195 ft. and is now fully equipped to the 14th level.

At an extraordinary meeting of the Cam and Motor Gold Mining Company to be held following the ordinary general meeting this month it will be proposed that the capital be reduced from £750,000 in £1 shares to £468,750 in 12s. 6d. shares by the return of 7s. 6d. capital per share. The report of the company for the year to June 30 last is covered elsewhere in this issue.

The accounts of Southern Rhodesia Base Metals Corporation for the year to March 31 last show a loss of £15,617, increasing the debit balance brought in to £54,604. No provision has been made for the redemption of the cost of the Alaska mine.

It was announced this month that the Rhodesian Corporation has been informed that the application of the Globe and Phœnix company for a stay of action has been refused and that the hearing will take place next January.

Northern Rhodesia.—At a meeting of shareholders of Rhokana Corporation, Ltd., held last month, resolutions proposing an increase of the capital to £2,520,000 by the creation of 520,000 new £1 ordinary shares were approved. The new shares, together with the 571,411 ordinary still unissued, will enable the directors to fulfil their offer to purchase the outstanding debentures.

Nigeria.—During the year to March 31 last Tin Fields of Nigeria, Ltd., made a profit of £41, increasing the balance brought in to £90. The output of tin concentrates for the year was 63·687 tons, as compared with 96¼ tons in the previous year, the average price realized being £69 12s. 5d. per ton, against £68 5s. 10d.

The accounts of Rukuba Tin Mines, Ltd., for the year ended March 31 last show a loss of £377, increasing the debit balance brought in to £4,628. Production during the year totalled 26¼ tons of concentrates, against 41¼ tons in the previous year, the average price realized being £70 2s. 2d. per ton, as compared with £69 3s. 9d.

Gold Coast.—Shareholders of the Ashanti Goldfields Corporation were informed last month that the cross-cut on No. 11 level S.W. has cut the Cote d'Or reef at 971 ft. from the Obuasi foot-wall side-tie, the width at the point of intersection being 4 ft. and the average value 2·6 dwt.

A circular to shareholders of Ariston Gold Mines (1929), Ltd., issued last month, contained a report by Messrs. Powell and Brodigan, the consulting engineers, who expect the connexion of the two shafts to be completed in November next, when the reserves should approximate 230,000 tons of the present grade. When connexion is completed it is expected that the monthly

output of the mine should be between 7,500 and 8,000 tons.

Australia.—The accounts of the Broken Hill Proprietary Company for the year to May 31 last show a profit of £103,720, after providing £252,590 for depreciation and £47,419 for debenture interest. It is stated that working options have been taken over several gold-mining properties and that prospecting is being carried out.

The gold production of New South Wales for the six months ended June 30, 1932, is estimated at 14,141 oz., valued at £60,068, as compared with 7,047 oz., valued at £29,934, in the corresponding period of 1931.

Shareholders of the Wiluna Gold Corporation, Ltd., were informed last month that experiments with new flotation reagents have been very encouraging, especially in the treatment of sulphide ores, a factor which should become of increasing importance to the company.

Important developments at the Great Boulder Proprietary mine have been announced during the past month. Cross-cutting west from section 52 on the 1,650-ft. level X lode showed a body of ore 30 ft. west of the level which was 6 ft. wide and which assayed 22 dwt. This lode is believed to be new and probably to be a continuation of the old X lode of the Boulder Perseverance mine. Meanwhile work on the 1,450-ft. and 1,800-ft. levels continues to reveal the importance of the new X lode.

It was stated early this month that labour trouble had developed at the Sons of Gwalia mine owing to the dismissal of two timbermen. The trouble has since been settled, the mill being restarted on October 7.

Shareholders of Associated Northern Blocks (W.A.), Ltd., have been informed that the company has granted an option over the Iron Duke lease at Kalgoorlie to an Australian company.

India.—Further dividends were announced last month by companies operating on the Kolar goldfield. The Champion Reef company is to pay an interim dividend of 1s. 3d. per share, while shareholders of the Mysore company receive 6d. per share.

A circular sent this month to the share and debenture holders of the Indian Copper Corporation gives notice of an extraordinary meeting to be held on October 19 when proposals for obtaining the new finance necessary for mill extensions will be submitted for approval.

Mexico.—The report of the El Oro Mining and Railway Company for the year to June 30 last shows a profit of £19,779, which, added to the sum of £12,221 brought in, gives an available total of £32,000. A dividend of 3d. per share is recommended. At the Noria mine 183,709 tons of ore was milled, and 5,699 tons of concentrates, assaying 13,854 gm. silver, 10·26 gm. gold, 10·34% lead, and 2·03% copper was recovered. The ore reserves at the end of the year were estimated to be 182,813 tons, averaging 528 gm. silver per ton.

Venezuela.—Extracts from a further report by Mr. C. O. Lindberg have been issued to shareholders of New Goldfields of Venezuela, Ltd. Mr. Lindberg has reported that the mines should in a year's time be in a position to supply 500 tons daily to the mill, when he estimates the annual operating profit would be £111,000. The company has, in view of this report, been able to obtain the financial assistance required for expediting development and it is stated that the majority of the debenture holders have exchanged their holdings for ordinary shares in the company.

Shareholders of South American Copper Co., Ltd., have been informed that Dr. Malcolm Maclaren has been asked to visit the property for the purpose of making a comprehensive examination and interpretation of the recent developments at the mine.

Yugoslavia. — Shareholders of Trepca Mines have been informed that the recent earthquake in the Balkans did not affect the company's property, where operations are proceeding smoothly.

François Cementation Company.—The report of the François Cementation Company, Ltd., for the year ended March 31 last shows a net profit of £9,420, which, added to the sum of £44,330 brought in, gave an available total of £53,750. Of this amount £15,000 is required for the payment of preference dividends, while £6,000 has been placed to debenture redemption reserve, leaving a balance of £32,750 to be carried forward. It is stated that, in spite of difficult trading conditions, the demand for the company's services has been well maintained.

Murex.—The accounts of Murex, Ltd., for the year ended June 30 last show a profit of £69,206, which, added to the sum of £28,908 brought in, gave an available total of £98,114. Dividends for the year will absorb £48,960, equal to 35%, and, after making allowance for sundry items, there is a balance of £34,204 to be carried forward.

THE GOLD OF MEXICO

By F. LYNWOOD GARRISON, M.I.M.M.

The author describes something of the past history of gold production in Mexico and endeavours to show how the restoration of a bimetallic currency would benefit not only that country but the world as a whole.

For several centuries Mexico has been the world's largest producer of silver and promises to so continue for years to come. Its yield of gold, however, has been, in comparison, of secondary importance and was apparently never considered as likely to be other than a negligible factor in estimating our future possible supply of this precious metal. The record or history of mining in Mexico is confined almost exclusively to the precious metals and it is long and profoundly interesting. The discovery or invention of the so-called " patio process," by Bartolome de Medina, said to be a Pachuca miner, in 1557, for the amalgamation of silver ores with mercury was an event of outstanding importance, for crude as it was, according to our modern understanding, without it the enormous production of silver amounting, according to Humboldt, to something over two thousand million dollars in value between the time of the Spanish Conquest in 1521 and 1803, would not have been possible. From what one is able to glean by careful reading of Humboldt's and Ward's writings, the ratio of gold to silver in the ores from the old Mexican mines, to whose records Humboldt at least had access, was about one to eleven or twelve. This seems to be quite close to the estimated average ratio of production the world over, which is about one to fifteen and has changed very little even in recent times. There could, perhaps, be no stronger refutation than this to the claim of the mono-metallists that were bimetallism once again adopted the established gold currencies of the world would be swamped and unduly diluted by a vast flood of silver. From pre-historic times silver has ever been the close companion to gold, constituting the twin sister of the precious metals for the basis of the " hard money " so beloved by the common people who toil and till the soil, the only real basis of wealth.

La Paz Mine, Matehuala.

The search for gold by the early Spanish invaders was intense and ruthless. It was their impelling motive, their one and definite purpose to which all others were subordinate, and on the whole the results achieved appear to have fallen short of their expectations, enormous as was their loot. Sword in one hand and the emblems of Christianity in the other, soldiers and priests alike treated the confiding natives with a cruelty that has left in the hearts of modern Mexicans an abiding bitterness, so well exemplified by the impressive paintings of Diego Rivera.

The Spaniards landed first on the Yucatan peninsula, but, finding the natives hostile and no gold near, they sailed further west and began their inland march from a point near the present city of Vera Cruz. From there on the natives were found to possess

some gold and they intimated to the Spaniards that much more was to be had further on in the interior past the giant mountains to the west. Such proved to be the case and the looting and destruction of one of the most wonderful pre-historic civilizations commenced. It has always been something of a puzzle as to where the natives obtained this gold. Was it the accumulation of centuries by a people who valued it simply for its decorative purposes, its winning made possible from lean alluvials by slave labour, or did rich mines exist unexhausted or even unworked ? Up to the present time there are very few evidences in Mexico of there having ever been any gold-bearing alluvials similar to those from which the contemporary natives of Peru, Colombia, and Equador obtained the gold that made those countries famous in the early days of the Spanish destructive incursions in South America. The old Spanish records prior to the revolution of 1813, when Mexico declared her independence, were mostly lost or destroyed and, although Humboldt previously had access to most if not all of them, his published observations do not throw much light upon the original sources of the gold except that which accrued as incidental to the silver mining, which, at the time of his sojourn in Mexico, had reached enormous proportions. It seems unlikely that the Aztecs engaged in lode mining to any notable extent and, as previously intimated, it appears unlikely that the placers yielded anything like such rich returns as those in the countries now constituting the northern section of South America including Peru.

None of the American aborigines appears to have possessed any metallic tools except those of copper before the advent of the Europeans. Hence it has been and continues to be very difficult to understand how the natives could have quarried and carved those great figures and monoliths now to be found in various parts of Mexico and South America. Much of this work is comparable to the Egyptian, Assyrian, or anything else in the world of similar ancient character, but it is known that the Egyptians and probably the Assyrians possessed tools of iron and that they knew how to harden it, just as to within very recent times the wild tribes in the interior of Africa smelted iron and wrought it into tools and weapons, as they probably had been doing for thousands of years. It has been assumed, on no substantial basis, that the ancient American natives knew how to harden copper and that it was a lost art. Undoubtedly the Aztecs had bronze, for there are evidences of pre-conquest alluvial washings in certain localities where tin is known to exist and where it has been mined to a small extent in modern times. It seems unlikely that they hardened copper in any other way than by alloying it with tin and they probably discovered the method accidentally. Cassiterite being very heavy, and easily reduced to metal, was probably thrown into the fire or melting hearth where copper was being melted and the bronze resulted. As far as the author is aware there have been no archæological

La Paz Mine : Sorting Ore on the Dumps.

La Paz Mine : Cutting "Chicken Ladders."

discoveries which would indicate any knowledge of smelting or the use of iron on the part of the pre-historic natives in any section of the American continents, north or south.

Although the amount of gold which Cortes and his followers found the natives to possess was undoubtedly large, it seems more than probable that it was an accumulation of perhaps centuries, moreover it was valued much less highly than by the Spaniards. It is evident that the gold supply rapidly diminished to enrich the coffers of old Spain and that it was soon replaced by silver, carried to the homeland in the famous galleons which became a synonym for riches in those old pirate days when piracy was not considered ungentle.

The paucity of gold-bearing gravels in Mexico, or, at any rate, the middle section of that great, highly-mineralized, country, can probably be explained on geological grounds, but the subject is highly technical and possibly controversial. There are, however, some general observations regarding its geology that may be stated with advantage. The great, high plateau of Mexico occupies the central mountain area of the country and is composed chiefly of folded and faulted Cretaceous and Jurassic sediments and by eruptive or intrusive igneous rocks. The mountains are mostly of limestone and the valleys are filled with the wash or debris from the erosion of the mountains, in this respect resembling Arizona, Nevada, and other semi-arid parts of the United States, where the valley wash is such a conspicuous feature of the terrain. The Mexican limestones are not Palæozoic as was

The Cathedral, Catorce.

once supposed, but are generally Cretaceous in age. The stratigraphic upheavals in this high plateau appear to be chiefly due to meridional movements at the beginning of the Tertiary and they are manifested by a vast network of faults. These disturbances were accompanied by the intrusion of great masses of igneous rocks, followed by the extrusion of the lavas and tuffs of the southern section of the plateau and the eruptive area extending to the Sierra Madre del Sud. In the southern section more particularly these great movements were followed during the Miocene by outbursts of extrusive rocks that have continued to the present time and on the tableland volcanoes form a notable feature of the area.

Limestone-Shale Contact above Catorce.

It is in these rocks, or relatively close to them, that the great silver deposits (and some of copper) are to be found. Such an association of distorted sediments (limestones and calcareous shales) with the eruptives appears to have offered ideal conditions for mineral deposition, the metallic minerals being certainly derived from the underlying and associated igneous rocks. Over much of this irregular, distorted area of Cretaceous sediments a more or less even surface was developed by erosion, sedimentation, and volcanic discharges, protruding summits forming the nucleus of the plateau as a series of approximately parallel ranges. The Gulf plain is composed mostly of the down-wash from the higher elevations.

On the whole, Mexico has long been considered a silver-producing country *par excellence*, although, for many years, it was fourth in the list of gold-producing countries, being surpassed only by the Transvaal, the United States, and Australia. The largest proportion of this gold came from gold-silver mines and, as a consequence of present world economic conditions, when silver has a value little better than that of a base metal, it has become a serious question to those engaged in the Mexican mining industry as to how to carry on without a complete shut-down. In not a few instances it has had to be decided whether or not it may be possible by some method of operation to increase the normal proportion of gold to the silver rather than to cease operations altogether. Where the ratio of gold to silver is variable or erratic, selective stoping may be used advantageously, but, as every mine operator knows, this practice is sometimes objectionable.

The question has to be debated as to whether the gold will increase with depth or not. In theory, at least, it might be assumed that as the workings approach the associated eruptives, from which it is logically supposed the mineralization has been derived, the content of gold might increase. Lindgren long ago described gold as one of the most persistent of minerals, ranging as it does from the region of high temperatures and pressures to those that prevail at shallow depths. It might also be added that it is one of the most elusive metals, although its presence is widespread in the earth. So in Mexico, although there are in that large country a few mines which are distinctly gold mines, gold occurs

ENTRANCE TO THE OLD MINT, CATORCE.

chiefly with the silver of the Tertiary and is subordinate to the silver as far as quantity is concerned. On the whole, the amount of gold in the precious-metal ores appears to be rather larger in the western cordilleran province, if one may thus differentiate or designate the mountain systems of Mexico, than in the eastern section, where many, if not most, of the great mines have been developed and operated.

It was pointed out by W. H. Emmons [1] some years ago that there is often a barren zone just below many bonanza silver deposits and below some copper, lead, and zinc sulphide deposits, which seems to represent the bottom of many Tertiary precious-metal veins and which is considered an important characteristic. It would seem highly probable that this observation may be considered a general rule for bonanza deposits in Mexican mines, although there are, no doubt, exceptions. Moreover, it is more than likely that exploration in depth has often ceased with the barren zone and nothing is known of what may be below.

Bonanza deposits of this character, carrying considerable quantities of manganese oxides, are common in the Mexican Tertiaries and the question as to what effect these oxides have upon the solution and migration of the gold seems to have been but slightly studied or understood, although it is well known that the presence of manganese salts in the oxidized sections of precious metal deposits has a decided effect upon the solution, migration, and secondary deposition of the gold. The chemical reactions that thus take place are complicated, but can perhaps be simply expressed by the equation :—

$$MnO_2 + 4HCl = 2H_2O + MnCl_2 + 2Cl.,$$

ENTRANCE TO CATHEDRAL, CATORCE.

[1] *Trans.* Am. Inst. Mining and Met. Eng., Feb., 1924.

the nascent chlorine thus evolved, together with other salts not indicated in the equation, having a potent solvent action on the gold in whatever may have been its primary condition, the metal being transported downwards when heat and pressure from below do not prevent it.

The Spaniards appear to have worked in the early days of the Conquest rich surface

Old Office, Catorce, showing Coat of Arms of former Manager.

pockets of gold and to have derived considerable wealth therefrom. There are several localities, which even in later days produced notable quantities of gold, such as the Altar district in Sonora and the Alamo section of Lower California. In the Parral district, State of Chihuahua, for instance, it has been stated that placer deposits of gold were worked by the Spaniards as early as 1556 and at Parral itself others of the same character as early as 1632. Deposits of this superficial character were soon exhausted, however, and it is doubtful on the whole whether the amount of gold derived therefrom was ever large. Such pockets were probably only relatively small alluvial or outcrop accumulations, due to erosion and weathering.

In considering the quantity of gold assumed to have been produced by the pre-conquest Mexicans and Peruvians, it should be borne in mind that these people then placed no monetary value upon gold, although probably they traded this metal among themselves and with other native tribes. They doubtless considered gold and silver simply as beautiful, malleable materials, which were easily worked into ornaments suitable to adorn their persons, their gods, and their temples or shrines, a practice continued to the present day. These American natives possessed an innate artistic sense which continues to be one of the most attractive characteristics of their descendants, the modern Mexican Indians. Gold, they said, resembled the sun, which they worshipped as the giver of life—a very logical deduction, be it observed—while the moon was silver, which they adored in lesser degree.

It is evident that what was lacking of gold in Mexico was more than made good by silver, when the value of that metal bore a fair ratio to that of gold, and Mexico became the world's largest producer of silver. During the old days, at any rate, this enormous yield of silver came from relatively few mines, such as those at Guanajuato, Catorce, Pachuca, and Real del Monte. The famous El Oro mine, 90 miles north-east of the City of Mexico on the border of the State of Michoacan, is distinctly a gold mine, as about 80% of its production is, or was, of that metal. The great silver mines of Mexico closely resemble the once-famous Comstock lode in Nevada. The ratio of gold in the Comstock ores was rather higher than has been commonly supposed, being about 43 to 57 or 1 to 1·3. A remarkable feature of all these great lodes, including the Comstock, is that they appear never to have produced or to have been accompanied by placers or surface accumulations of gold. At Guanajuato it has been estimated by some engineers that the proportion of gold to silver, taking the district as a whole, is, or was, roughly 2 to 3. According to the same authority the dumps of the Veta Madre (the largest mine of the group) sampled $3·80 (American currency) per ton and the

dumps of the La Luz $4·30, of which 50% is in gold, and that the dumps of the Jesus Maria averaged over $4·50, of which 52% was gold.[1]

It is evident that under the present world financial conditions, when the value of silver, as well as of copper and of other base metals, is so low that mines which produce gold as an incidental or secondary product can be operated profitably only with difficulty, perhaps at a loss, or probably not at all, that the outlook for any considerable steady output of gold from Mexico is decidedly unpromising. It is difficult to impress upon those concerned that there is certain to be a very decided shrinkage in the world's normal gold supply required for business and trade. There is no class of men to which this fact is better known than mining engineers and geologists or who know so well that this shortage cannot be expected to be made good by future gold discoveries of major importance anywhere in the world. This question is obviously of fundamental importance and, so it seems to the writer, strikes very close to the root causes of the present universal "depression." It has been estimated that to meet the demands for ever-growing trade and industry the universal stock of gold should be increased each year by an amount equal to about three per cent. of the whole. This is by now fairly well known to be impossible. Moreover not only will the annual gold increment shrink, but in a few years may hardly suffice to cover the inevitable losses consequent on its use as money as well as its irreclaimable consumption in the arts. It should therefore be realized that something which possesses an inherent value must be found to supplement gold. Silver seems to be the only logical and suitable material and it should once again take its place in the western world as a companion or twin sister of gold, in other words become once again one of the "precious metals."

The writer hopes the foregoing dissertation regarding Mexico may throw a little light upon the importance this highly-mineralized country is likely to have when silver is once again restored to its logical place as a world's money metal. These observations may perhaps also give some idea of Mexico's capacity to produce gold, which on the whole cannot be profitably mined at present on account of the desperately low price of silver.

Eastern Section of Catorce at end of Great Tunnel.

Mexico is a country of great interest; its natural resources are large, although possibly at times overestimated. It possesses a native population having a remarkably high degree of artistic sense, which is just beginning to be recognized and which no doubt is an inestimable inheritance from their pre-historic cultured ancestors. Its people are somewhat nervous and very illiterate, which makes their government difficult, a condition doubtless due to centuries of oppression and poverty which they are now striving to overcome. They have, in addition, an abiding hope that their great neighbour on the north will allow them to achieve

[1] Robert T. Hill, *Eng. and Mining Journ.*, April 21, 1904, p. 642.

their future in their own way. The two cultures, Anglo-American and Hispano-American, are so different that it is often difficult for them to agree, although the latter is by far the most American. It is much the weaker and past experience with the former cannot be said to be wholly sympathetic or reassuring to the latter.

THE OPERATION OF A DIAMOND CONCENTRATING PAN

By C. W. WALKER, A.I.M.M.

In this article special reference is made to the 8 ft. pan used in Gold Coast Colony

INTRODUCTION.—Beyond a few statements that concentration is effected by centrifugal force little seems to have been written concerning the operation of a diamond pan, yet opinions differ on this subject even among engineers in charge of diamond plants. A brief account of the history of the pan was given in an abstract of an article [1] which appeared in the MAGAZINE for March, 1928, and from this it appears that the forerunners of the pan were the "baby" and the "cradle." A diagram and description of the pan were given in an article [2] appearing in the MAGAZINE for November, 1929.

DESCRIPTION.—The pan is a cylindrical vessel, 8 ft. in diameter, with an outer wall 14 in. high and an inner wall 11 in. high and 2 ft. 6 in. diameter. A notch is cut in the inner wall 15 in. wide and 9 in. deep and the tailings discharge gate so formed can be built up to any desired height above the pan bottom, usually 4 or 5 in. An opening is also cut in the outer wall of the pan to form a feed inlet, the feed chute being tangential to the pan. The concentrate discharge opening is a circular hole $1\frac{1}{4}$ in. diameter in the bottom of the pan, close to the outer wall, and the discharge is controlled by a shutter. A central vertical shaft carries eight radial, horizontal arms and to each of these arms five tynes are bolted vertically so that, as the shaft revolves, the tynes are carried round in the annular channel between the two walls. Thirty-nine of the tynes are triangular in cross-section with sides 1 in., $1\frac{1}{2}$ in., and $1\frac{7}{8}$ in. respectively, while the remaining tyne is circular in cross-section and $1\frac{1}{4}$ in. diameter. The triangular tynes are fixed with their bottoms 1 in. above the pan floor, and the round tyne $\frac{1}{2}$ in. above the floor, and their positions are arranged so that, starting from the round tyne, which is at the end of one arm, a spiral is formed by tracing the position of each preceding tyne on the leading arm. The short side of each tyne bears against its arm and the long side faces outwards so that the tynes appear as an impeller with an outward thrust.

OPERATION.—The feed to the pan is the undersize from a trommel having a $\frac{5}{8}$ in. screen and in quantity is about 3·7 cu. ft. per minute (in place measurement) with about 60 gals. per minute wash water. The percentage of solids in the feed is, therefore, about 28%. The pan shaft revolves at 13 to $13\frac{1}{2}$ r.p.m. so that the linear velocity of the round tyne is about 310 ft. per minute. The lighter and larger particles find their way to the upper and inner part of the pan and are discharged over the gate. The smaller and heavier particles (the concentrate) remain at the outer part of the pan and work their way to the bottom, where they are discharged intermittently. The ratio of concentration depends on the amount tapped and this amount is fixed by trial as the concentrate varies locally in both quantity and kind, 4% being an average figure. Common minerals of the concentrate are: Diamond, staurolite, ilmenite, rutile, tourmaline, corundum, and rounded lateritic grains of hæmatite and limonite. The tailings consist chiefly of quartz grains.

The capacity of a pan in operation is about 38 cu. ft., made up of about 11 cu. ft. of gravel and 27 cu. ft. of water. The average length of time a particle of gravel stays in the pan, therefore, works out to be about 3 minutes. The stirring action of the tynes creates a vortex and, with a 5 in. gate, the height of the vortex at the outer wall is about 13 in., while, at the inner wall, it is about 7 in. Continuing this surface in cross-section it is found that the vortex centre would be

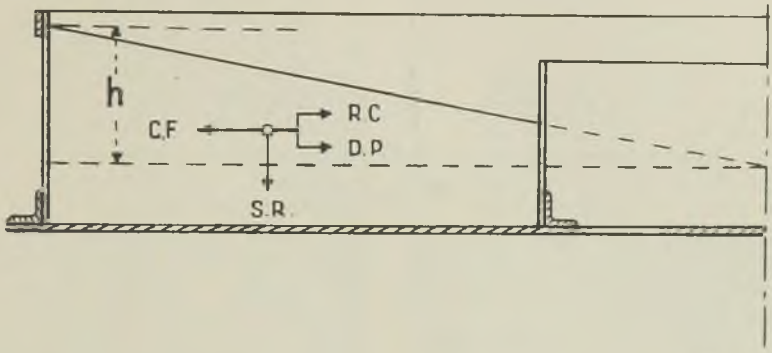
[1] *South African Mining and Eng. Journal*, June 14, 1928.

[2] S. V. Griffith, THE MINING MAGAZINE, November, 1929.

about 4 in. above the pan floor, that is, the vortex head at the outer wall is about 9 in.

Operating Forces.—The path of the "puddle" from inlet to discharge is a spiral. Therefore all particles in the pan must experience a force tending to carry them along the same path. This force can be resolved into two components, one radial towards the centre of the pan and the other tangential. All forces acting on a particle can now be referred to a radial vertical plane, that is a cross-section of the pan, and the first of these is the force mentioned above, which may be called the radial component. This force will vary with the quantity of gravel and water admitted to the pan and the force per cubic inch, towards the centre, on a particle in the pan. Should the angular velocity of any particle in the pan be so low that the centrifugal force acting on it is less than 0·0067 lb. per cu. in. then it will be driven towards the centre by the above force alone. This is analogous to a body rising through water when the downward force of gravity is less than the upward thrust of the water. The above figure is only theoretical, as allowance must be made for the puddle.

The third force acting on a particle is centrifugal force and this varies directly with the mass, the square of the angular velocity, and the radius. If the puddle and the gravel moved with the same angular velocity the



Radial Cross-Section of Diamond Concentrating Pan, showing vortex and illustrating forces acting on a particle: h = vortex head at outer wall, C.F. = centrifugal force, R.C. = radial component, D.P. = difference of pressure due to h, S.R. = settling ratio.

with the density of the puddle. The effect on a particle will depend on its size, specific gravity, and position in the pan, being greater on a larger and lighter particle and on one near the upper surface of the stream where the velocity is greater.

A second force acting in the same direction is that due to the difference of pressure between the water at the outer pan wall and that at the vortex centre, where it is zero. As stated before, the vortex head at the outer wall is 9 in., which corresponds to a pressure of 0·325 lb. per square inch. Thus all particles in the pan will experience a force acting towards the point of lowest pressure, that is the centre. At a distance of 4 ft. from the centre the water has a pressure of 0·325 lb. per square inch. In other words 48 in. of water produce a pressure of 0·325 lb. in a horizontal direction from the centre, so that 1 cu. in. has what might be called a "centrifugal weight" of 0·0067 lb. and this would be second and third forces could be considered as one, acting outwards, but, as this is not the case, they must be considered separately.

The mechanical action of the tynes, other than that of agitating and stirring, is a debatable point and some engineers maintain that they exert an outward thrust on the gravel, particularly on the concentrate, and push it to the outer wall of the pan. The lower ends of the outer tynes wear considerably and, at the end of a week's run, may be only one-quarter the original cross-sectional area. This shows that the gravel near the bottom of the pan has a much smaller angular velocity than that near the surface, so any outward thrust by the tynes would have a greater effect on the lower gravel. At the surface of the puddle there is no apparent outward movement, so, if any concentrate travelled part way to the centre of the pan before settling to the bottom, it is possible that it would then be acted on

by the tynes and be pushed outwards again. The originator of the triangular tyne probably had this in his mind, but the writer cannot say definitely that this action does or does not take place. No doubt the triangular tyne has been compared with tynes of other sections and found advantageous but this is beyond the writer's experience.

The remaining forces acting on a particle are gravity and the upward pressure of the water. These two may be combined under the term "settling ratio" and this is not settling ratio in clean water but in a puddle of variable density with an average of about 1·08. From the foregoing it is seen that large and light particles tend to be carried inward by the radial component and that heavy particles tend to be carried downwards and outwards by gravity and centrifugal force, the settling direction being roughly normal to the surface of the puddle. And, for the efficient working of the pan, it is necessary that the various forces be so adjusted that the above action takes place. The pan, therefore, may be compared with a V-shaped sluice of infinite length with inlets along one steep side, tailings discharge over the other side, which is at right angles to the first, and concentrates collection in the angle between the two sides.

Control of Pan.—The variable factors which control the operation of the pan are :—

1.—Quantity of gravel per hour.
2.—Texture of gravel.
3.—Quantity of water per hour.
} Density of puddle.
4.—Setting of tynes.
5.—Speed of tynes.
6.—Height of discharge gate.

1.—*Quantity of Gravel per Hour.*—The average length of time a particle stays in the pan varies inversely as the quantity of gravel feed per hour and sufficient time must be allowed for the concentrate to settle, otherwise there is the danger of its being carried away with the tailings. Tailings tests show when this limit is reached and the remedy then is to reduce the feed.

2.—*Texture of Gravel.*—The matrix of the gravel may be fine sand or clay or a mixture of the two. The proportions of gravel and matrix vary, also the proportion of concentrate in the gravel. The sandy or "free wash" gravel makes a thin puddle while the clayey or sticky gravel makes a thick puddle. Settling is quicker with a thin puddle and therefore a greater quantity can be treated in a given time. A varying proportion of the feed, when working sticky gravel, is in the form of clay balls and, as these have an average specific gravity of about 1·7, they are carried away with the tailings. A high tailings loss when working this gravel is invariably due to diamonds lost in the clay balls. The thick puddle from this gravel causes slower settling, so that the feed needs to be reduced or the puddle will be too thick for efficient working. Scrubbing or washing before pan treatment would overcome both these defects.

3.—*Quantity of Water.*—The quantity of water must be sufficient to enable the contents of the pan to behave as a fluid. also, as it largely varies the force called here the radial component, it must be sufficient to carry the larger and lighter particles to the centre of the pan, but not sufficient to carry the concentrates to the centre.

Density of Puddle.—The above three factors together vary the density of the puddle and this in turn varies the radial component. Too thin a puddle so diminishes this force that spill occurs over the outside edge of the pan, while with too thick a puddle concentrate minerals will be carried over with the tailings. Between these two limits, which give a wide range, the density of the puddle may vary without affecting the efficiency of the pan. The remedy for too thin a puddle is to mix clayey material with the feed, but increasing the water supply is not a remedy for too thick a puddle as this increases the radial component and the cure is no better than the disease. The only remedy is to reduce the feed.

4.—*Setting of Tynes.*—A "bed" consisting of black sand and silt forms between the bottoms of the tynes and the floor of the pan, and the round tyne, being ½ in. lower than the triangular tynes, makes a groove in the bed, into which the concentrates collect. It is important that the whole area of the bed should be swept by the tynes so that no groove may form other than that made by the round tyne. To accomplish this the tynes must be of uniform length below their tyne arms. Uniform wear on the bottoms of the tynes would still fulfil this condition so long as the ends did not become pointed. The effect would be to raise the bed and this would be equivalent to lowering the discharge gate that amount.

5.—*Speed of Tynes.*—The speed of the tynes, since it governs centrifugal force and the angle of the vortex, must be adjusted to

suit the other forces and, for the size of the pan stated, this has been found to be about 13½ r.p.m.

6.—*Height of Discharge Gate.*—The upper limit for the height of the discharge gate is fixed by the height of the outer wall and the speed of the tynes, because too great a height will cause spill over the edge of the outer wall. For the given height of wall and speed of tynes the maximum height of gate is 5½ in. The lower limit must leave the gate high enough to retain the solid contents of the pan when it ceases operation and it must maintain a working depth of gravel in operation. Taking the latter at five diameters of the largest grains, that is 3⅛ in., and allowing for the bed and wear on the tynes, the minimum is found to be 3½ in. and this also satisfies the first condition, so that 3½ in. is the lower limit. As the height of discharge gate does not affect any of the forces acting on a particle in the pan any variation in the height, between the stated limits, should be equally efficient. All tests carried out so far, within the writer's knowledge, confirm this.

Conclusion.—As a concentrating machine the diamond pan is very efficient, being able to treat about 9 cubic yards per hour with an efficiency of about 96% and the writer considers that it might be usefully employed in the milling of other minerals where the ratio of concentration is comparable with that in diamond milling.

DERBYSHIRE MINING

By LESLIE B. WILLIAMS, B.E. (*Sydney*), M.I.M.M.

(*Concluded from the September issue, p. 158*)

It was not until the reign of William and Mary that the repeal of the statute relating to royal mines was effected. By the time of Elizabeth's death her great venture at Keswick had failed, the famous firm of Haug Langnauer and Co., of Augsberg, who were the principal shareholders and general managers, had retired, and mining in England was at a low ebb. In the reign of James I (second year) all the substance of the grant made to Thurland, Hōchstetter, and others was confirmed to the Company of Mines Royal, and it is significant that during this reign and subsequently until the Restoration there does not appear to have been any real activity in mining. But it was actually going on in Derbyshire.

In Elizabeth's time the name of Rowland Eyre appears in the records of the Duchy Court as representing her in cases where mines or the duties payable on their account were in dispute. He would be her Majesty's Farmer of the Revenues, paying to her a definite sum yearly for the privilege of collecting the duties. In 1613 one of the same name sued a number of miners for the payment of lot and cope on lead ore taken from the manor of Stanton in the High Peak. This case seems to have excited some concern because in 1614 the grand jury of the barmote court of the lordship of Youlgreave and Gratton adjoining Stanton, refused to admit that the lord had the power to hold a barmote court and were only satisfied on that count after being shown a deed dated 1320, which proved the right of the lord to hold the Court. It is perhaps permissible here to digress and deal with some features of this "Court of Barmote" (Berghmoote, Bergmooth, Barmoot, etc.).

In the districts known as the King's Field (or Fee) which includes practically the whole of the Hundreds of the High and Low Peak mining affairs are administered by a sort of warden called the "Barmaster," who is appointed by the Crown and acts in conjunction with the steward, the latter being also an appointee of the Crown, but with duties judicial rather than executive. He is steward of the Barmote Court and must belong to the legal profession. At the time of the commission of 16th Edward I (1288) the former was referred to as the "berghmayster" or "magister del bergmoth." Subsequent to that date the word does not appear often. It is not in common use, but appears to have been confined to legal documents. It has been seen in a copy of a deed executed in 1320, and refers to the office not the official. The word here is "barmestre." It has become Normanized in the space of less than 40 years, if indeed the record of 1288 contains the correct spelling. The official

is "barmaster" in the case quoted by Tapping (Manlove's "Rhymed Chronicle") taken from the records of the Duchy of Lancaster, Vol. 1, No. 4 circa 22 Henry VII, and thence onwards for some time. It is "barmaster" in the time of Elizabeth, of Edward VI, and of James I. It has become "berghmaster" in 1677, which is only a few years after Sir John Pettus borrowed it from the publication of 1645 (and probably the "Rhymed Chronicle" of 1653) where, however, it is "barghmaster" in the text. These latter spellings do not matter.

The functions of the official are stated by Hoover to be approximately identical with those of the German "bergmeister." This would appear to be extremely doubtful. In fact the influence of the Saxon on Derbyshire mining is untraceable to-day. But the functions of the two offices differ in essence. Assuming the word to be correctly spelt in the copy of the original document produced before the House of Lords in the case Duke of Devonshire v. Wall and others, the earliest form is "berghmayster," and his office is that of "magister del bergmoth." Neither of these words appears in any other writing of the time. The word itself is not a form which appears anywhere in Middle English nor in Anglo-Saxon. That it is a variant of "mōte" is certain. This is the Middle English form of O.E. gemōt—an assembly.

The word "bergh" is apparently Middle English "berz"—a hill or mountain, and the word "bergmoth" connotes the "Hill Assembly." What this has to do with mining is not clear, and it has appeared at times as if the word "bar" was the correct explanation, its meaning being simply that of the old Norman word—man. On this basis the implication of the word barmaster would be simply overseer. But the pronunciation of the word "berz" to-day in Yorkshire and Derbyshire is "bargh," shortened to "bar," and it means a steep hill, or a road up a hill, so that it is possible that it was pronounced so in Middle English time and got into the deed referred to as bar.

The circumstances of the use of bergmoth in any case could not have been otherwise than peculiar and what seems to be the most likely explanation is rather long, but as it has not been given before may be worth stating. Long before the Norman came to England it was the custom to call assemblies of men when any important question affecting the common weal was to be discussed, and these assemblies were held under trees and generally on hills where the speakers could be seen and heard.

> Indeed, says Coventry (Watkins on Copyholds by Coventry, 1825), so prevalent was this custom among the Britons that the "top of a hill" of "eminence" became at length significative or a court of justice . . . and vestiges of this custom remain among us to this day in the "moot" or "mute" or "parling" hills still known in various parts of this and "the neighbouring islands."

This establishes pretty fairly the possibility of the "berz-mote"—the hill assembly. What were the circumstances under which it came to be connected with the mines of Derbyshire? Under the feudal law instituted by William the Conqueror, the territories were parcelled out amongst his more important supporters in the first instance. In the reign of Henry III, and indeed until the final defeat of the Barons headed by Simon de Montfort in 1265, the lands in which were included what afterwards became the Hundred of the Low Peak (that is, the Wapentake of Wirksworth) were held by Robert de Ferrers and his heirs. The wapentake passed to the Crown on the failure of the Barons—the representative of the Ferrers family, then Earl of Derby, losing his estates and his state as Earl. Under circumstances such as these, once the lands remained unallotted they were in the demesne of the king himself and, if not suffered to lie waste, were cultivated by his servants, or granted out in small allotments to persons who not being free held under base service called villeinage. The Lord of a Manor—the Mesne Lord—had in addition to his villeins (who were his actual property) a series of followers who held from him by Frank-tenure. The king had none of these Franks. All questions affecting the holding of lands, etc., arising between Frank and Frank were decided at the Court Baron (Court of Men) which was the essence of the Manor. No manor could exist without such a court. These courts were held always in the manor house. They were presided over by the lord, or by his steward. The conduct of the court was in the hands of the bailiff (*ballivus*) and the judges were the Franks themselves, in number according to the size of the Manor. These assemblies were known as the Hall-Mote.

In the case of villeins justice was administered on the same lines, but the Franks could not act as jury because they could not concern themselves with matters

NUTTALL'S PLAN OF 1768, SHOWING YATESTOOP SOUGH AND POSITION OF "NEW FIRE ENGINE" ON YATESTOOP TITLE.

between the lord and his bondmen. These courts, known as customary courts, were not held in the Hall. The lord held them wherever he wished, but generally on one of the hills. These were known as "places" (from placitum—a plea) that is—where pleas were heard.

An important difference arising out of the status of the men is this (and it is, to be noted in connection with the barmote courts) that the Frank tenants could not be sworn. They were not juratores. The villeins were always sworn, but the villein was not judged by his peers. They formed the jury, but the lord was the judge. It is from this class apparently that the jury of twenty-four—the body of the mine was ultimately derived. All the affairs of the estate in so far as they excluded those of the Frank tenants were settled at these courts. In the case of the forests the lord presided over the juratores (and these held only by base tenure) and his steward and bailiff were present. Assuming, therefore, that lead was of value, those who desired to do so could, no doubt, hold the right from the lord in the usual way of villein tenure, and the "magister del bergmoth" or customary court would act for the lord to see that the latter was

not defrauded. He was a bailiff (ballivus) of the Franchise or the Liberty.

Cowell says :—

> These ordinary bailiffs were of two sorts—"bailiffs errants" and "bailiffs of franchises." These be those that be appointed by every lord within his Liberty . . . There be likewise bailiffs of husbandry belonging to private men of great substance who seem to be so-called because they dispose of the under-servants, every man to his labour and task, check them for misdoing their business, gather the profits to the lord and master and deliver an account for the same at the year's end or otherwise as it shall be called for.

The functions of the berghmayster, too, have varied so little in the course of time, from these, that there can be no doubt but that he was a bailiff appointed by the lord and that the men had no say whatsoever in that appointment.

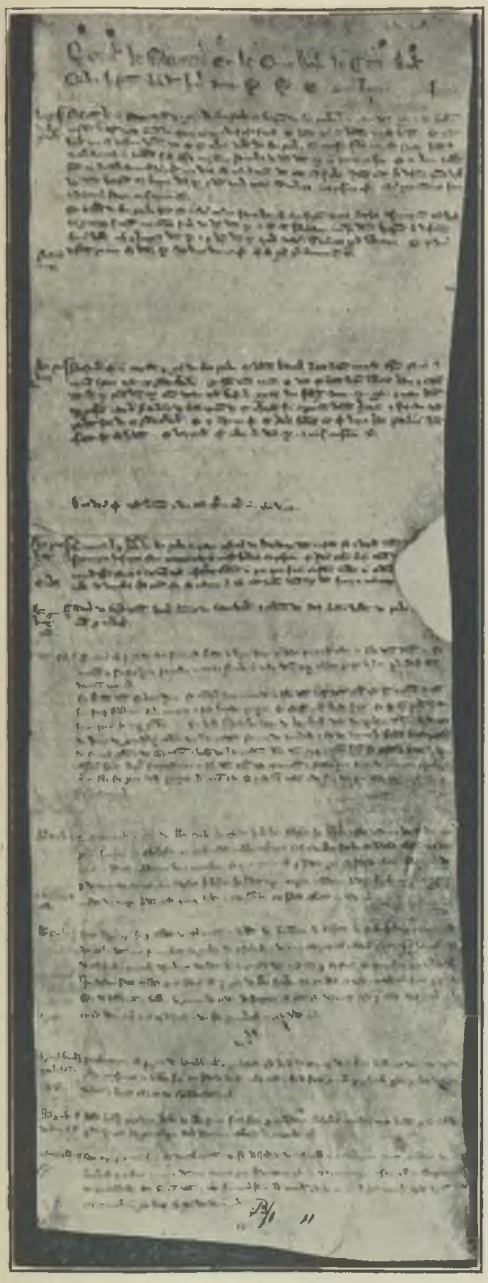
In the case of the King's Field, therefore, there was no Mesne Lord, and, ipso facto, there could be no Frank tenants. There would have been, however, a few years before when the Earl of Derby held this land *in suo dominio*. But to hold any right by payment in kind was pure villeinage, as opposed to holding by service.

The findings of the commission of 1288 therefore point to the probability that villeins owned by the king and previously perhaps by the dispossessed lord were mining for lead under the usual conditions of base tenure, modified to suit the particular conditions. Edward I could not have sent Frank tenants to Devon. They must have been villeins. Those findings embody the conditions usual between Mesne Lord and base tenant, husbandry being exchanged for mining. If it had not been for the mere accident by which the wapentake of Wirksworth passed into the hands of the king and was not handed out to another lord, there would have been no basis for any uniform set of customs. These would have been simply customs of the manor. The Hundred of the High Peak did not become the property of the king till Edward III's time, therefore the customs claimed in 1288 did not apply to this section. The wapentake of Wirksworth therefore became the cradle of the customs because no other field was available nor subject to the same circumstances. The necessary conditions were that lead should be found and that the land should be a "feod" (*feudum*) of the king himself. The barmaster therefore was in no sense a *præfectus* or *procurator*. He was simply the lord's bailiff and his duties were those of a sort of warden acting for the Lord of the Soil. Except in the King's Field to-day all barmasters are appointed by the particular Lord of the Manor.

With the inclusion of the High Peak in the King's Field an anomaly is apparent. In the findings of the commission of 1288 (16, Edward I) it is set down that a measure (*meta*) of ground to which the miner (*mineritor*) was entitled should be four perches (*quattuor perticatae*) and for his shaft (*ad suam foveam*) seven feet. The lineal perch was 24 ft. in length in Staffordshire and this has been established since in the courts. But the "measure" to-day and for long periods past has been 96 ft. only. The seven feet are not allowed. This is in the wapentake of Wirksworth or Low Peak. In the High Peak the miner gets 87 ft., that is four perches and seven feet, the perch in the High Peak being apparently 20 ft. (it differed in various parts of England from 13½ ft. to 27 ft.). Seemingly the miner in the High Peak got his allowance of seven feet along the vein for his shaft.

The right to search for mines was as old as the Romans at least, and the right of the Lord of the Soil probably older still. The control by the magister del bergmoth was essentially feudal. The customary courts came in with the Normans whose system of administering justice was identical. When the Ashbourne commission recorded its findings for the king's benefit it set out, for the mining of lead, conditions which applied to all other forms of labour on the manors with one exception, which was the implied right of the miner to look for a mine, and as to this the mine could not be found in any other way.

To return to the mines : The interest in mining that had been aroused during Elizabeth's reign and which had been inspired by the necessities of the realm died in the first half of the seventeenth century. The King's Field seems to have been neglected, but as already shown there had been some activity on those holdings in which the lord could receive royalties apart from the sovereign himself. The Civil War that ended with the death of Charles I, and the period of the Protectorate (1649–60) upset all the arrangements between the sovereign and the Company of Mines Royal, which latter went out of existence altogether. With the Restoration, however, a change came over the country. At the



A Page of Assize Roll 152 (Public Record Office).

The seventh entry on this page reads :—

Roll of Ragemann and de Quo Warranto Pleas in the County of Derby before the Justices Itinerant there. 9. Edw. I. (1280/1).

It is presented by the Twelve of the High Peak that Ralph le Wyne has made a certain pourpresture in the soil of our Lord the King in Tatington and Presteclyne (now Taddington and Priestcliff) in making a Lead mine whereof our Lord the King was accustomed to receive the Lot of the Ore (le Lot Min) that is the thirteenth dish (ras) etc. And Ralph comes and declares that he has never made mines in the soil of our Lord the King. He says that he and his Ancestors were always accustomed to make mines in their soil of Monyas, and that he had done nothing but this . . . Therefore it is agreed that our Lord the King shall take nothing for this inquest.

period there is a revival of the barmote courts, all the traditional customs are set for manor after manor, and in general the value of these customs is really felt for the first time. The articles are recited and affirmed by court after court, they are enlarged and added to and where in the time of Edward I there are no more than fourteen they now begin to run into forties and fifties. The small volume of 1645 was no doubt taken as a model, but Edward Manlove, formerly steward of the barmote court in the wapentake of Wirksworth, must have helped considerably by putting them into rhyme. His chronicle repeats some of the errors of the small volume of 1645, and it is fairly certain that it formed the basis of the matter of his poem.

The Society of Mines Royal was revived at the Restoration. Prince Rupert, soldier, sailor, and patron of arts and sciences, was made Governor. He died in 1683 and one year after his death the first mention of the Mill Close mine is found. It was producing ore during 1684–5–6, the amount of galena produced during that period being roughly 2,500 tons.

Following the example of Wirksworth, courts were being held in what are known as the " private liberties." That at Hassop (the great barmote court of Rowland Eyre) is dated the " 16th year of the reign of Charles II," that is 1664, making him king from the death of his father in 1649, as if Cromwell had never existed. It will be remembered that there was a Rowland Eyre in Elizabeth's time, and that the name appeared also as farmer of Her Majesty's revenues in the Duchy Court in 1613. The Court of Ashford is held in 1655 under William Earl of Devon. The manuscript copy of the proceedings of this court is known to be in existence and in private hands. But a great barmote court had been held for the Manour of Eyam and Middleton in 1652 following a previous one in which the date is not given, but which, from the

identity of some of the names of the jurors, must have been held not long before. This was during the Protectorate, 3 years after the death of Charles Stuart. Cromwell was probably fairly busy elsewhere and it may have been a defiance to the usurper. Shortly before the death of Charles I, he (Charles) had established a mint at Shrewsbury at which silver used for his war purposes and obtained from the mines of Wales had been minted. In all of these courts, however, there is one marked difference. The dish which at one time had to be supplied by the Lord of the Soil (Henry VIII supplied one in 1512) is now supplied by the barmaster with the consent of the jury. The jury, too, is now twenty four strong.

This really marks an accession of power to the jury, giving them a control that they had not previously had, and it really for the first time establishes the customs as an important factor in the government of mines. At the same time one at least of the articles then laid down would not hold when subjected later to the test at a higher court. In 1760 the House of Lords on appeal confirmed to the Duke of Devonshire as Farmer of the Revenues his claim, to receive the duty of lot on "smitham" (fine ore), although the Great Barmote Court of 1664 held at Wirksworth had stated that such duty was not payable. It has been payable ever since. Periods of activity in mining seem to have coincided pretty closely with those of our wars especially after the Restoration, and it was generally during the revivals that the lawsuits cropped up. Things settled down pretty well in the 18th century and troubles were infrequent up to the date when the customs were codified and became law, i.e., 1851.

It is difficult to say which was cause and which effect ; but the period beginning with the Restoration is responsible for a number of very important innovations which made mining cheaper, and which enabled the miner to overcome some of the difficulties which beset him in the shape of water and hard rock. The most important of all was the introduction of gunpowder. The use of this was known before 1700 and new methods of tamping had been introduced together with an improved fuse which lessened very considerably the risk of accident. At its first coming into common use, the miner ran a risk comparable with that of the *pénitent* in the French colleries of the next century, who confessed and received absolution before carrying out his duty of firing the inflammable gases with a naked light on the end of a stick. Those interested will find a very full description of the technique of blasting in Hooson's "Miner's Dictionary," 1747.

The actual date of the introduction of gunpowder is not known. It had been used on the Continent in 1627, but did not come into general use in England till near the end of the century—Hunt says 1670. It was not in use in Cardiganshire in 1662, when John Ray visited that centre of active mining. The method of using it at Liège was recorded in the *Philosophical Transactions* of the Royal Society in 1665. There are grounds, however, for believing that it was introduced somewhere between 1636 and 1645 and by Prince Rupert, at the Ecton mine in Staffordshire. It is generally assumed that he introduced a company of German miners familiar with the use of it to Ecton in his capacity of Governor of the Company of Mines Royal. A strong objection to this view is that Ecton was not a Mine Royal, and it seems unlikely that to bring a new invention to a private mine would not have been resented by the patriotic gentlemen of the company. It is more likely that it was an act of friendship towards the tutor of his cousin Charles II. This tutor was William Earl of Devon, the owner of Ecton. Rupert was intensely interested in gunpowder and quite a lot of improvements and inventions for its use are attributed to him.

Bishop Watson, F.R.S., a man with a fine scientific mind and no inclination to accept any statement without proof, quotes "a very able and intelligent person" who declared that it was a tradition that the first shot ever fired in Derbyshire or Staffordshire was fired at Ecton. He thinks the period was 1636–45. William Hooson (a "Derbyshire Miner") writing in 1747 has the following :—

> About 40 years ago some gentlemen came to a place called Ecton in Staffordshire there for to venture at an old work which was drowned with water in hopes to get copper . . . but no Old People in the neighbourhood could give any account when it was last wrought. They got churn pumps, sweap pumps, and forces, and got at length to bare the soles . . . but in the work it was admired by all miners that saw what blast holes had been bored, most a yard or four foot long and two inches or more diameter so that in those days they used not such small holes as we do in these . . . the report was that they were Dutchmen, others say Germans, that was their workmen, etc.

Now Ecton lay idle in 1686 and was re-opened later by the Earl of Devon, not to be closed again for many years, so that it rather appears, seeing that the old people could not remember when it was last wrought, that there is some truth in Bishop Watson's idea. The Ecton records are missing, and it is not known what has become of them.

The use of gunpowder seems to have spread rather slowly, but the production of copper ores at Ecton in the beginning of the 18th century was very heavy and enriched the owner, who became Duke of Devonshire after the accession of William of Orange. Side by side with this invention came the use of steam for lifting water. The first fire engine in Derbyshire appears to have been brought into use in 1743. The rag and chain pumps similar to those shown in the woodcuts in Hoover's translation of the "De Re Metallica" were in use for the removal of the more localized water before the fire engine was used. Prior to the use of this engine (probably Savory's, or later, Newcomen's), but subsequent to the introduction of gunpowder, water was the great enemy of the miner (See Hunt—"British Mining"—for a full history of pumping).

Along with these two innovations came that of smelting lead ores with pit or sea coal. Price ("Mineralogia Cornubiensis") says that it was introduced "of necessity" in the reign of Charles I. Beccher ("Alphabetum Minerale," 1682) in his dedication of the work says that he was responsible for the introduction of coal for smelting "tin and minerals" and that it had been unknown in Cornwall up to then (quoted by Bishop Watson). It was used by the Company of Mine Adventurers in Neath in 1699, and its use must have been universal in the mining counties of England early in the 18th century. The introduction of what is known as the cupola furnace is said to have taken place in 1698. This is the Flintshire or Derbyshire lead-smelting furnace working on the reverberatory system, but designed to use ordinary coal (See Percy, "Lead," 1870).

The practice of smelting on the hill sides quoted by Camden, appears to have persisted for many years in Derbyshire. In the King's Field custom gave the miner wood for his burning, and it is said that the forests were depleted entirely of timber by this means. White and black coal were in use up to the second half of the 17th century, the former being wood, the latter wood charcoal both used mixed because the white was too wasteful and the black was too hot.

A company known as the "Governor and Company for Smelting Lead Ores with Pit or Sea Coal" was operating in 1743. It was known locally as the Quakers Company, and was the most important operator in Derbyshire up to 1759. It introduced the fire engine, sank shafts, and drove soughs, and in the last-mentioned year fought a law suit on the interpretation of the customs, with the Lord of the Soil at the time. There are some interesting points in this suit.

It is stated by Hoover ("De Re Metallica") that it is not known whether the "Apex Law" of the United States originated in Derbyshire. As a matter of fact there has never been the slightest suspicion of any effort on the part of the landowner to restrict mining in depth, and once a miner got on to a "rake" it was his till he could no longer work it profitably, provided he paid his dues. No one could take his "deeps" because no one could get land given to him unless he first proved by actually showing a dish of merchantable ore, that an ore-body existed on that land. This remark needs qualifying in so far as private liberties were concerned. A miner working on the boundary between two manors with different overlords could not work in both manors without authority from each lord, but apart from this he was never limited except in length. But as far as the surface was concerned he was strictly limited in width. He never had any title to the surface nor in fact to anything except the lead ore in the vein. But custom allotted to him a certain amount of the surface for the purpose of dressing his ore, and this came to be known in time (it is not known when) as the "quarter-cord." A "cord" or "raip" (rope) was used for measuring the length of his "meta" and a quarter of this, i.e., 8 yards in the Low Peak and $7\frac{1}{4}$ yards in the High measured on each side of the veins was allotted to him for his general purposes. The lawsuit between the Governor and Company, etc., and the Lord of the Soil was in connexion with this question of the quarter-cord and judgment was given that the measurement must be from the walls on each side and not from the centre of the ore-body. In the case of a "flatting" the miner received a

square of land just as it is provided for in the case of alluvial mining in the Australian states.

In the sixth year of William and Mary the repeal of the Statute concerning Royal Mines was effected. The Sovereign, however, retained the right of pre-emption on all ore raised. That the industry was attracting a good deal of attention during the latter half of the 17th century is evident from the very considerable amount of publishing of treatises on mines and minerals that took place at that time. Of course the efforts of Sir Humphrey Mackworth in Wales in reviving the smelting of copper following on the success (earlier in the century) of Sir Hugh Middleton in extracting silver from lead ores in Cardiganshire and the impeachment of Sir Humphrey for embezzlement must have touched the imagination of the people. Sir Hugh had spent his vast fortune in providing a water supply for London from the New River. The king, by the way, received a number of fully-paid shares in that venture, and one of that lot has changed hands in London within recent years for the sum of £75,000. Sir Hugh died in poverty. In any case, mining promoters and others from the City, many of them unscrupulous, were roaming the Midlands in the early part of the 18th century and the boom was then in full swing.

About 1695 there is found the first mention of those enormous drainage adits known as "soughs" which seem to-day to typify a breed of men with hearts bigger than the normal. Some of them were 20 years in the driving and one at least is four miles long. Two of these were started from the Derwent River to work westward into the lead-bearing measures of the limestones, and the work occupied over forty years cumulatively—from 1743 to 1785. In all cases the mineral deposits towards which they were directed were almost depleted before the soughs were completed. Quite a number of these adits are still in operation and several mines are using two of them to take their water into the river. A third was used by the inventor of the "spinning jenny" to provide power for his work at Cromford.

Somewhere about 1698 Hunt says a Quaker lady urged a number of her friends to form a company to work the mines so that poor people could be helped, etc. That company known as the Quakers Company took up a mine in the King's Field in 1744, and worked it till 1759. It had previously operated with varying success in Durham and Northumberland. Its successor was the London Lead Company, which within the last thirty years or so is stated to have burned deliberately, not only the mass of plans, but the records which had come down to them, as well. The mine which it worked was in the Mill Close. It was reopened in 1859, and is to-day the largest producer of lead in England. The shaft which was sunk by that company is still spoken of as the Quakers' shaft, among the villagers.

If Hunt is correct in his assertions concerning the origins of this company it is curious that the date corresponds so identically with that of Sir Humphrey Mackworth's adventure. It is also a matter of some interest that Moses Stringer should have put forward in 1713 a reasoned article on the subject of working mines by employing poor people so that they could pay rates and thus avoid the expense of being on the parish. Incidentally Sir Humphrey Mackworth's affairs were in an almost helpless state in 1711, and an Act of Parliament placed them in the hands of a strong committee of administrators. The venture in Cardiganshire, however, had been prosperous. While the company which worked the Mill Close mine in the Liberty of Wensley in 1744 seems to have been the successor in a direct line of Sir H. Mackworth's Company, the actual connexion is not now very clear.

One interesting fact comes from the comments made by Stringer on Sir Humphrey's attempt to flout the Company of Mines Royal by denying its paramount position. The adventurers tried to prove that the ores of Cardiganshire contained no silver, and according to Stringer they actually had them "salted" with Derbyshire lead ore which carried very little of the royal metal. Subsequently the adventurers made a profit of £2,000 per month out of the silver; but they had, by then, apparently bowed to the authority of the Company of Mines Royal. They obtained the right to have this silver minted at the Royal Mint and to have the three feathers of Wales on the coins. These were known as "Quakers'" money, from the large number of this persuasion who had shares in the company.

It is perhaps more than a coincidence that the company which operated the Mill

NUTTALL'S PLAN OF 1769, SHOWING YATESTOOP AND HILL CARR SOUGHS. (SURVEY BY SOUTHERN, 1766.)

Close mine from 1744 to 1759 should have been known as the Quakers' Company. In the latter year the right of this company to use the land for the erection of fire engines, workmen's cottages, and the like, was contested by the owner of the soil. The court held that since the customs must go back beyond the memory of man in order to be, in essence, customs, and since the fire engine was new, custom could not be held to apply to such apparatus, and the verdict was for the lord. Since then it has been customary to pay rent for the use of land for kindred purposes.

Workers in lead ores do not seem to suffer at all from lead poisoning. Men with fifty years of service below ground in Derbyshire mines do not appear ever to have

been affected by it. Amongst the smelters, however, it seems to have made its appearance along with the cupola furnace. None of the writers mentions it prior to 1700. In that year Charles Leigh, M.D., in his "Survey of Lancashire, Cheshire, and Derbyshire," refers to it as a "sort of byon." [1] It is called "belland." This word signified in Middle English "wheezing" or "roaring" applied either to man or beast. It is simply the word "bellende," present participle of A.S. "bellan," to roar (cognate with Fr. *bélier* and Lat. *balare*). When it was recognized as being a sympton of the effects of lead, the compound of lead was spoken of as belland. To-day, land impregnated with lead from smelters is said to be "bellanded," while fine galena is called belland. Fine galena will not cause the trouble, but according to Hooson the practice of ramming (tamping) drill holes with fine ore would cause it. The effect was hoarseness and subsequent paralysis of the larynx which showed itself as a wheeze in men. It seems as if lead fume only will cause the trouble and the sulphate is the worst. Prior to the use of the cupola the ore was mixed with the fuel and the fume was taken in long flues up the hillside while the lead ran down hill into trenches. If the cupola was really the cause of the employees getting the complaint it must have been due to restricted draught.

The cupola was really rather late in appearing. The principle of reverberatory smelting is set out in Alonso A. Barba's treatise—"El Arte de los Metales," 1640. The first two books of this work were translated in 1674 by the Earl of Sandwich; but the description of the reverberatory principle is in Book IV. A reprint of this translation (of the two books) was made in a "Collection of Rare and Valuable Treatises," 1738, and Barba's work is there referred to as a "rare jewel." It is stated therein that the book had been banned by the Inquisition and that copies of it were extremely rare. That must have been a lure to trap the unwary because the edition of 1640 is still procurable and copies of later editions are plentiful.

Barba called these furnaces "hornos de reververacion" and says :—

> Little or no use has been made up to our times . . . of smelting in reverberatory furnaces, and although before the present time reference to such is found, they were not used with the perfection of to-day nor for the same object. They were for refining only. As sufficient proof of this George Agricola, who wrote so voluminously (*dilatadamente*) of everything pertaining to the art of metals has not mentioned them as being used for this purpose. The method is the most noble amongst all methods of smelting and more suited for metals of gold and silver, especially if they are rich such as (certain ores of silver) . . . galena and other lead ores (*Plomeria ?*).

From 1640 to 1698 is no long period for a new method to take, to make headway in England. The furnaces are stated by Barba to have been used with wood as fuel, but it is probable that on their introduction into England coal was used. They were not suitable for use with charcoal as a long flame was a necessity. Barba says, too, that :—

> In Truro (Oruro ?) a square chimney is built over them which extends in height about 1 yard above the furnace so that smoke can get away with less hurt to those who are carrying out the work of smelting.

In 1652 John French, M.D., translated John R. Glauber's "Novi Furni Philosophici." This is a cleverly worded exposition of what he could tell if he wished, but he gives little away—on page 331 of the translation, amongst the secrets is :—

> A very speedy way of melting minerals whereby they are melted in great plenty by the help of pit coals in defect of other coals.

On page 361 :—

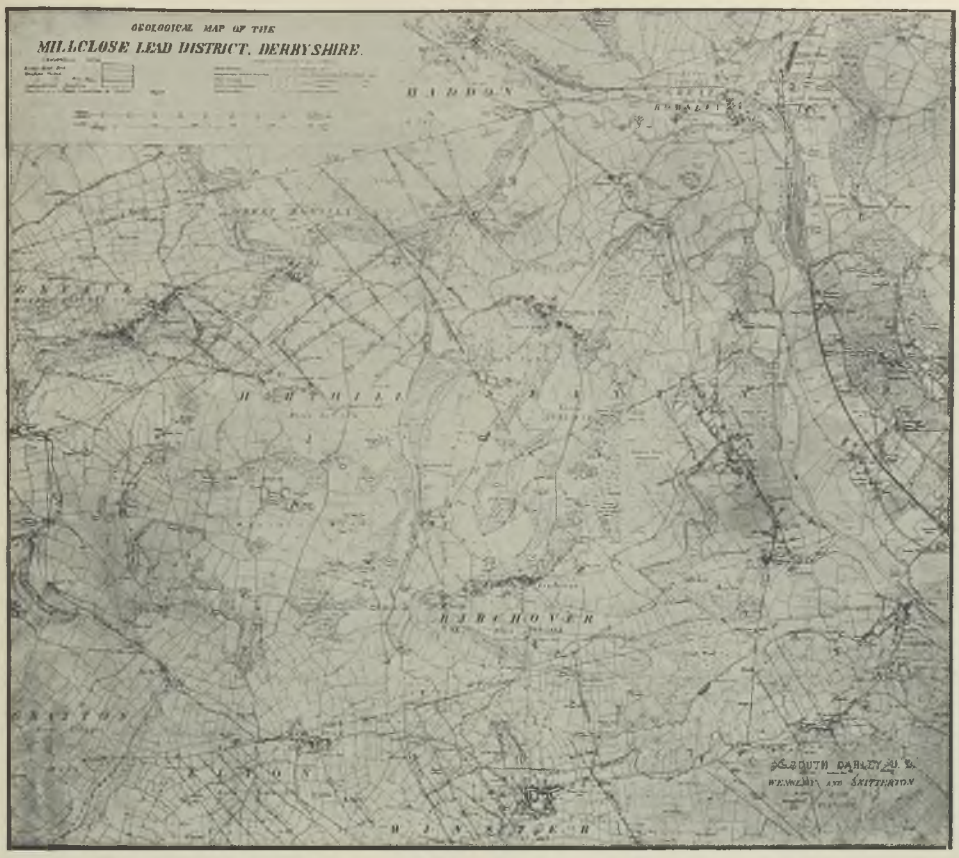
> In this our new way of melting, we need not bellows, nor mils although we erect never so great furnaces, for by how much the greater they are so much the greater quantity may be melted in them. Wherefore I do not doubt but that of all this is the most noble, profitable and excellent way of melting. Now whether or no all minerals may be melted in this furnace I know not for I made a trial only in the mine of lead and in no others by reason of defect of mines and places convenient for the erecting of the furnace. But I hope shortly to live in a more convenient place where I shall neither want coals nor mines (minerals) whereby to make tryal in fire and mines.

It looks as though he was familiar with Barba's work if not the actual furnaces.

Simon Sturtevant had obtained a patent in 1612 for a process :—

> Whereby all kinds of mettles, etc., as namely irons, steels, leads, tins, coppers, brasses and such-like now made after the ordinary course with wood fewell and charcoal may be as well made wrought and effected, as the said Simon Sturtevant affirmeth with sea coale, pit-coale, earth coale, and brush fewell, etc. And for as much as our said Souveraigne Lord is given to understand that this art skill industrie and inventions of the said Simon Sturtevant, etc., etc., is a thing not yet practised

[1] Quinsy.



PORTION OF THE KING'S FIELD AND MANORS OF STANTON, YOULGREAVE, ETC.

nor brought into any trade occupation or mystery, but is an invention in substance new, etc., in regard whereof this indenture witnesseth that our Souveraigne Lord the King of his especial grace and certaine knowledge and mere motive and of his prerogative royal hath given and granted, etc., all kindes of the aforesaid mettles, etc., by and with sea coale, pit coale, etc.

The term was for 31 years. Sturtevant failed and his patent was transferred in 1613 to John Rovenzon. His exposition of the subject of his patent includes a description of a reverberatory furnace using "pit or sea coale" for the melting of ores and metals. He did not succeed and his patents were ultimately (1654) taken up by Dud Dudley, who used coal for the smelting of iron only. In 1683 Sir John Pettus in his appendix to his translation of Erckers' work spoke of ovens of reverberation used for making enamels, and under "coal" as follows :—

Coal . . . viz., wood coal . . . used chiefly for metals, sea coal . . . and pit coal—but these are not useful for metals. 'Tis true many have attempted to chark, or make cinders of them to be used for metals when wood is scarce; but I have not yet heard of any certain success therein (although I wish it).

Percy, "Metallurgy of Lead," 1870, quotes a "very humane man" :—

I have seen a great deal of lead smelting works and I never saw any sickness which did not arise from attempts to condense the smoke. With a good draught I consider lead smelting . . . as healthy as any ordinary occupation.

On the whole, therefore, it is probable that lead poisoning from smelting did not become a serious complaint until the cupola was brought into use.

In the first half of the 18th century the great drainage adits of Derbyshire were begun. The first mention so far found is in 1695 when the words "A Sough is bringing up" are used in a reference to a Mine in Stanton. The word "sough" is Middle English. Its first meaning was a sewer. In Derbyshire to-day the house drains are still called "soughs." In John Ray's time it meant a dyke or ditch. A dyke was a sough when it was full of water.

The word was used by Dud Dudley (1654) to denote an adit. Fortunately for the ambitions of those who made them the work was chiefly in shale and the later ones, notably the Hill Carr Sough in Stanton, could not have been driven without gunpowder, as it passes through 176 yards of crystalline limestone in its passage from the river to the Youlgreave district four miles away. The flow to-day is 15,000 gallons per minute. Only one mine makes use of it. The great Yatestoop Sough which is said to have been begun in 1743 by the Quakers' Company (there is considerable doubt as to the correctness of this statement) was designated to drain the mines in the Liberties of Winster, Birchover, etc., while the Hill Carr Sough above referred to drained those in Alport and Youlgreave and part of Stanton, all private Liberties.

Both of these soughs on leaving the river pass through ground owned or leased by the Mill Close Mines, Ltd. The bulk of the water pumped from this mine, amounting to 3,000,000 gallons daily, is discharged into this sough some 40 ft. or so below the surface. All the soughs were built up with stone masonry well arched. The cleaning out of the Yatestoop Sough was carried out a few years ago by fastening a sort of sledge to a small boy and sending him like a weasel to find his way to the river with this contraption dragging behind him. And, in the history of civilization that was not so long ago either.

The introduction of Watts' engine altered the whole complexion of mining. It was first successful in Cornwall and when in later years one of this type was installed in the Alport mining area, Cornishmen were brought over under contract to work it and were guaranteed continuous work so long as the pumps " remained in the mine ". The mines failing, tradition says that they sat tight, did no work whatsoever and did not leave until the owners in desperation withdrew the pumps.

At the end of the 18th century the production of Derbyshire had fallen away very seriously from that of the first half of the period. The fields had died one by one and even the great wars on the Continent had failed to revive the industry. As before stated the ores had no silver, but the cause of the decline lay chiefly in the fact that the deposits as a rule have no depth. They are essentially shallow depositions in which the best ore over the greatest widths is at the top of any occurrence. This is due to the fact that the ore lies in caverns formed by the action of water passing along cracks in the upper limits of the limestones, and that an impervious bed overlies the limestone and forms a trap for the waters. The tendency, therefore, is towards the formation of bonanzas alternating with great lateral expanses of absolutely barren limestone, the prospecting and exploration of which would put a serious strain on the longest purse. The very influences, too, which made the caverns and open joints have made them the channels of artesian waters which add to the expense of mining operations. Lead, too, is the only metal of importance, the ore contains no silver beyond a meagre twenty pennyweights to the ton of pig lead, and although the associated metals such as antimony, copper, etc., when they are present at all, are in extremely low proportions they are still high enough to limit the market for such pig lead when it is in competition with lead which has to be refined of necessity. As a consequence much of it is sold in the form of dressed galena, and leaves the country for the more cheaply-run furnaces of the Continent.

The ores are associated chiefly with calcite, zinc blende, and fluorspar with occasional increases in the iron pyrites content ; but the best deposits, and these are generally exceptionally rich, are most usually accompanied only by calcite.

In Derbyshire itself the industry is one of the glories of the past. At no period of its existence was the output ever very large ; but in the 18th century it must have formed a not inconsiderable proportion of the world's production. To-day it is hardly worth taking into account. Side by side with the great natural disadvantages it carries the disability of that burden of lot and cope—the former a very serious burden on the gross production because it takes no count of the value of the product in the world's markets. The word " lot " is just another name for royalty paid to the owner of the soil. On top of this comes the tithe, that irritating and unreasonable impost out of the past. And above all these the burden of taxes which are based on both has up to the last year fallen with terrible severity on those operators who have been fortunate, or rather, unfortunate enough to have weathered the financial storms brought about by the war.

The miner of to-day, too, gives practically no more for his wage then he did before the war, and his pay is two and one half times his pre-war earnings. The cost of power has increased in like proportion, and the total burden is one that must preclude all future ventures even if it does not kill the industry altogether. The burden of water alone in all low-lying areas is such that once a stoppage occurs and work of pumping ceases the mine is drowned for ever. That the limestone measures still carry lead ore in great quantities cannot be doubted. The ore occurs, however, in sporadic fields, which may be segregated from one another by great distances. As mining ventures even without the burden of royalty, tithe, and rates, they would offer no attraction except at periods of unusually high lead values. They do not respond to the usually accepted methods of exploration or of working. They cannot be found by surface indications any longer, because all the bodies in the outcrops of the limestone have probably been worked out, and where they may lie beneath the shales, the shales give no sign. They have never excited scientific interest, and the conditions governing their genesis remain to this day practically unknown, and when the last remaining mine is full of water whatever of valuable evidence the workings might have afforded to the investigator will have been hidden for ever.

The I.M.M. Benevolent Fund

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

	£	s.	d.
E. Hogan Taylor	150	0	0
Albert E. Payne	20	0	0
W. T. Anderson	10	0	0
J. J. Gillio	10	0	0
A. Broughton Edge	5	5	0
A. T. Holman	5	5	0
J. L. Holman	5	5	0
R. E. Commans (additional)	5	0	0
K. Richardson	5	0	0
D. J. Rogers	5	0	0
R. E. Palmer	3	3	0
D. A. Thompson	2	2	0
Anonymous	2	0	0
J. F. Durling	2	0	0
Blakeslee Barnes	1	18	0
Anonymous	1	5	9
E. Oughton	1	1	0
J. B. Richardson	1	0	0
Previously acknowledged	£673	3	0
Total	£908	7	9

BOOK REVIEWS

A New Geological Map of Australia, with Explanatory Notes by Sir T. W. Edgeworth David. Scale 1 : 2,990,000. Price, unmounted, 20s. ; mounted, 42s. London : Edward Arnold.

The area of Australia is 2,948,366 square miles, and is only slightly less than that of U.S.A. From east to west it measures 2,400 miles, and from north to south 1,970 miles. The present map has been issued in four parts, each 42 in. by 34 in., and includes Tasmania and New Guinea and shows the salient geological features as a connected whole, while around the margins there are eleven typical sections across different parts of the Commonwealth. This map is an integral part of a large work by Sir Edgeworth David on the geology of these regions, to be published in two or three volumes. Pending the completion of this work, which may require at least another year, the map and the volume of Explanatory Notes of 175 pages with numerous diagrams and tables, have been published. To entitle this volume " Explanatory Notes " is all too modest ; it is a treatise in itself involving an immense amount of labour and only possible to one with an intimate knowledge of Australian geology. Necessarily limited in detail, it is an adequate summary of the complete work to which those interested in Australian geology will look forward.

The notes trace as a vivid picture the geological history of Australia, lying firmly but mobile through so many ages, though flanked off its northern coast for 1,500 miles by that most unstable of areas, New Guinea. It is shown that as the result of the extreme rigidity of its shield, Australia has no young mountain ranges. Folding ceased for the most part, except in eastern Queensland, after the end of Palæozoic time. Since then the old fold ranges have been lowered by denudation, without much compensating uplift or addition of later sediments, and

so Australia has become reduced to a vast peneplain. The deposition of metallic ores in the Commonwealth can frequently be, and probably in most instances are to be, referred to the various epochs of igneous intrusion, the most extensive and profitable dating back to pre-Cambrian intrusive epochs. Ore deposits undoubtedly still remain hidden, particularly in the arid and little-known inland areas, beneath the thin formation from one to six feet thick known as "duricrust," which covers vast areas of Australia.

One of the most fascinating features of Australian geology is the evidence of at least three pre-Pleistocene glaciations, one of which affected at least half of the continent, while the others were also far-reaching. For one of these, usually known as the Permo-Carboniferous, a name familiar to students of Australian, Indian, and South African geology, the local term Kamílaroi is here introduced, although the advantage of this is not very apparent.

All the various minerals of value occurring in the Commonwealth are dealt with, as well as the Great Artesian Basin, the largest of all artesian basins.

J. H. RONALDSON.

Markscheidekunde. By G. SCHULTE and W. LÖHR. Cloth, octavo, 242 pages, illustrated. Price RM. 13. Berlin: J. Springer.

This little book is exactly what it pretends to be, namely a book on mine surveying suitable for mining schools and giving such practical information for executing surveys as a colliery official is likely to require. It must, however, be remembered that German colliery officials are more highly trained technically than colliery officials in this country. The authors have written this book with the object of using it in their teaching at the Mining School at Bochum; they appear to have succeeded Dr. L. Mintrop, who was teacher of mine surveying at Bochum and has now been transferred as Professor of Mine Surveying to Breslau. He had written an Introduction to Mine Surveying, which was used as a textbook in the Bochum Mining School both by him and by his successors, and the present work is intended to replace this and to bring it up to date. It no doubt will answer its purpose quite satisfactorily, but will be of little or no use to surveyors in this country, because it is confined to German methods and instruments, and the authors entirely ignore all that has been done in other countries. For example, they describe in considerable detail the various tacheometers made by German firms, not excluding a special instrument designed for reducing inclined readings to the horizontal but they utterly ignore the instruments devised in Sweden and in this country for the same object. Further, as might be supposed from the origin of the book, it deals exclusively with coal mining as practised in the Rhenish coalfield, and entirely ignores the methods used in metalliferous mines. The book consists essentially of two parts, the first and larger part dealing with the various methods of surveying, the second part with the various forms of representation of the results of such surveys. There is also an appendix containing a certain number of drawings illustrative of the symbols and abbreviations used in Germany, and also a table of sines and cosines, which is, however, of but little use to surveyors in this country, because it only deals with tenths of degrees and not with single minutes. To sum up, the work may be described as one that will no doubt fulfil its object very thoroughly, and which is quite a good book within the limits which the authors have set for themselves, but would be of very little use to surveyors in this country.

HENRY LOUIS.

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

NEWS LETTERS

BRISBANE

August 22.

Mount Isa.—As a result of interviews between the General Manager (Mr. Julius Kruttschnitt) with Ministers in Brisbane the Queensland Government is granting a rebate on ore freights to the Mount Isa company. The arrangement made is a form of deferred payment. Rebates on existing freights (which are already less than the ordinary charge to the public) are being given on account of the abnormally low price of lead. The arrangement made with the com-

pany is based on the price of lead generally, and repayments are to be made as the price levels increase. The Premier (Mr. W. Forgan Smith) explained that the Railway Department will be recouped when prices reach a normal level. He mentioned that the company is losing heavily and that the closing down of the works would throw thousands out of employment. The Government has also decided to forego, for the last financial year, the guarantee for which Mount Isa Mines, Ltd., is liable for loss incurred in the working of the Mount Isa branch railway. While Mr. Kruttschnitt was absent in Brisbane some trouble arose at the mine through three miners having been dismissed, the men demanding their reinstatement. On his return, and after the calling in of the services of the local industrial magistrate (Mr. Stanley Wilson, Government warden), a settlement was agreed to and the trouble ended. The reason given to the three dismissed men was that insufficient work was being done at the particular job they were on. The company has agreed to give the three dismissed men preference of employment for surface work. To avoid future trouble it was further agreed, on the suggestion of Mr. Wilson, that no employee other than a casual worker shall be disciplined without a fair hearing by a board appointed by the management. According to official reports for July good progress is being made on the main haulage level, preparatory to opening up the Black Rock lode for stoping. Here the ore is being transferred through 1A winze to the main haulage level. The electric winder at Davidson's shaft (Black Star lode) will be ready to be placed in commission shortly. During last month the middle lode stope was worked continuously on carbonate ore of good grade. Now that the cross-cuts are clear of the main haulage way the development of the Black Star sulphide ore-bodies will be accelerated. Diamond drilling underground has been continued and one hole has been completed at 200 ft. The information obtained confirmed the geological projection of structures from No. 3 level on the Black Rock lode.

Mount Wandoo Gold Mine.—At the newly-discovered Mount Wandoo mine, North Queensland, work is reported to be still suspended, but it is stated by the local mining warden that, now the owner (Mr. Alexander Macdonald) has returned from London, an active development policy in two of the shafts of the mine (the Hardman and the Wendy) is to be pursued. The shaft bins, as well as the small battery that has been purchased, have been erected at the mine.

Mount Morgan.—Only a moderate amount of work, mainly of a preliminary nature, is being done at Mount Morgan, in Central Queensland. Operations are in progress in connexion with the open-cut and a further trial of the ore under working conditions for the recovery of values, under the improved froth flotation process, is under way. About 100 men are now employed, some of them preparing for production at the company's Dawson Valley coal mine, for running the power plant.

Prospecting Central Australia.—A second expedition has left Brisbane, on a less pretentious scale than that which started last month, to prospect for gold in Central Australia. It consists of the leader, a former Protector of Aborigines in the Northern Territory (Mr. T. J. Beckett); a mining engineer, for some years a Government inspector of mines in Queensland (Mr. Murray Russel); and Mr. L. A. H. Thomsen, a mechanic, who have gone out in the interests of a small company of Queensland business men formed in Brisbane. The party, which is well equipped, is travelling by motor truck and is provisioned for an absence from Brisbane of six months.

Search for Oil.—It is estimated that in Queensland about £800,000 has been spent in prospecting for oil and that over 100,000 ft. of drilling has been done. Approximately some 30,000 gallons of oil has been won, the greater part from gas at Roma (300 miles inland from Brisbane), where petroliferous gas is met with near the bottom of the Mesozoics, at about 3,700 ft. In the opinion of the Queensland Chief Government Geologist (Mr. L. C. Ball), the petroliferous gases and light oils found at Roma are confined to the cross-grained clastics mantling the pre-Mesozoic land surface. It has been suggested that these gases and oils may have migrated from the Permo-Carboniferous sediments, but, in Mr. Ball's view, evidence of these rocks being petroliferous is wanting. Present operations in connexion with the search for oil in the State are confined to geological mapping in the Roma and Longreach (Central Queensland) districts and to the drilling of one hole in the Roma district in addition to two others near Brisbane. The Commonwealth Geological Adviser (Dr. W. G. Woolnough) is at present

conducting an aerial photographic survey around Australia in connexion with the search for oil. In a report to the Federal Government he states that the results obtained by new technique in the Fitzroy River area of Western Australia showed that additional information could be obtained in this promising area if scientific methods were energetically applied.

Gold Bounty.—A statement published a few weeks ago that the Commonwealth Government would be forced to review the position with regard to the bonus on gold produced in Australia, and possibly either to reduce the amount payable or to abolish the bounty entirely, caused much concern to those interested in the gold-mining industry in Australia and, judging from cable advices, also among companies in London whose capital is being invested in the industry here. As yet, however, no definite decision has been reached by the Federal authorities. It is claimed by those who favour the suggested review of the position that the benefit of exchange premiums has obviated the further necessity for a bounty. On the other hand, those who oppose a change, especially all concerned in the industry in Western Australia, maintain that any additional interference with the bonus now paid would be nothing less than repudiation. The total sum paid as a bounty on the gold production of 1931 was approximately £90,000, but it is expected that the gold output will be much more this year. The vote on the estimates for 1931 was £100,000. It is now suggested that the amount will be cut by £50,000 for the current financial year.

Great Boulder.—The Great Boulder Proprietary Gold Mines, Ltd., Western Australia, reports (rather belatedly) a profit of £35,971 for 1931, compared with £4,847 in 1930. The total dividend for the year on the 1,750,000 shares of 2s. each was 6d., less tax. Since 1895 this company has earned a total profit of £7,597,224, out of which it has paid dividends aggregating £6,107,841. The dividend for 1904 was 162½%. In 1931 the company crushed 97,789 tons of ore for a yield of 79,547 oz. of gold and since then its prospects have been greatly enhanced by the developments which have occurred on the " X " lode at various depths.

New Development at Kalgoorlie.—It was announced at Kalgoorlie, Western Australia, last week that five leases, covering in all about 60 acres, have been taken up between the old Brown Hill mine and the Brown Hill railway station. They adjoin the Golden Mile Syndicate's group. On the properties a new lode over half a mile long has been discovered and the southern portion of it opened up. The cap of the lode has been reached 45 ft. below the surface and the values disclosed are said to be good. The width is not yet known. An inspection and full report for this company is being made.

British Capital for Australia and New Guinea.—Mr. A. Pearson, legal manager, of Melbourne, has just reported that British capital will be made available to test gold-mining properties over which Mr. H. Cyril has taken options on behalf of a London group. The properties include groups of gold mines in Western Australia, Victoria, and New Guinea. Mr. Cyril has agreed to send an expedition to New Guinea to test the properties under offer and to verify reports already received.

JOHANNESBURG

September 8.

Western Rand.—Following upon very favourable reports concerning the prospects of Randfontein Estates and of Luipaards Vlei Estate and Gold Mining Co. comes the official announcement that in the West Rand Consolidated's west sub-incline shaft the Main Reef has been intersected at the horizon of the 31st level—the lowest point of development in the western section of the mine—and values for the first 50 ft. sampled give the excellent average of 14·6 dwt. over 68 in., equivalent to 992 in.-dwt. This strike indicates that the earlier improvement of values at depth in the levels immediately overlying this latest disclosure is being maintained. With the stoping on each succeeding new level the mill grade should improve, giving a corresponding increase in the monthly profits. The mine has had to deal with a considerable tonnage of development rock from upper levels during the past year, which has naturally had a detrimental effect on the grade for that period, but once the blocking out and development of the upper workings are completed it will be possible to run a screen value nearer the ore reserve value, at present standing at 5·6 dwt. The inclusion of 965,000 tons of ore, having an average value of 3·7 dwt. per ton, in the reserve, has reduced the mean ore reserve value to 5·2 dwt., or practically the same as the present recovery value, and it is

with the exhaustion of this tonnage and the gradual mining of the richer ore in the lower levels that an appreciable improvement in grade is to be looked for.

Randfontein Expansion.—By pegging claims within the last few months Randfontein Estates have ensured a solid block of ground for working, extending from the southern boundary of the Luipaards Vlei Estate to the Randfontein main block, from which development can take place. There are still considerable areas held for water rights, etc., of which the Government have the underground mining rights, and by means of tender it should be possible for the company to straighten out its boundaries and complete a compact and workable block of claims. The gradual expansion of the mine has been going on for some years now and has resulted in hundreds of valuable claims being added to the property.

Lydenburg Gold Mining.—In connexion with the reorganization of ore treatment after milling at the Transvaal Gold Mining Estates Co.'s property, in the Lydenburg district, it was stated at the annual meeting of shareholders that ore was mined during the year from six different reef horizons. These reefs are worked in more than a dozen different mines and at nearly every working point the reef from time to time shows variations of refractory constituents in greater or less degree. It is in circumstances such as these, as the chairman pointed out, that the benefits of the group system of control become self-evident, for the company has a call upon technical services, skill, and experience of a character which would not otherwise be available.

Half-Year's Diamond Output.—In view of the fact that the De Beers and Premier mines have suspended operations, it is not surprising that the South African diamond production returns for the six months to June 30 last indicate a further heavy decline. The output for the period, 546,503 carats valued at £922,868, represents a decrease of 627,004 carats and £1,634,679 compared with the figures for the first six months of last year. Sales totalled £903,733 against £2,183,673, a decrease of £1,279,940, and the value realized per carat at 35s. was 5s. down. The alluvial diamond output for the six months to June 30, 1932, was 240,520 carats valued at £547,962, as against 341,591 carats valued at £1,061,572 for the corresponding period of last year. The value per carat has declined from 62s. 6d. to 45s. 7d.

Small Gold Mines.—According to the latest official statistics 26 small South African mines, including prospecting concerns, small working syndicates, and individual diggers, whose properties cannot be considered as having reached the status of established producers, recovered 2,156 oz. of gold valued at £9,159 during the month of July. Of these 26 small producers 22 are in the Transvaal, six on the Rand, six in the Pilgrims Rest area, five in the Pietersburg area, four in the Barberton area, and one in the Klerksdorp area and their contributions amounted to 2,119 oz. valued at £9,004. Natal has three small mines whose outputs totalled 23 oz. (£101), while one Free State small mine turned out 12½ oz. (£54) during the month. Forty-one Transvaal alluvial diggers sent in returns totalling 181½ oz. (£771), 122 oz. (£517) of which were recovered by 21 men in the Pilgrims Rest district. Gold won from old tailings and reduction sites in July totalled 459 oz. (£1,951). All but 24½ oz. (£104) of this output was Rand gold.

Manganese Industry.—The Manganese Corporation's mines at Postmasburg have been closed down for some time, but, in view of the improvement in base metal prices, shipments of ore from available supplies have been resumed. Two consignments of 1,500 tons each will be sent overseas during the current month. It is hoped that the decisions reached at the Ottawa Conference will benefit the South African manganese industry and enable the corporation to resume mining operations.

South African Marble.—A quantity of marble from the farm Marble Hall, near Pretoria, was sent to England recently to be included in the new South African House, now in course of erection in London.

IPOH

September 9.

Tin Prices.—The continued rise in the price of tin has now reached the level of quotations such as have not been recorded since April, 1930—a period of nearly two and a half very lean years. Here it was generally expected that ore sales in August, before termination of the two months' quota period, would probably cause a decline in the price, but this has not happened and the current quota period being for one month only there can be no great accumulation of unsold ore in so short a time.

Grouping.—It has been the declared policy of the Government that grouping of assessments on the lines laid down, and now generally well understood, would be facilitated, but at the end of August instructions were issued from Kuala Lumpur that no application for grouping could be considered unless the consents of all occupiers of all leases in the schedules of all certificates of production in the proposed group had been obtained and, further, that any occupier who wished a certificate of production degrouped must obtain the consent of all occupiers of all leases in the schedule of that certificate. The implications of this instruction depend on the meaning of the word "occupier," which in fact includes the lessee and every holder of a valid subsequent sublease down to the present actual occupier who holds the certificate. Hitherto the last named—the actual producer—has been the only party whose consent had to be obtained for grouping, but on the above new instruction other parties whose interests are not identical with those of the producer must give consent and, apart from other obvious difficulties likely to arise, it will be difficult to obtain the consent of some holders of original mining leases who are not resident in this country. The excessive subdivision of mining land in the tin-producing districts has already been noticed and this subdivision may itself involve consents by several or many parties to any action as to grouping desired by a single present producer. This new instruction, if not modified, must cause a great deal of difficulty and gives opportunities for extortion that were formerly lacking, and it will also delay and may even prevent the full development of schemes for economical production in which a number of active producers would combine for working to the best advantage. If this is another example of an unfortunate attempt to please everybody it is as unlikely to succeed in that as such efforts usually are. Under the simple procedure hitherto sufficient cases might arise in which a sublessee, who was the producer, having grouped his assessment on a certain mine, closed that mine down, or reduced operations to a care-and-maintenance basis, preferring to produce the quota elsewhere to better financial advantage. In such a case the lessee or sublessee might cease to receive tribute from the producer, because the mine had ceased to produce, but there are obvious arrangements possible between the parties and it would have been better to leave all such cases to be settled among those concerned. Even if a lessee's income from tribute ceases, as the result of a sublessee grouping and closing down, that lessee's interests are protected by the fact that his ore reserves are not being depleted and when productive work is resumed the output will yield a higher rate of income on the better prices that are to be expected.

Retirement.—The Mines Department and the mining community in this country have just lost a valued member of the Government service on the retirement of Mr. J. Laird, the Warden of Mines, Perak. Before his departure Mr. Laird received many expressions of regret at his going and of appreciation for his capable and strict but always fair and often helpful conduct in the duties of a department which has expanded greatly during his period in the service. The Chinese miners recorded their opinion that there had been no senior officer in the country who was more thoroughly acquainted with the troubles and difficulties of the miners.

TORONTO

September 19.

Mineral Production.—Production of metals, fuels, and non-metals in Canada during the first six months of 1932 reached a total of $83,384,705, as compared with $95,689,288 during the corresponding period of 1931, a decline of 12·9%. The total value of the metallic output during the period amounted to $54,092,915, as compared with $61,717,841. The decline was caused by the lower prices prevailing for the base metals and the lessened demand for nearly all mineral products except gold. Copper, lead, zinc, nickel, and the platinum groups all showed a falling off, but gold production at 1,496,078 fine oz., worth $30,926,683 when calculated at standard rate, was greater than ever before for a single period. Ontario with an output of 1,127,801 fine oz., worth $23,313,715, produced 75% of the total for the Dominion. Prospecting for gold has been greatly stimulated and the probabilities are that the results of the intensified field work of the present summer will be beneficially felt in the next few years.

Porcupine.—The output of seven producing mines in the Porcupine area during August was valued at $1,865,385, from 289,565 tons of ore, as compared with $1,608,025 from 276,270 tons treated the

previous month. Dome Mines during August produced bullion to the value of $317,788, as compared with $311,846 for the previous month. Total production for the eight months ending August was $2,735,800. A new ore zone has been located in the greenstone on the 23rd level and a drive is now proceeding to intersect this mineralization. The company is rapidly increasing its ore reserves and these are now at the highest level so far reported. At the McIntyre Porcupine mines preparations are continuing for the sinking of the big new winze, which will extend from the 3,750-ft. level to the 6,750-ft. horizon and will permit the opening up of both the Platt Veteran section of the property and a new deposit discovered on the 3,750-ft. horizon of the old mine. Meanwhile little or no work is being done on the Platt as it will be more economical to develop this area from the new winze. A new compressor has been installed, which will augment the air supply and will facilitate the new development. The Coniaurum is preparing for operations on an increased scale. A new hoist has been installed, which will permit the workings to be continued down for another 500 ft. Plans for increasing the mill capacity are under consideration while development work is producing good results from the lower levels, and some sections of high grade have been recently located. Mill heads are now averaging around $6 per ton in gold. Hayden Gold Mines is carrying out a comprehensive programme of development and pushing lateral work on various levels down to 1,000 ft., opening up ore stated to run from $8 to $9 per ton in gold. Work has been started on the installation of a cyanide unit to have a capacity of 100 tons per day. Its present concentrator capacity is sufficient to supply the new unit.

Kirkland Lake.—Production of the Kirkland Lake area during August was valued at $1,985,125, from the treatment of 150,721 tons of ore, as compared with $1,879,871, produced from 149,430 tons of ore in July. The mill of the Lake Shore is treating approximately 2,000 tons of ore per day and attaining a new high record among gold mines for recovery. Since beginning operations it has produced a total of approximately $50,000,000. The records of the mine, based on areas where mining has extended from boundary to boundary, show about $6,500,000 occurring in every 100 ft. vertical, which suggest a gross gold content of $260,000,000 between the surface and the 4,000-ft. level to which the work is now closely approaching. The Wright-Hargreaves has completed plans for the construction of an addition to the mill, which will bring its capacity up to 1,500 tons of ore per day. Good progress is being made with the sinking of the new central shaft which has now reached a depth of 2,650 ft., its objective being 4,000 ft. On the 3,000-ft. level a large ore zone has been opened up with some sections returning values of $30 of gold to the ton. Current production of the Teck-Hughes is approximately $500,000 per month according to an official statement. The five new levels from the 31st to the 35th are approximately two-thirds developed and on August 30 the total ore length on these levels amounted to 2,728 ft., with an estimated average stoping width of nine feet and an estimated stoping grade of $8·50 per ton. The mill of the Sylvanite is treating about 260 tons per day and preparations are being made to increase this rate to 300 tons. Important finds have been made on the 2,500- and 3,000-ft. levels. On the latter horizon new ore indicated by diamond drilling was cross-cut, the vein showing a width of 30 ft. of high-grade material. The Barry-Hollinger is handling an average of about 100 tons daily, but operations have been handicapped by a drop in the grade of ore and financial difficulties have prevented the carrying of development to lower levels. The shaft of the Macassa has been connected with the drive from the adjoining Kirkland Lake Gold property, at a depth of 2,475 ft. Work will be started immediately to open up the ore-bodies encountered in the drive. The Kirkland Gold Belt, in the eastern section of the camp, has met with good success in underground development and has encountered high-grade ore on the 125- and 250-ft. levels.

Other Ontario Goldfields.—At the Parkhill, in the Michipicoten gold camp, the shaft will be put down to a depth of 537 ft. and four levels opened up. The shaft will eventually be deepened to 750 ft. and the downward continuation of the vein followed. A new electric hoist capable of operating to a depth of 2,000 ft. is being installed. The Minto, in the same area is maintaining production at a steady rate and pushing developments on the second level with good results. In the Matachewan area the 150-ton mill of the Ashley has been completed and is operating at the rate of 75 tons daily. Considerable stoping has been done on the four

levels down to 500 ft., rendering a large tonnage of ore available for treatment. In the Patricia district there has been much activity in prospecting particularly in the region around Red Lake, where some important discoveries have been made. The Patricia-Birch Lake Mining Corporation will carry out an extensive programme of diamond drilling on their property to be followed by shaft sinking. The Niagara Falls Syndicate is resuming operations on its property in the Woman River area.

Sudbury.—Operations at the mine and refinery of the International Nickel continue on a low level but, while the demand for nickel and its products has for some time been light, there is encouragement in the fact that about 60% of the orders come from the steel industry and may be expected to increase when it resumes activity. New equipment has been installed in the Levack mine to prevent flooding. The Falconbridge Nickel has started excavation for the construction of a 200-ton concentration mill, sintering plant, and additions to the smelter. This will enable the output to be increased by 50%, and the cost is estimated at $400,000. A new high average has been made by the smelter, which treated 360 tons daily, or a total in excess of 11,060 tons of ore during August. A recent order closed with Japanese interests renders it necessary for the company to increase production. Prospecting for gold is very active and a rush has set in through the area south-east of Chapleau where many claims are being staked.

North-Western Quebec.—The Noranda Mines is carrying out an extensive programme of mine development and probing for new ore sections. Diamond drilling to a depth of 1,000 ft. from the 2,500-ft. level shows favourable mineralization all the way, carrying high values in some sections. President J. Y. Murdoch states that gold is being produced at a rate of approximately $7,000,000 a year, the past few months showing an increase in the output over the earlier months of the year. No further effort is being made to reduce copper production and the company finds a ready market for its output. The Siscoe gold mine during August produced bullion to the value of $91,491 from the treatment of 5,128 tons of ore, mill heads averaging $18·05 in gold per ton. Good results are reported from development work and new ore is being opened up on the bottom levels, which will materially increase the ore reserves. The Abana property has been acquired by the Mining Corporation of Canada. The Granada is meeting with good results from its deep development programme, having encountered a new ore-body on the 1,075-ft. level. High-grade gold values have been found in the bottom level in a small porphyry dyke, which near the surface carried low gold content, the grade going higher as work proceeded downward. The O'Brien Cadillac is about to begin production, with a mill having a capacity of 100 tons a day. Other properties in this locality under development are the Thompson-Cadillac, Ranger-Cadillac, and Pandora.

Manitoba.—The mill of the San Antonio, in Central Manitoba, is treating 3,750 tons of ore monthly, with average recovery of $14 per ton. A second shaft is being put down and will connect up with the 950-ft. level, thus facilitating deep development and ore handling operations. Ventures, Ltd., is installing a 50-ton mill on its property at Island Lake. Gold discoveries have been located along a break having a length of about 1,200 ft. In this distance several ore-shoots have been opened up and surface sampling, together with diamond-drilling, has indicated a total of about 15,000 tons of ore, from which an average recovery of about $18 per ton is expected. At the Oro Grande mine at Bulldog Lake, in Manitoba, excellent results are being obtained with the small test mill now in operation. Ore has been taken from the dump and various test pits along the break, which has been opened up for a length of 3,000 ft., and high-grade ore is in evidence in all the workings. The mill of the North British Mining and Milling Company at Herb Lake has been in steady production for three months and has made several shipments to the mint at Ottawa. The Hudson Bay Mining and Smelting Company is carrying on active exploration work on the Flin Flon property. Development work has opened up ore carrying higher gold contents and it is estimated that the company will this year have an income from the precious metals alone of $2,500,000, enabling it to show a fair margin of profit on the year's operations, notwithstanding the low price of copper.

Great Bear Lake.—New and important mineral discoveries are being reported in rapid succession from the various properties under development in the Great Bear Lake district. A gold-bearing vein with a width of five feet, carrying free gold, has been located

on the Contour group, across the bay from the Eldorado property. The vein has a length of 1,500 ft. at least, but further work will be necessary fully to determine its value. The Eldorado has recently made discoveries of silver, both on the main claims at Echo Bay and on the Bonanza group. On the B.E.A.R. property work is being centred on opening up the silver and pitchblende deposits recently located. Great Bear Lake Mines has located good values on both of its properties and is pushing work to determine the possibilities of the new finds. While the season of prospecting and surface exploration in the Great Bear Lake district is drawing to a close, the Eldorado and the Bear Exploration and Radium will be engaged in underground development throughout the winter. Work on the refinery of the Eldorado at Port Hope is making good progress and treatment of pitchblende ore for the production of radium will probably be started about the middle of October.

VANCOUVER

September 10.

Coast.—Active work has been commenced in re-opening the Venus mine on Lasqueti Island. This is a copper property and is most favourably situated at tide-water. The mine was under development some 11 years ago, when a body of solid chalcopyrite was opened up in underground workings that were carried out by Lasqueti Island Mining Company. The Venus group consists of nine mineral claims and a fraction extending southerly from Barnes Cove across the island. At the head of the cove two adits had been driven for 140 ft. and 80 ft. respectively—the lower one at the shore and 5 ft. above high-water line, the upper one 16 ft. directly above. Part of the intervening ground was stoped and an amount of 196 tons of ore was shipped to the Tacoma smelter, returns from which are said to have averaged 12·82% copper, 0·63 oz. gold, and 3·27 oz. silver. The ore is found in a zone of crushing that varies in width from a few inches to several feet, and which passes through quartz-diorite and volcanic formations. The stope length of the principal shoot, which had a maximum width of 4 ft. of solid ore, was 80 ft. A winze was sunk to a depth of 70 ft. below the lower tunnel, but it is understood that the ore-shoot pitched away from it and was not picked up at a lower level. There are believed to be good chances for the discovery of further deposits along the length of the mineralized zone which may be traced on surface for a considerable distance.

Queen Charlotte Islands.—Development of the Skidegate-Sunrise group of claims by Kitsault Eagle Silver Mines, Ltd., is reported to be meeting with encouraging results. This property represents one of the oldest locations on the islands and has been described as being interesting on account of its gold possibilities. The showing consists of three quartz veins in a sheared zone about 30 ft. wide in a doleritic country rock. One of these veins has been traced about 1,000 ft., averaging 8 ft. in width. Mineralization consists of pyrite and galena with some zinc blende and chalcopyrite carrying $10 to $15 in gold. An amount of 140 lb. of ore, taken from a showing on Indian Reserve, which probably represents a continuation of the same zone, was shipped some years ago and yielded returns of $582 in gold. Encouraging values in gold have now been encountered in further underground workings and it is understood that plans have been completed for the installation of a flotation plant at the property. Successful operation of this mine would lead, probably, to further developments on the islands where many promising prospects exist.

Bridge River.—Considerable interest attaches to the decision of Pioneer Gold Mines of B.C., Ltd., to proceed immediately with the continuation of sinking operations. Apart from the fact that proof of continuity of the gold-bearing vein for another 100 ft. or so below the present depth of the shaft would constitute a record in the depth-development of gold-quartz ore-bodies in Western Canada, it is suggested that recent lateral exploration has shown that the vein fissure, which evidenced a tendency to swing towards, and beyond, the diorite contact, appears to resume its normal trend towards the north-west. With territory yet to be explored in this direction, within the ore-bearing diorite formation, the strike of the vein fissure is a matter of very great importance, not alone to the Pioneer property, but also in connexion with possibilities of continuation of the vein into the neighbouring Lorne holdings. With the breaking out of four new levels the development of the Pioneer mine is well ahead and possibilities in connexion with the new vein that was discovered above and on the 1,625 ft. level have yet to be estimated. At the time of writing it is expected that the new mill addition will be tuned in within

a week, the whole programme of expansion having been carried out as planned.

Lillooet.—It is stated that good results are being obtained in the work that is being done at the Big Slide mine on the Fraser River. At this property two tunnels were driven on a zone of fracturing in which lenses of quartz occur, carrying occasional notable values in gold. The lower of these tunnels was continued for over 400 ft., but the old-time operations were suspended. More recent work on the surface has proved the continuity of the zone and open-cutting has exposed bodies of gold-bearing quartz following the same general direction. The present operating company is sinking a shaft by hand from the lower tunnel, which is to be carried down to a depth of 200 ft. as soon as power machinery can be obtained. Plans include also the erection of a small mill.

Portland Canal.—Wellington Beaton, president of Georgia River Gold Mines, Ltd., has returned to the property with a crew of men and has recommenced exploratory work, which is planned to include a comprehensive attack on the rather widespread ore occurrences on the property. A cross-cut is to be driven to intersect the south-west vein at a depth of 260 ft. below the point where good values were obtained in the No. 1 tunnel, the summit vein is to be explored on surface where attractive showings occur near the top of the mountain, and the value of the big quartz outcrops of the main vein south of the Bullion vein is to be probed by a cross-cut driven from the No. 3 tunnel. According to the Government engineer, there are a number of small rich veins, more or less parallelling one another, which would prove valuable "sweeteners" if a tonnage of milling-grade ore could be developed in the big vein.

Cariboo.—Prince George interests are reported to be connected with a revival of mining on Hixon Creek between Quesnel and Prince George, where there have been interesting discoveries of both placer and lode gold. This creek was mined originally over 50 years ago and a small stamp mill was erected to treat ore that had been discovered as a sequel to placer mining prospect work. It is stated that hitherto-unknown ore-bodies have been discovered in surface prospecting and some heavy nuggets have also been recovered recently. C. W. Moore, a well-known placer miner, who was at one time in the employ of the Provincial Government in the examination of placer areas, has taken an option on a property in the Lost Valley channel, between Swift River and Lightning Creek. It is reported that Reward Mining Company of Vancouver has acquired a group of gold-quartz claims near Barkerville that was owned and worked formerly by C. J. Seymour Baker. The property is situated on Proserpine mountain and lies within the mineralized zone which traverses this famous placer country. The vein occurrences were investigated in detail by W. A. Johnstone and the late W. L. Uglow, for the Geological Survey of Canada, and their report was published in 1926. The conclusion that was reached was that the placer gold of the region was derived from a belt of auriferous quartz veins of two distinct classes, namely large bodies of almost barren white quartz, sparsely mineralized with pyrite carrying low gold values, and a set of veins that cross-cut the former and which are well-mineralized with galena, arsenopyrite, pyrite, and siderite, and have some quantities of scheelite, sphalerite, and pyrrhotite. At the junctions of the two sets of veins there are usually developed shoots of sulphide minerals of considerable size. Both sets of veins are found on the property in question and a considerable amount of work was done by Mr. Baker in 1906 which resulted in opening up several ledges, all of which appeared to be low-grade on surface. Several shafts were sunk as well as a large amount of open-cutting and tunnelling. The plans of the present company include the continuation of an existing 125 ft. tunnel for an additional 1,000 ft., in which distance a point will be reached whence a rise may be put up to connect with old workings and permit of deeper development than has been yet attempted on this ground. It is stated that a contract for this work has been let. The company also proposes to erect a 50-ton mill in the near future.

Big Bend.—Total returns from the hydraulic operations of French Creek Development Company for the year amount to 363 oz. gold, and it is expected that there will be substantial additions to this amount before the season's work is terminated.

Boundary.—It is reported that the Molly Gibson group of six claims situated about 4 miles south-west of Paulson on the Canadian Pacific Railway in the Grand Forks district has been leased by O. M. Molander and associates and that extensive developments are planned. The property

is owned by the Molly Gibson (Burnt Basin) Mining Company, of Rossland, and has at different times attracted attention on account of the number of good showings of gold-silver ore that are found. The ore occurs as a siliceous replacement in limestone beds and, owing to the hardness of the ground and to lack of proper equipment, the development of the property has been slow. Active development at the Homestake property in the Franklin camp by Hecla Mining Company has been commenced with diamond drilling. Prospecting work that has been carried on since the company obtained an option on this claim is said to have given encouraging results and it is understood that an exhaustive programme of work has been laid out. A shipment of concentrate estimated to be worth about $110 per ton has been made from the Dividend-Lakeview property near Osoyoos, where operations were commenced recently by Lakeview Mining Company, Ltd.

East Kootenay.—Placer miners have been obtaining good results on Wild Horse Creek, where several small parties are working, and some good-sized nuggets have been found, the largest yet discovered having a value of $51·30. A New York group has commenced drilling operations with a view to estimating possibilities for dredging extensive areas along the creek. Three holes have been put down, and it is understood that the results were encouraging. The full programme of work that is outlined covers a stretch of 10 miles of the creek bed, requiring the drilling of 150 test holes.

Sheep Creek.—Progress at the Reno mine was described at a recent meeting of the company held in Vancouver. The No. 5 level that is being driven at a vertical depth of about 265 ft. below the level next above had been advanced 1,588 ft. and for the last 304 ft. of its length was in ore of good grade and width, which continued in the face. The average gold content of the vein on this level is stated to be 1·97 oz. per ton. An amount of 100,000 tons is said to be blocked out as a result of the development to date and the proof of this ore at a depth of 1,000 ft. below the outcrop holds promise of considerable possibilities in connexion with deeper work. In addition to these reserves in the Reno mine it is estimated that there is an amount of about 46,000 tons available in the Nugget and Motherlode mines that have been acquired by the company. All arrangements for the inauguration of productive operations are expected to be completed by the end of October, when the Motherlode mill will be ready to treat 100 tons per day, the ore being delivered over the new aerial ropeway and power being supplied by a new hydro-electric installation capable of developing 800 h.p.

PERSONAL

R. Allen is returning from the Gold Coast.
R. A. Archbold is returning from New Guinea.
J. Mackintosh Bell is here from Canada.
J. Chapman Brown has returned from Germany.
George S. Dyer has returned to California.
W. J. Evans is leaving for West Africa.
E. H. Greig has left Burma for Melbourne.
W. T. Harry has left Ontario for Colombia.
A. W. Jennings has joined the firm of F. W. Payne and Son.
Eldred A. Knapp has left for the United States.
A. D. Lumb has left for the Gold Coast.
H. E. McKinstry has left Ontario for Pennsylvania.
Alexander Rodger has returned to Spain.
C. H. Russell has left for Korea.
N. L. Smith is returning from Uganda.
Leslie F. Strong is home from Panama.
D. A. Sutherland has returned from Egypt, Palestine, and Transjordania.
E. O. Teale has left Tanganyika for Victoria.
William Thomas is returning to India.
W. H. Trewartha-James is home from Alaska.
H. S. Weigall has left Japan for France.
L. M. Winn has left for Sierra Leone.
Harley B. Wright is home from Spain.
H. W. Yates has left for New Guinea.

Robert E. Cranston died in San Francisco July 30. He was one of the pioneers in the gold dredging industry in California. He also had had extensive experience in the sampling and operation of lode properties in Colorado, California, and Montana. His work on alluvial properties took him to Brazil, Colombia, New Zealand, and Australia.

Frederick Henry Hatch died on September 22, at the age of 68. Dr. Hatch was a gold medallist and Tufnell scholar of London University and a Ph.D. of Bonn. He entered the Geological Survey in 1886, leaving in 1892 to follow the profession of mining engineering in South Africa, subsequently proceeding to Canada and the United States. In 1900 he was asked to report on the gold resources of India for the Indian Government and similar survey work followed in Abyssinia. Between 1902 and 1906 Dr. Hatch was consulting engineer to Messrs. Lewis and Marks and it was towards the end of this period that he was elected president of the Geological Society of South Africa. Further reporting work on mineral resources was undertaken, including those of Natal and Zululand, the Urals, and Canada. For 1914–1915 Dr. Hatch was president of the Institution of Mining and Metallurgy. He was also a Member of the Institution of Civil Engineers. During the war he rendered valuable service as a member of the Advisory Committee on Mineral Resources and in connexion with the Ministry of Munitions, in recognition of which he received the O.B.E. Of recent years Dr. Hatch has served on a number of commissions

to report on minerals or industries associated therewith, but he will best be remembered as the author of several standard works on geology and mineral resources.

TRADE PARAGRAPHS

O. T. Lempriere and Co., of 158, Fenchurch Street, London, E.C. 3, announce that their telephone number has been changed to Monument 3661–2.

Donald F. Foster has opened an office at 37, Little Ryrie Street, Geelong, Victoria, and is prepared to make examinations of mining prospects.

Renold and Coventry Chain Co., Ltd., of Manchester, issue their latest catalogue giving the prices of all the various chains, including roller, bush, and inverted tooth types, together with various accessories.

R. R. Knuckey, who has been with the Burma Corporation for 12 years, has opened an office at 831, Salisbury House, London, E.C. 2, as consulting engineer and is prepared to undertake plant inspection and adjustment in any part of the world.

United Steel Companies, Ltd., of Sheffield, in association with the **English Steel Corporation, Ltd.,** of Sheffield, have issued a brochure covering some 30 pages, which advocates the case for steel springs *versus* rubber, particularly in reference to their adoption in railway traction.

Murex Welding Processes, Ltd., of Ferry Lane Works, Forest Road, London, E. 17, send information with regard to electric welding in building construction as exemplified particularly by an extension of their own factory at Walthamstow, for which the steel girder work was entirely welded.

Mavor and Coulson, Ltd., of Broad Street, Glasgow, recently arranged a demonstration of their Joy loader, described in the MAGAZINE for May. By means of this coal was loaded into railway wagons at the rate of three tons per minute, 150 tons being moved by one man per hour. The electric power consumption was 0·068 B.O.T. units per ton.

Bureau of Information on Nickel of the Mond Nickel Co., Ltd., of Thames House, Millbank, London, S.W. 1, have published a booklet describing the applications of nickel alloy steel castings, among the instances of which are their employment in the manufacture of heavy hydraulic valves, gearing for tube-mills and such like, core cutter heads, and rack and pinion for operating bucket excavators.

Richard Garrett and Sons, Ltd., of Leiston, Suffolk, whose works have been almost completely idle since the affairs of Agricultural and General Engineers, Ltd., were put into the hands of a receiver, have been taken over by Beyer, Peacock, and Co., Ltd., of Manchester, the well-known locomotive manufacturers. In future the business will be carried on as Richard Garrett Engineering Works, branch of Beyer, Peacock, and Co., Ltd.

H. R. Marsden, Ltd., of Soho Foundry, Leeds, have published a new catalogue of their Blake-Marsden stone-breakers, which are already well known to mining men. These breakers are of the jaw type and are made in sizes of from 8 in. by 6 in. to 30 in. by 18 in., with corresponding capacities of 3 tons to 36 tons for stone 2½ in. and under. The catalogue gives details of the various component parts and mentions complete units for crushing and screening.

Sir Isaac Pitman and Sons, Ltd., of Parker Street, Kingsway, London, W.C. 2, have published No. 1 of a new edition of their *Engineering Educator*, which is to be completed in about thirty parts. The work covers mechanical engineering and all its branches, including sections on the running of steam boilers, air-compressors, and Diesel engines. It should prove useful to the mechanic and plant operator who has not had an opportunity of studying the theory of his subject.

Ruston and Hornsby, Ltd., of Lincoln, in conjunction with their associate company, Ruston-Lister Marine Co., Ltd., were exhibiting at the British Exhibition at Copenhagen. Their exhibits included a crude-oil locomotive of 16 b.h.p., described in the MAGAZINE for December, 1931, a 17 b.h.p. horizontal crude-oil engine, and some petrol-paraffin engines, while the Lister exhibits consisted of a 64 b.h.p. four-cylinder vertical oil engine, which develops 70 b.h.p. at 1,000 r.p.m., and a 38 b.h.p. marine engine.

Pulsometer Engineering Company, Ltd., of Nine Elms Iron Works, Reading, announce that they have received an order from the West Rand Consolidated Mines, Ltd., for the supply of five TR. 7 13-stage turbine centrifugal pumps, each to deliver 417 to 434 gallons per minute against a total head of 2,000 ft., when running at 1,460 r.p.m. Each set is in two units of 6 and 7 cells respectively, one unit being arranged at each end of the base-plate with a 500 b.h.p. motor between. These sets are duplicates of others supplied in 1919 and 1926.

Head, Wrightson, and Co., Ltd., of Stockton-on-Tees, issue a booklet describing the Colorado rod-mill, in which they claim that the crushing principle of the rod-mill is more positive than that of the ball-mill, because in the former the crushing is done on line contact, while in the latter it is done on point contact. The use of rods instead of balls, they state, allows for 30% more metal to a given volume and consequently a rod-mill may be made smaller in diameter than a ball-mill carrying the same weight of crushing media, thus entailing a lower power consumption.

British Flottmann Drill Co., Ltd., of Allensbank Works, Cardiff, announce that in future their hammer drills will be British made throughout. At their works there has been considerable activity in recent months in preparation for this and for drill manufacture on a much larger scale than has hitherto been possible. Numbers of new machines have been installed for drilling, grinding, hobbing, broaching, etc., all existing machinery has been completely overhauled, and the works staff has been much augmented. A new and greatly improved heat-treatment plant has also been laid down.

Filtrators, Ltd., of Hazlitt House, Southampton Buildings, London, W.C. 2, furnish particulars of their continuous blow-down system for use in conjunction with the Filtration system of feed-water treatment mentioned in the MAGAZINE last month. With the blow-down system is associated a means of heat recovery, the blow-down water being led to a heat exchanger where the sludge and salt content are eliminated to waste in concentrated form and the heat and pure water are returned to feed. It is claimed for this method that it is more economical than the usual intermittent practice and ensures clean boiler conditions.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, in their *Edgar Allen News* for September, have illustrated articles describing some of the heavy steel parts of a 3-cu. yd. electric shovel, the product of **Ransomes and Rapier, Ltd.,** of Ipswich. The same issue also contains some further details of their centrifugal vibrating screens, which have already been described in the MAGAZINE, and also a reference to the longest steel wire rope, the product of the **Whitecross Co., Ltd.,** of Warrington, which is 7¼ miles in length, without joints or splices, and weighs approximately 57 tons. The steel dies through which this wire was drawn were of Edgar Allen K. 9 oil-hardening steel.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report having received the following orders : For England : One 4 ft. by 3 ft. 1-surface type 72 Hum-mer screen, one 3 ft. Raymond separating plant for hydrated lime, one 3 ft. Raymond separating plant for lime, one 4 ft. by 5 ft. 2-surface type 39 Hum-mer electric screen for granite chippings, one 5-roller Raymond mill and Rayco separator for limestone, and one pneumatic air conveying plant for sodium formate. For Belgium : One No. 1 Raymond pulverizer for hydrated lime. For South Africa : Three No. 70 Impax pulverizers for hard coal. For Gold Coast : One Ro-tap testing sieve shaker. For Holland : One Ro-Tap testing sieve shaker. For Rumania : One Type 72 Hum-mer electric screen and one Ro-Tap testing sieve shaker.

METAL MARKETS

COPPER.—The standard copper market fluctuated quite appreciably during September but closed, on balance, at a moderate loss on the month. Some quite good buying, particularly on the Continent, was witnessed early in the month, but, later on, interest flagged. American consumers are taking a little more metal, but the industrial revival there, as distinguished from the Wall Street "boom," is only making a slow appearance. The market has been affected to some extent by the uncertainties connected with the proposed British import tariff and the policy of individual producers.

Average price of Cash Standard Copper : September, 1932, £35 0s. 7d. ; August, 1932, £31 9s. 1d. ; September, 1931, £31 11s. 1d. ; August, 1931, £32 12s. 3d.

TIN.—Sentiment remained cheerful throughout September and at one time £160 cash was touched though that position finally closed the month at about £152. There was a fair amount of industrial buying, both on European and American account, a feature being a sudden and non-seasonal improvement in the transatlantic tinplate industry. With the statistical position steadily improving, the undertone has inevitably been firm and the parties to the restriction scheme and the associated "pools" seem to have a fair amount of control over the market. The price of course has had a good jump from the lowest level of £100 cash witnessed earlier in the year.

Average price of cash standard tin : September, 1932, £152 16s. 3d. ; August, 1932, £142 2s. 4d. ; September, 1931, £117 17s. 10d. ; August, 1931, £114 19s. 1d.

LEAD.—The market exhibited marked strength early in September, some good buying being witnessed, especially on Continental account. Some of this purchasing was probably on behalf of actual consumers, but investors were also active, regarding metals as a profitable proposition in view of the economic and financial outlook. Later on, things quietened down, however, and in the United States (which had exhibited pronounced and consistent strength) weakness developed. To some extent, of course, the advances in all metals outstripped the actual economic improvement and it now remains for a genuine industrial revival to follow the stock markets boom to justify the better prices which, despite the setback, now rule.

Average mean price of soft foreign lead : September, 1932, £13 4s. 8d. ; August, 1932, £11 9s. 4d. ; September, 1931, £11 19s. 6d. ; August, 1931, £11 19s. 4d.

SPELTER.—Distinct firmness early in September, in common with all the non-ferrous metals, gave way later to easier conditions, but the market maintained a pretty good tone throughout. Sentiment has undoubtedly been strengthened by the knowledge that the statistical position is steadily improving, even though the demand from consumers is quieter than producers would like. This market is probably the healthiest of all the non-ferrous metals.

Average mean price of spelter : September, 1932, £15 10s. 8d. ; August, 1932, £13 14s. 4d. ; September, 1931, £11 16s. 4d. ; August, 1931, £11 14s. 7d.

IRON AND STEEL.—The British pig-iron market exhibited a rather cheerful aspect during September and there was a tendency for foundry pig-iron stocks to be reduced. The revival, however, can only be described as slight so far. Continental material is now virtually excluded from the British market, but Indian pig-iron is arriving in fair quantities. Cleveland makers, although they make concessions for Scottish business, maintain their minimum prices for local delivery, with No. 3 foundry priced at 58s. 6d. per ton. The hæmatite pig-iron market was a little brighter during the month, but prices were none too firm around 60s. per ton for East Coast Mixed Numbers. No noticeable improvement has yet occurred in the British finished steel industry though the shipbuilding outlook is a trifle more hopeful. The Continental market, however, is distinctly more active and firmer and the belief is now widely held on the other side of the Channel that the corner of the economic depression has been definitely turned as far as iron and steel is concerned.

IRON ORE.—In this country business has shown a slight expansion, a few works being able to take advantage of the cheap parcels now offering, but on the whole demand continues very poor. Best Bilbao rubio is nominally about 14s. 6d. per ton c.i.f.

ANTIMONY.—In the early part of September a fair business was done in Chinese regulus, but subsequently interest died away, and prices are now rather below the best at about £22 c.i.f. for forward shipment, and £25 ex warehouse for spot.

ARSENIC.—Moderate quantities continue to change hands at the unaltered prices of £24 10s. to £25 f.o.r. mines for 99% Cornish white and £23 to £23 10s. c.i.f. for high-grade Mexican.

BISMUTH.—There is no change in the official price of 4s. 6d. per lb. for 5 cwt. lots and over.

CADMIUM.—A very fair business has been done, mostly in moderate parcels, prices keeping steady at 1s. 8½d. to 1s. 9d. per lb.

LONDON DAILY METAL PRICES.

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard.		Electro-lytic	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	For-ward.	
Sept.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
12	36 0 7⅛	36 0 7½	39 5 0	—	155 2 6	156 17 6	15 12 6	13 8 9	15 5 0	18¼	18¼	118 0
13	31 11 3	31 11 3	36 0 0	33 10 0	147 12 6	149 5 0	15 0 0	12 6 3	14 5 0	17⅞	17¾	118 4
14	33 8 1⅛	33 6 10½	37 10 0	—	151 15 0	153 7 6	14 16 3	12 15 0	14 10 0	17 15/16	18	118 3
15	33 6 3	33 3 1½	37 10 0	—	149 12 6	151 7 6	14 15 0	12 11 3	14 10 0	17¾	18	118 6
16	34 1 3	34 1 3	38 0 0	36 0 0	151 15 0	153 7 6	15 5 0	12 18 9	14 15 0	17⅞	17¾	118 7
19	32 14 4½	32 14 4½	37 10 0	—	147 3 9	148 18 9	15 0 0	12 13 9	14 10 0	17 15/16	17 15/16	118 6
20	32 18 9	32 18 9	37 10 0	35 10 0	149 12 6	151 7 6	15 5 0	12 13 9	14 10 0	17⅞	17 15/16	118 8
21	34 15 7½	34 14 4½	38 5 0	—	151 17 6	153 12 6	15 7 6	12 18 9	14 10 0	17 15/16	17 15/16	118 10
22	35 15 0	35 16 3	39 10 0	—	154 8 9	156 3 9	15 15 0	13 6 3	15 0 0	18 1/16	18 1/16	119 1
23	35 3 1½	35 3 9	39 5 0	37 10 0	153 17 6	155 12 6	15 11 3	12 17 6	14 15 0	17⅞	17⅞	118 11
26	35 8 9	35 9 4½	39 5 0	—	153 5 0	154 18 9	15 11 3	13 2 6	15 0 0	17 15/16	17 15/16	119 1
27	34 6 3	34 8 1½	38 15 0	36 10 0	151 11 3	152 13 9	15 1 3	12 13 9	14 15 0	17 15/16	17 15/16	119 3
28	34 13 1½	34 14 4½	38 15 0	—	153 11 3	155 1 3	15 6 3	12 18 9	14 15 0	17⅞	17⅞	119 5
29	34 11 10½	34 13 1½	38 15 0	—	153 7 6	154 17 6	15 5 0	12 17 6	14 15 0	17 15/16	17 15/16	119 4
30	34 0 7½	34 3 1½	38 15 0	36 0 0	151 17 6	153 6 3	15 10 0	12 18 9	14 15 0	17 15/16	17 15/16	119 5
Oct.												
3	33 14 4½	33 16 10½	38 5 0	—	150 2 6	151 15 0	15 2 6	12 11 3	14 10 0	17 15/16	17 15/16	119 3
4	33 6 3	33 7 6	37 15 0	35 15 0	151 7 6	152 12 6	15 1 3	12 8 9	14 10 0	17 15/16	17 15/16	119 4
5	33 13 1½	33 14 4½	37 17 6	—	151 7 6	152 13 9	15 5 0	12 13 9	14 10 0	17 15/16	17 15/16	119 4
6	32 14 4½	32 16 10½	37 10 0	—	149 3 9	150 12 6	14 17 6	12 8 9	14 5 0	17 15/16	17⅞	119 5
7	32 10 7½	32 13 1½	36 17 6	34 15 0	148 18 9	150 8 9	14 13 9	12 5 0	14 0 0	17 15/16	17⅞	119 6
10	31 15 7½	31 19 4½	36 10 0	—	148 2 6	149 8 9	14 10 0	11 17 6	13 15 0	17⅞	17⅞	119 7
11	31 15 7½	31 18 9	36 10 0	34 0 0	149 8 9	150 12 6	14 12 6	11 16 3	13 15 0	17 15/16	17 15/16	119 6

COBALT METAL.—The official quotation is unaltered at 7s. per lb., but demand continues slack.

COBALT OXIDES.—Business is slow, but prices are fairly steady at about 4s. to 4s. 2d. per lb. for black and 4s. 10d. to 5s. for grey.

CHROMIUM.—There is no change in prices, which are about 2s. 9d. per lb. delivered.

TANTALUM.—The market is quietly steady at about £15 to £20 per lb.

PLATINUM.—Although September normally witnesses an expansion in demand this has been conspicuously absent this year. So much so, indeed, that prices have been lowered to £8 19s. to £9 5s. per oz. for refined metal.

PALLADIUM.—Very little interest has been shown in this metal recently, but prices are quotably unchanged at £4 to £4 5s. per oz.

IRIDIUM.—Sponge and powder are quietly steady at about £12 to £14 per oz.

OSMIUM.—Prices remain at about £11 10s. to £12 10s. per oz., with sales still very limited.

TELLURIUM.—Only occasional lots change hands, prices being rather nominal in the region of 20s. per lb.

SELENIUM.—High-grade black powder is unaltered at 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse.

MANGANESE ORE.—Buying interest is still very restricted, although now and then odd cargoes change hands. Prices have tended to stiffen a little owing to the limited freight space now offering, but quotably they are unchanged at 9½d. per unit c.i.f. for best Indian, and 8½d. to 9d. c.i.f. for 50 to 52% washed Caucasian.

ALUMINIUM.—Towards the end of September the price in this country was raised to £100 less 2% delivered for ingots and bars, and £102 for rolling billets. Demand has not improved appreciably, but for some time the sterling quotation has been under the parity of the international price, which remains at £80 (gold) per metric ton, and with some signs of industrial improvement makers have brought prices more into line.

SULPHATE OF COPPER.—About £17 15s. to £18 5s., less 5%, is now quoted for English material

NICKEL.—Although demand is slow prices are steadily maintained at £240 to £245 per ton, according to quantity.

CHROME ORE.—Some expansion in demand is noted, although business generally remains slow. Prices are steady at 80s. to 85s. per ton c.i.f. for good 48% Rhodesian, and 92s. 6d. to 97s. 6d. for 52 to 54% Baluchistan ore. New Caledonian is about 100s. to 110s. c.i.f. for 55 to 57%.

QUICKSILVER.—Whilst sales have not been at all impressive, prices have been pretty well maintained, spot being quoted at £9 17s. 6d. to £10 per bottle, net.

TUNGSTEN ORE.—Consumption remains very depressed, and although at one time sellers of ore for shipments from China raised their ideas, buyers did not follow suit. The current value lies between 11s. and 11s. 6d. per unit c.i.f.

MOLYBDENUM ORE.—There is not much available and prices are firm, about 42s. 6d. per unit of metal being asked.

GRAPHITE.—Prices are nominally unchanged at £17 to £19 c.i.f. for 85 to 90% raw Madagascar flake, and £15 to £17 c.i.f. for 90% Ceylon lumps.

SILVER.—At the beginning of September the market wore quite a firm appearance, Indian buying raising prices from 18 7/16d. on September 1 to 18 13/16d. on September 6. American purchasing then quietened down and with some reselling from that quarter coupled with Chinese offerings, prices declined to 17⅞d. on September 15 Subsequently, the market was rather inactive. for although India and China bought a little, the latter country turned seller on any sign of strength and America continued to offer small quantities. On September 30 spot bars closed at 17 15/16d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
September, 1931	872,053	43,971	916,024
October	900,353	44,760	945,113
November	855,102	45,408	900,510
December	877,178	46,175	923,353
January, 1932	890,688	46,096	936,784
February	869,711	44,301	914,012
March	914,017	46,018	960,035
April	901,894	47,902	949,796
May	919,223	46,421	965,644
June	913,297	45,714	959,011
July	933,947	47,213	981,160
August	943,174	48,148	991,322
September	912,870	48,631	961,501

TRANSVAAL GOLD OUTPUTS.

	August.		September.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	115,000	£168,146	110,500	£154,796
City Deep	86,500	22,173	83,000	21,459
Cons. Main Reef	73,000	24,303	70,500	24,017
Crown Mines	285,000	89,408	279,000	88,520
Daggafontein	44,000	£71,293	44,000	£70,203
D'rb'n Roodepoort Deep	50,000	15,826	49,000	15,499
East Geduld	61,600	20,022	61,500	20,030
East Rand P.M.	161,500	42,607	158,000	41,675
Geduld	86,800	27,676	84,000	26,796
Geldenhuis Deep	78,100	17,627	76,000	17,427
Glynn's Lydenburg	7,100	2,525	7,200	2,657
Government G.M. Areas	212,000	£420,404	207,000	£406,414
Kleinfontein	54,000	10,984	50,500	10,515
Langlaagte Estate	82,000	£109,674	82,000	£106,066
Luipaard's Vlei	34,700	8,673	34,500	8,656
Meyer and Charlton	—	—	—	—
Modderfontein New	175,000	64,223	174,000	62,982
Modderfontein B	77,500	21,960	76,000	21,262
Modderfontein Deep	46,100	22,321	44,800	21,529
Modderfontein East	77,500	22,605	76,000	22,319
New State Areas	92,000	£187,770	89,000	£180,586
Nourse	72,000	21,511	71,000	21,078
Randfontein	250,000	£302,205	240,000	£293,877
Robinson Deep	100,000	28,629	98,400	28,453
Rose Deep	65,700	13,302	61,000	12,888
Simmer and Jack	79,900	22,164	68,500	18,932
Springs	81,000	£169,053	77,500	£160,873
Sub Nigel	37,200	33,232	36,200	33,163
Transvaal G.M. Estates	19,100	5,744	18,500	5,548
Van Ryn	51,500	£46,707	50,000	£46,737
Van Ryn Deep	74,000	£94,127	71,000	£92,099
West Rand Consolidated	96,500	£108,331	93,500	£105,483
West Springs	81,500	£82,310	80,000	£78,880
Witw'tersr'nd (Knights)	70,000	£56,143	70,000	£54,504
Witwatersrand Deep	49,900	15,888	48,700	15,492

Values in S.A. currency.

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
June, 1931	2,698,100	28 0	19 7	8 5	1,140,399
July	2,771,400	27 10	19 6	8 4	1,155,466
August	2,799,800	27 10	19 5	8 5	1,159,382
September	2,765,400	27 10	19 5	8 5	1,162,355
October	2,870,800	27 8	19 3	8 5	1,210,743
November	2,726,720	27 10	19 5	8 5	1,144,208
December	2,793,900	27 10	19 5	8 5	1,173,732
January, 1932	2,880,500	27 5	19 4	8 1	1,163,434
February	2,775,400	27 8	19 6	8 2	1,133,212
March	2,901,300	27 10	19 7	8 3	1,200,278
April	2,883,500	27 9	19 5	8 4	1,196,011
May	2,964,100	27 6	19 2	8 4	1,228,198
June	2,927,200	27 9	19 3	8 6	1,241,392
July	2,993,600	27 5	19 0	8 5	1,260,744
August	—	—	—	—	1,277,923

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
September 30, 1931	209,424	13,276	1,626	224,326
October 31	208,987	13,061	1,517	223,565
November 30	209,270	12,882	1,429	223,581
December 31	211,552	12,260	1,402	225,214
January 31, 1932	215,752	12,394	1,598	229,744
February 29	216,171	12,177	1,363	229,711
March 31	214,024	12,009	—	226,033
April 30	214,334	11,943	—	226,277
May 31	215,926	11,972	—	227,898
June 30	217,077	11,833	—	228,910
July 31	217,525	12,056	—	229,581
August 31	217,658	11,727	—	229,385
September 30	216,398	11,642	—	228,040

PRODUCTION OF GOLD IN RHODESIA.

	1929	1930	1931	1932
	oz.	oz.	oz.	oz.
January	46,231	46,121	45,677	42,706
February	44,551	43,385	42,818	45,032
March	47,388	45,511	42,278	47,239
April	48,210	45,806	43,776	46,487
May	48,189	47,645	43,731	46,854
June	48,406	45,208	44,118	48,441
July	46,369	45,810	44,765	47,331
August	46,473	46,152	43,292	49,254
September	45,025	46,151	42,846	—
October	46,923	45,006	44,260	—
November	46,219	44,351	44,516	—
December	46,829	46,485	50,034	—

RHODESIAN GOLD OUTPUTS.

	August.		September.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,200	9,622	25,400	9,619
Globe and Phœnix	6,208	6,376	6,054	6,362
Lonely Reef	8,600	2,328	8,800	2,296
Luiri Gold	—	—	—	—
Rezende	6,500	2,553	6,500	2,556
Sherwood Star	4,800	£7,907	4,800	£8,129
Wanderer Consolidated	15,300	3,400	14,800	3,388

WEST AFRICAN GOLD OUTPUTS.

	August.		September.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	6,150	£17,085	6,211	£18,083
Ashanti Goldfields	13,430	14,629	13,374	14,617
Taquah and Abosso	10,100	3,312	10,350	3,457

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
September, 1931	38,173	—	638
October	52,741	7,838*	1,031
November	53,869	4,758	1,428
December	49,215	4,700	1,224
January, 1932	44,037	—	916
February	44,672	—	981
March	47,108	9,735†	769
April	48,936	3,912	1,216
May	53,928	2,782	692
June	50,079	—	920
July	53,585	—	—
August	51,536	—	—
September	54,427	—	—

* Sept. and Oct. † Jan., Feb., and March.

AUSTRALASIAN GOLD OUTPUTS.

	August.		September.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,377	5,944	5,168	5,358
Blackwater (N.Z.)	3,602	2,126	3,605	2,015
Boulder Persev'ce (W.A.)	8,359	14,531	7,701	14,274
Grt. Boulder Pro. (W.A.)	7,400	23,990	6,968	22,636
Lake View & Star (W.A.)	30,063	38,659	29,936	38,720
Sons of Gwalia (W.A.)	12,692	16,461	12,554	16,092
South Kalgurli (W.A.)	9,628	17,157	9,447	15,727
Waihi (N.Z.)	18,864	{ 6,602* 37,688†	18,538‡	{ 6,045* 38,519†
Wiluna	28,437	48,883	—	—

* Oz. gold. † Oz. silver. ‡ To Sept. 17.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA

	August.		September.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Balaghat	—	1,749	—	655
Champion Reef	9,360	5,628	9,060	5,625
Mysore	14,650	7,390	14,350	7,339
Nundydroog	13,967	9,470†	15,000	9,079*
Ooregum	11,750	4,199	12,500	4,364

* 1,650 oz. from 1,521 tons Balaghat ore. † 2,070 oz. from 1,661 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	August.		September.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	48,492*d*†	—	—
Chosen Corp. (Korea)	10,290	14,933	10,260	14,653
Frontino Gold (Colombia)	3,750	15,821	3,160	16,641
Fresnillo	77,962	4,468*d*‡	—	—
New Goldfields of Venezuela	8,589	2,727*	9,036	2,230*
Oriental Cons. (Korea)	—	70,056*d*	—	66,304*d*
St. John del Rey (Brazil)	—	44,000	—	37,200
Santa Gertrudis (Mexico)	23,589	32,486*d*	22,046	25,091*d*
Viborita	—	—	—	2,274
West Mexican Mines	1,570	23,300*d*	—	—

d Dollars. * Oz. gold. † To Sept. 11. ‡ Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1932	3,014	July, 1932	1,437
February	2,132	August	1,164
March	3,064	September	1,123
April	3,333	October	2,075
May	2,276	November	—
June	2,491	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	July.	August.	Sept.
Ayer Hitam	—	—	32½
Batu Caves	—	—	—
Changkat	—	—	20
Gopeng	—	—	24½
Hongkong Tin	—	—	31½
Idris Hydraulic	—	—	12
Ipoh	—	—	26½
Kampar Malaya	—	—	—
Kampong Lanjut	35	25	—
Kamunting	—	—	113
Kent (F.M.S.)	—	—	—
Killinghall	32½	33½	32
Kinta	—	—	11½
Kinta Kellas	—	—	—
Kramat Tin	70	75	80
Kuala Kampar	—	—	—
Kundang	—	—	—
Lahat	11½	—	11
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	59½	48	52½
Malim Nawar	20	28	30
Pahang	78	78	78
Penawat	—	—	42
Pengkalen	—	—	22½
Petaling	—	—	90
Rahman	25	—	—
Rambutan	—	—	4½
Rantau	—	—	—
Rawang	30	30	33
Rawang Concessions	35	60	25
Renong	—	—	7½
Selayang	—	—	—
Southern Kampar	—	—	53½
Southern Malayan	59½	46	51½
Southern Perak	38½	—	19½
Southern Tronoh	—	—	17½
Sungei Besi	—	—	—
Sungei Kinta	—	—	24
Sungei Way	—	—	38½
Taiping	—	—	—
Tanjong	—	—	11½
Tekka	—	—	39*
Tekka Taiping	—	—	22
Temoh	—	—	—
Tronoh	—	—	38½
Ulu Klang	—	—	—

* 3 months to Sept. 30.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	July.	August.	Sept.
Anglo-Nigerian	12½	12⅞	17½
Associated Tin Mines	108	108½	107½
Baba River	—	—	1
Batura Monguna	—	—	—
Bisichi	—	17	—
Daffo	—	—	—
Ex-Lands	23	—	23½
Filani	—	—	—
Jantar	10	10	—
Jos	7½	7½	—
Juga Valley	5	5	5½
Kaduna Syndicate	13	13	11½
Kaduna Prospectors	7	7	5½
Kassa	8	8	5
London Tin	75	77	76
Lower Bisichi	8½	5½	—
Naraguta Extended	—	—	—
Nigerian Consolidated	5	5	5
Offin River	—	—	—
Ribon Valley	10	10	9
Tin Fields	—	—	—
United Tin Areas	11	12	10
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	July.	August.	Sept.
Anglo-Burma (Burma)	43½	48	—
Aramayo Mines (Bolivia)	119	114	129
Bangrin (Siam)	—	38⅜	36¼
Beralt	26½*	26½*	—
Consolidated Tin Mines (Burma)	120	150	140
East Pool (Cornwall)	46½	36	41½
Fabulosa (Bolivia)	—	38	32
Kagera (Uganda)	25	25	—
Kamra	—	—	—
Malaysiam Tin	13½	14½	14¼
Mawchi	193*	198*	208*
Patino	—	—	—
Pattani	—	—	—
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	—	152½	170½
South Crofty	52	55½	53¾
Tavoy Tin (Burma)	73	97¾	69
Tongkah Harbour (Siam)	30	45	40
Toyo (Japan)	72	75	59½
Zaaiplaats	—	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		August.	Sept.
Britannia Lead	Tons refined lead	4,058	2,618
	Oz. refined silver	82,002	274,070
Broken Hill South	Tons lead conc.	5,044	5,612
	Tons zinc conc.	5,573	6,286
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	475,032	480,634
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	380	383
	Tons yellow metal	—	507
Messina	Tons copper	739	669
Mount Isa	Tons lead bullion	3,771	4,406
Mount Lyell	Tons concentrates	3,305*	3,280†
North Broken Hill	Tons lead conc.	4,980	2,840
	Tons zinc conc.	4,800	2,870
Rhodesia Broken Hill	Tons V_2O_5	32½	30
	Tons V_2O_5 conc.	100	100
Roan Antelope	Tons concentrates	—	—
	Tons blister copper	2,166	3,017
Sulphide Corporation	Tons lead conc.	1,748	—
	Tons zinc conc.	2,579	—
Trepca	Tons lead conc.	4,892	4,795
	Tons zinc conc.	7,323	7,863
Zinc Corporation	Tons lead conc.	5,671	—
	Tons zinc conc.	4,296	—

* To August 10. † To Sept. 3.

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

		July.	August.
Iron Ore	Tons	134,162	101,434
Manganese Ore	Tons	5,162	9,630
Iron and Steel	Tons	118,740	105,072
Copper and Iron Pyrites	Tons	13,564	34,729
Copper Ore, Matte, and Prec.	Tons	805	961
Copper Metal	Tons	10,402	18,731
Tin Concentrate	Tons	2,260	4,926
Tin Metal	Tons	170	120
Lead Pig and Sheet	Tons	17,118	21,997
Zinc (Spelter)	Tons	6,360	2,674
Zinc Sheets, etc.	Tons	1,743	1,298
Zinc Oxide	Tons	11	670
Zinc Ore	Tons	15,800	4,395
Aluminium	Tons	177	1,823
Mercury	Lb.	95,553	192,925
White Lead	Cwt.	4,703	4,417
Barytes, ground	Cwt.	24,874	14,133
Asbestos	Tons	1,334	1,023
Boron Minerals	Tons	814	739
Borax	Cwt.	11,400	8,741
Basic Slag	Tons	1,054	400
Superphosphates	Tons	1,345	3,687
Phosphate of Lime	Tons	46,971	41,892
Mica	Tons	112	118
Tungsten Ores	Tons	308	471
Sulphur	Tons	3,067	5,455
Nitrate of Soda	Cwt.	7	10,085
Potash Salts	Cwt.	294,411	491,013
Petroleum: Crude	Gallons	43,857,257	32,538,683
Lamp Oil	Gallons	9,293,690	15,205,089
Motor Spirit	Gallons	83,839,798	103,769,067
Lubricating Oil	Gallons	5,691,640	5,479,627
Gas Oil	Gallons	4,281,893	6,483,496
Fuel Oil	Gallons	43,030,277	55,335,331
Asphalt and Bitumen	Tons	9,817	14,103
Paraffin Wax	Cwt.	58,715	63,900

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	July.	August.	Sept.
Anglo-Ecuadorian	16,928	16,226	15,578
Apex Trinidad	51,260	48,230	48,650
Attock	1,998	1,543	1,397
British Burmah	3,875	3,798	3,662
British Controlled	42,263	43,019	40,171
Kern Mex	830	852	834
Kern River (Cal.)	2,067	2,518	2,275
Kern Romana	76	93	82
Kern Trinidad	1,766	1,703	1,545
Lobitos	25,260	25,013	23,912
Phœnix	80,434	97,900	105,139
St. Helen's Petroleum	4,903	4,770	4,678
Steaua Romana	98,968	103,504	108,507
Tampico	2,294	2,391	2,352
Tocuyo	1,253	1,161	—
Trinidad Leaseholds	28,600	27,600	28,600

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Sept. 9, 1932.	Oct. 11, 1932.
	£ s. d.	£ s. d.
Anglo-Ecuadorian	11 3	10 9
Anglo-Egyptian B	1 13 0	1 15 0
Anglo-Persian 1st Pref.	1 8 0	1 9 6
,, ,, Ord.	2 5 0	2 11 9
Apex Trinidad (5s.)	16 0	1 0 6
Attock	12 6	10 6
British Burmah (8s.)	5 0	4 6
British Controlled ($5)	2 6	4 0
Burmah Oil	3 3 9	3 5 0
Kern River Cal. (10s.)	3 0	2 9
Lobitos, Peru	2 3 9	1 18 9
Mexican Eagle, Ord. (4 pesos)	8 6	7 9
,, ,, 8% Pref. (4 pesos)	8 3	7 6
Phœnix, Roumanian	10 9	11 9
Royal Dutch (100 fl.)	19 15 0	17 12 6
Shell Transport, Ord.	2 10 9	2 9 0
,, ,, 5% Pref. (£10)	11 2 6	11 10 0
Steaua Romana	10 0	8 9
Trinidad Leaseholds	1 16 9	2 11 9
United British of Trinidad (6s. 8d.)	4 3	4 6
V.O.C. Holding	1 13 9	1 11 3

PRICES OF CHEMICALS. Oct. 10.

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

		£ s. d.
Acetic Acid, 40%	per cwt.	19 9
,, ,, 80%	,,	1 16 5
,, ,, Glacial	per ton	59 0 0
Alum	,,	8 7 6
Aluminium Sulphate, 17 to 18%	,,	6 15 0
Ammonium, Anhydrous	per lb.	1 0
,, 0·880 solution	per ton	15 10 0
,, Carbonate	,,	27 10 0
,, Nitrate (British)	,,	16 0 0
,, Phosphate, comml.	,,	40 0 0
,, Sulphate, 20·6% N.	,,	5 5 0
Antimony, Tartar Emetic, 43/44%	per lb.	10
,, Sulphide, golden	,,	9
Arsenic, White (foreign)	per ton	22 0 0
Barium, Carbonate (native), 94%	,,	4 10 0
,, Chloride	,,	10 10 0
Barytes	,,	8 5 0
Benzol, standard motor	per gal.	1 6½
Bleaching Powder, 35% Cl.	per ton	8 15 0
Borax	,,	16 10 0
Boric Acid	,,	26 10 0
Calcium Chloride, solid, 70/75%	,,	5 15 0
Carbolic Acid, crude 60's	per gal.	1 7
,, ,, crystallized, 40°	per lb.	6
Carbon Disulphide	per ton	30 0 0
Citric Acid	per lb.	10½
Copper Sulphate	per ton	16 5 0
Creosote Oil (f.o.b. in Bulk)	per gal.	4½
Cresylic Acid, 98–100%	,,	1 3
Hydrofluoric Acid, 59/60%	per lb.	6
Iodine	,,	1 0 11
Iron, Nitrate 80° Tw.	per ton	6 0 0
,, Sulphate	,,	1 15 0
Lead, Acetate, white	,,	31 0 0
,, Nitrate (ton lots)	,,	27 10 0
,, Oxide, Litharge	,,	29 10 0
,, White	,,	39 10 0
Lime, Acetate, brown	,,	8 10 0
,, ,, grey, 80%	,,	11 0 0
Magnesite, Calcined	,,	8 5 0
Magnesium Chloride	,,	5 10 0
,, Sulphate, comml.	,,	4 10 0
Methylated Spirit Industrial 61 O.P.	per gal.	2 0
Nitric Acid, 80° Tw.	per ton	23 0 0
Oxalic Acid	per cwt.	2 5 6
Phosphoric Acid. (Conc. 1·750)	per lb.	10
Pine Oil	per cwt.	2 7 6
Potassium Bichromate	per lb.	5
,, Carbonate, 96/98%	per ton	29 10 0
,, Chlorate	per lb.	4
,, Chloride, 80%	per ton	9 10 0
,, Ethyl Xanthate	per 100 kilos	7 0 0
,, Hydrate (Caustic) 88/90%	per ton	39 0 0
,, Nitrate	,,	30 0 0
,, Permanganate	per lb.	8½
,, Prussiate, Yellow	,,	8
,, ,, Red	,,	2 0
,, Sulphate, 90%	per ton	10 10 0
Sodium Acetate	,,	19 10 0
,, Arsenate, 45%	,,	23 0 0
,, Bicarbonate	,,	10 10 0
,, Bichromate	per lb.	4
,, Carbonate (Soda Ash), 58%	per ton	6 0 0
,, ,, (Crystals)	,,	5 5 0
,, Chlorate	,,	28 10 0
,, Cyanide, 100% NaCN basis	per lb.	8
,, Ethyl Xanthate	per 100 kilos	6 12 6
,, Hydrate, 76%	per ton	14 0 0
,, Hyposulphite, comml.	,,	9 2 6
,, Nitrate (ordinary)	,,	8 9 0
,, Phosphate, comml.	,,	12 0 0
,, Prussiate	per lb.	5
,, Silicate	per ton	9 10 0
,, ,, (liquid, 140° Tw.)	,,	8 10 0
,, Sulphate (Glauber's Salt)	,,	2 15 0
,, ,, (Salt-Cake)	,,	3 1 0
,, Sulphide, Conc., 60/65%	,,	10 15 0
,, Sulphite, pure	per cwt.	14 0
Sulphur, Flowers	per ton	10 0 0
,, Roll	,,	10 10 0
Sulphuric Acid, 168° Tw.	,,	4 5 0
,, ,, free from Arsenic, 140° Tw.	,,	3 0 0
Superphosphate of Lime (S.P.A. 16%)	,,	3 4 0
Tartaric Acid	per lb.	10½
Turpentine	per ton	64 0 0
Tin Crystals	per lb.	1 0
Titanous Chloride	,,	10½
Zinc Chloride	per ton	9 10 0
,, Dust, 90/92%	,,	20 0 0
,, Oxide (White Seal)	,,	35 0 0
,, Sulphate	,,	8 10 0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Sept. 9, 1932. £ s. d.	Oct. 10, 1932. £ s. d.
SOUTH AFRICA:		
Brakpan	4 1 9	4 5 6
City Deep	8 9	10 0
Consolidated Main Reef	1 4 0	1 6 0
Crown Mines (10s.)	5 16 9	6 1 3
Daggafontein	2 18 9	3 1 3
Durban Roodepoort Deep (10s.)	1 3 9	1 3 6
East Geduld	3 16 3	4 1 0
East Rand Proprietary (10s.)	15 3	15 3
Geduld	4 16 3	4 18 0
Geldenhuis Deep	11 9	11 9
Glynn's Lydenburg	12 6	11 3
Government Gold Mining Areas (5s.)	1 15 0	1 16 3
Grootvlei	1 8 9	1 10 0
Langlaagte Estate	1 2 0	1 0 0
Meyer & Charlton	1 10 0	1 10 0
Modderfontein New (10s.)	2 8 0	2 6 3
Modderfontein B (5s.)	12 9	12 0
Modderfontein Deep (5s.)	15 6	15 9
Modderfontein East	2 5 6	2 3 9
New State Areas	3 0 0	3 0 0
Nourse	1 0 0	18 3
Randfontein	2 0 0	2 2 0
Robinson Deep A (1s.)	14 3	14 6
,, B (7s. 6d.)	15 0	14 3
Rose Deep	8 0	7 3
Simmer & Jack (2s. 6d.)	4 3	4 3
Springs	4 11 9	4 12 0
Sub Nigel (10s.)	5 8 9	5 17 6
Van Ryn	14 0	13 9
Van Ryn Deep	1 2 9	1 3 0
Village Deep (9s. 6d.)	1 6	1 6
West Rand Consolidated (10s.)	18 3	17 9
West Springs	1 3 0	1 6 6
Witwatersrand (Knights)	10 6	10 0
Witwatersrand Deep	8 6	7 9
RHODESIA:		
Cam and Motor	2 6 3	2 8 0
Globe and Phœnix (5s.)	19 6	16 6
Lonely Reef	16 9	15 0
Luiri Gold	2 6	2 6
Rezende	1 11 3	1 10 0
Sherwood Starr (5s.)	17 9	17 6
GOLD COAST:		
Ariston New	5 0	6 3
Ashanti (4s.)	1 16 6	1 17 0
Taquah and Abosso (5s.)	6 0	8 0
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	4 9	4 3
Great Boulder Propriet'y (2s.), W.A.	7 3	7 6
Lake View and Star (4s.), W.A.	15 0	15 6
Sons of Gwalia, W.A.	12 3	12 3
South Kalgurli (10s.), W.A.	1 1 0	1 0 6
Waihi (5s.), N.Z.	16 0	16 0
Wiluna Gold, W.A.	1 5 0	2 2 9
INDIA:		
Balaghat (10s.)	13 6	11 6
Champion Reef (10s.)	18 6	19 6
Mysore (10s.)	13 6	13 0
Nundydroog (10s.)	1 13 6	1 17 0
Ooregum (10s.)	6 3	5 6
AMERICA:		
Camp Bird (3s.), Colorado	6	¼
Exploration (10s.)	3 3	3 0
Frontino and Bolivia, Columbia	19 3	1 0 0
Mexican Corporation, Mexico (10s.)	5 6	4 9
Mexico Mines of El Oro, Mexico	3 3	3 3
New Goldfields of Venezuela	4 3	4 0
St. John del Rey, Brazil	1 2 0	1 7 6
Santa Gertrudis, Mexico	8 0	6 6
Selukwe (2s. 6d.), British Columbia	3 0	3 0
MISCELLANEOUS:		
Chosen, Korea	3 0	6 9
Lena Goldfields, Russia	5	6
New Guinea	6 6	6 3

COPPER:		
Bwana M'Kubwa (5s.), Rhodesia	4 9	3 9
Esperanza Copper	13 9	7 3
Indian (2s.)	1 6	1 3
Loangwa (5s.), Rhodesia	2 0	1 6
Messina (5s.), Transvaal	7 6	5 6
Mount Lyell, Tasmania	19 0	19 0
Namaqua (£2), Cape Province	3 6	2 6
Rhodesia-Katanga	12 6	11 3
Rio Tinto (£5), Spain	20 0 0	16 5 0
Roan Antelope (5s.), Rhodesia	11 6	9 9
Tanganyika Con.	1 2 6	17 0
Tharsis (£2), Spain	3 11 3	2 16 3

LEAD-ZINC:	Sept. 9, 1932. £ s. d.	Oct. 10, 1932. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	7 6	6 3
Broken Hill, Proprietary, N.S.W.	16 9	18 6
Broken Hill, North, N.S.W.	3 0 0	2 18 9
Broken Hill, South, N.S.W.	2 2 6	2 0 0
Burma Corporation (10 rupees)	11 6	10 3
Electrolytic Zinc Pref., Tasmania	18 9	1 3 9
Mount Isa, Queensland	13 6	12 0
Rhodesia Broken Hill (5s.)	1 9	1 6
San Francisco (10s.), Mexico	11 0	9 0
Sulphide Corporation (15s.), N.S.W.	8 9	8 0
ditto, Pref.	12 0	11 0
Zinc Corporation (10s.), N.S.W.	1 3 9	1 3 9
ditto, Pref.	3 7 6	3 5 0
TIN:		
Aramayo Mines (25 fr.), Bolivia	17 6	15 0
Associated Tin (5s.), Nigeria	6 0	5 0
Ayer Hitam (5s.)	13 0	11 9
Bangrin, Siam	16 3	13 6
Bisichi (10s.), Nigeria	6 3	6 3
Chenderiang, Malay	9	—
Consolidated Tin Mines of Burma	5 0	4 0
East Pool (5s.), Cornwall	1 0	9
Ex-Lands Nigeria (2s.), Nigeria	1 9	1 3
Geevor (10s.), Cornwall	4 0	3 6
Gopeng, Malaya	1 12 6	1 10 0
Hongkong (5s.)	14 0	13 6
Idris (5s.), Malaya	7 0	7 0
Ipoh Dredging (16s.), Malay	16 3	15 6
Kaduna Prospectors (5s.), Nigeria	3 9	3 6
Kaduna Syndicate (5s.), Nigeria	12 6	12 0
Kamunting (5s.), Malay	6 9	5 4
Kepong, Malay	7 6	7 6
Kinta, Malay (5s.)	6 3	5 6
Kinta Kellas, Malay (5s.)	5 3	5 0
Kramat Pulai, Malay	19 3	17 6
Kramat Tin	1 10 0	1 10 0
Lahat, Malay	3 0	5 0
Malayan Tin Dredging (5s.)	1 0 0	17 9
Naraguta, Nigeria	8 9	8 9
Nigerian Base Metals (5s.)	6	—
Pahang Consolidated (5s.), Malay	6 6	5 6
Penawat ($1), Malay	1 6	1 3
Pengkalen (5s.), Malay	10 0	8 9
Petaling (2s. 4d.), Malay	10 6	9 9
Rambutan, Malay	5 0	5 0
Renong Dredging, Malay	16 3	16 3
Siamese Tin (5s.), Siam	9 6	7 6
South Crofty (5s.), Cornwall	3 0	2 9
Southern Malayan (5s.)	11 3	9 3
Southern Perak, Malay	1 5 0	1 5 0
Southern Tronoh (5s.), Malay	6 0	5 6
Sungei Besi (5s.), Malay	8 0	7 6
Sungei Kinta, Malay	13 0	11 6
Tanjong (5s.), Malay	7 0	7 0
Tavoy (4s.), Burma	5 9	4 0
Tekka, Malay	12 6	12 0
Tekka Taiping, Malay	13 0	12 0
Toyo (10s.), Japan	2 6	2 6
Tronoh (5s.), Malay	16 3	15 0
DIAMONDS:		
Consol. African Selection Trust (5s.)	11 3	15 0
Consolidated of S.W.A. (10s.)	5 0	4 3
De Beers Deferred (£2 10s.)	5 2 6	4 0 0
Jagersfontein	1 8 9	1 1 3
Premier Preferred (5s.)	1 12 6	1 5 0
FINANCE, ETC.:		
Anglo-American Corporation (10s.)	12 6	11 6
Anglo-French Exploration	16 6	15 0
Anglo-Continental (10s.)	4 3	4 0
Anglo-Oriental (Ord., 5s.)	6 6	6 6
ditto, Pref.	11 0	11 3
British South Africa (15s.)	1 1 3	18 6
Central Mining (£8)	12 0 0	11 7 6
Consolidated Gold Fields	1 12 6	1 16 3
Consolidated Mines Selection (10s.)	11 3	9 6
Fanti Consols (8s.)	7 6	8 0
General Mining and Finance	1 8 6	1 6 9
Gold Fields Rhodesian (10s.)	4 6	4 3
Johannesburg Consolidated	1 13 3	1 11 6
London Tin Corporation (10s.)	12 3	9 6
Minerals Separation	3 7 6	3 5 0
National Mining (8s.)	3	6
Rand Mines (5s.)	4 1 3	3 18 9
Rand Selection (5s.)	12 3	11 6
Rhodesian Anglo-American (10s.)	13 6	11 0
Rhokana Corp.	5 7 6	4 12 6
Rhodesian Selection Trust (5s.)	6 6	5 3
South Rhodesia Base Metals	2 6	1 6
Tigon (5s.)	2 3	3 0
Union Corporation (12s. 6d.)	3 2 6	2 19 0
Venture Trust (10s.)	5 9	5 3

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

THE PERRUNAL-LA ZARZA ORE-BODY, HUELVA DISTRICT

The *Bulletin* of the Institution of Mining and Metallurgy for September contains a paper by G. Williams on the Perrunal-La Zarza pyritic ore-body, extracts from which are given here. The author is concerned mainly with the genesis of the ore and the application of his conclusions to the genesis of similar bodies in the district, but he also gives an account of the geology of the area. In the introduction to his paper he says that the mineral province of southern Iberia extends from the province of Alemtejo in Portugal, across the international boundary, and through the Spanish provinces of Huelva, Sevilla, and Cordova. The largest mines now operating are those at Rio Tinto, Calañas (La Zarza), Tharsis, and S. Domingos. The Perrunal-La Zarza ore-body is situated in the province of Huelva, 55 km. by rail north of the port of Huelva. The ore-body is 2500 m. long, and is worked by two companies: The Tharsis Sulphur and Copper Co., Ltd., Glasgow, and the Société Française des Pyrites de Huelva, Paris. The part worked by the French company is at the extreme western end, and has a longitudinal extension of 500 m. The remaining part falls within the mining claims of the British company and extends to about 2000 m. Extraction from the section owned by the British company is from workings which are in part open-cast and in part underground. The ore is massive pyrites, which is exported for treatment as sulphur ore, the copper content being too low to warrant the recovery of this metal at the mine.

The object of the present paper, he says, is to describe the structural relationship between the ore-body and the surrounding rocks and to discuss the current genetic hypotheses in the light of the detailed structural forms observed. As a preliminary to the discussion of these problems, the local geology is described.

Regional Geology.—The general geology of this pyritic province has been described on many occasions and is well known. The brief summary in the paper is compiled mainly from the comprehensive account given by Finlayson (1910).

Geology of Area Surrounding Ore-body.—Erosion has exposed the uppermost feather-edges of a major intrusion of porphyry; thus the greater part of the area is slate, with isolated lenticular outcrops of porphyry.

Slates.—As the slates are remarkably homogeneous throughout the district, the original sedimentation can seldom be traced. The only place near La Zarza where the writer saw a marked change in the lithological character of the slate was at the head of El Chorro Stream, where there are a few thin laminæ of greywacké. The position of the bedding-planes in the apparently homogeneous slates may, however, be determined by etching fragments of known orientation in dilute hydrochloric acid for several hours, when the direction of the bedding is revealed by lines of fine quartz grains projecting from the etched surface. From observations on fragments treated in this way, and from cursory field observations along cuttings on the Huelva-Zafra railway and elsewhere in the district, it is suggested that the actual bedding-planes are seldom steeply inclined, although in all cases they are cut by a steeply-dipping cleavage. An exception to the general low angle of dip of the bedding-planes may be seen along the upper benches of the Los Silos face of the open-cast. Here the etching has been effected naturally by the circulation of acid waters derived from the decomposition of the underlying ore-body. Minor overthrusting can be discerned, but this crumpling was probably formed by the intrusive pressure of the porphyry exposed in the lower benches of the open-cast.

Porphyries.—The porphyries are oriented with their greatest length parallel to the regional trend. The parallelism between the sides of the intrusions and the general cleavage direction is a regional feature only, for any variation in the width must be accompanied by a local transgression of the slaty cleavage. The margins only show schistosity, which is always parallel to that cleavage.

Two main intrusions occur in the area and another mass makes up the Sierra del Cerrejon. For convenience, the three porphyries have been named from north to south, the Sierra del Cerrejon porphyry, the Sierra Blanca porphyry, and the Mesa porphyry.

The Mesa porphyry enters the area at the south-west corner, where it forms the northern wall of the ore-body. The apparent parallelism between the trend of the ore-body and that of the porphyry is caused by the feathering-out of the intrusion eastwards and the consequent cutting of the trend-lines by the wedge-shaped extremity of the intrusion, which pitches steeply eastwards, and will probably be found at the extreme end of the 14th floor. On account of its proximity to the ore-body, the porphyry has been extensively sericitized by the escaping hydrothermal solutions. A greyish white rock, veined with calcite, which is exposed over the greater part of the northern face of the open-cast, is a product of this process. The detached block of porphyry on the southern side of Los Silos face shows remarkably little shattering in a thin section cut from a sample obtained only 12 m. from the ore-body. In hand-specimens the rock is greyish green. The colour is due to the sericitization it has undergone, and to the introduction of large quantities of calcite. The porphyritic felspars consist of orthoclase and oligoclase-andesine in equal proportion. They are thinly clouded with kaolin, but sericitization has been restricted to the margins. Quartz occurs only in the groundmass.

The Sierra Blanca porphyry constitutes the range of hills bearing that name, lying 4 km. east of La

Zarza. In that locality the exposed porphyry is 1000 m. wide, but thins rapidly westwards to 450 m. where it enters the area mapped by the present writer, and here represents only the tail-end of the intrusion. Almost everywhere schistosity is developed and locally the rocks are crushed and shattered. On the eastern side of Alcornocoso it contains many included fragments of the invaded slates, which have been well rounded by magmatic corrosion. Collins (1922), in his list of contemporaneous ash beds in the slates, included one stated to occur at the saddle on the road leading from the eastern end of the village to the reservoir. This was examined by the present writer, who considers it to be a contact breccia formed during intrusion. An excellent section across this porphyry is exposed in the cross-cut under Alcornocoso. At frequent intervals it is crossed by shear zones, which run in directions comparable with the trend of the fracture-cleavages described in the next section. Sericitization and kaolinization occur throughout the mass; the effects of these processes are most marked near the planes of movement. A thin section, cut from a sheared fragment, shows a mineral composition similar to that of the Mesa porphyry. Porphyritic quartz is absent.

The Sierra del Cerrejon porphyry was not mapped by the writer.

Basic Rocks. — The La Zarza district is unfavourably placed for the study of these rocks. They do not outcrop in the area mapped (unless the decomposed material in the recent cuttings for the foundation of the new winding-house in the Algaida valley be referable to this group), but have been encountered in the underground workings. They are included in this paper for completeness, but the writer cannot confidently discuss their origin or relationships without studying their occurrence in other areas where they are more clearly exhibited. A considerably mass has been penetrated by the mine workings close to the southern wall of the Perrunal ore-body. This is an intensely altered dolerite. The steepness of the inclination indicates that it is probably an intrusion and not a tilted lava, as the dip of the bedding-planes of the slates is, in general, low. A similar rock also appears at several points in the underground workings in the La Zarza mine, but, owing to the intense alteration, it is difficult to follow the individual occurrences and to correlate them from place to place.

Contact-altered Slate.—The metamorphic effects of the intrusions are most pronounced above the highest points. This may be ascribed to the concentration of volatiles in the upper parts, assisted by the fracturing of the slates across the broad summit. Along the flanks the cleavages were parted but less extensively ruptured, forming fewer passages for the escape of the fugitive constituents. The contact-altered slate is readily recognized in the field by its reddish colour on weathered surfaces and by its less perfect cleavage. The metamorphic boundaries cannot be accurately mapped as the transition from altered to unaltered slate is gradual. An extensive area of slates in the western end of the village is metamorphosed, so it may be inferred that the porphyry underlying Alcornocoso Hill continues in this direction, although it is not exposed.

Jasper.—The most characteristic features of the landscape in the central part of the Huelva province are the piles of large red boulders that cap many of the maturely eroded hills. The higher elevations are composed of porphyry and the boulders breaking the even sky-line in almost every direction are the resistant remnants of the masses of jasper that invariably appear above the highest points of the intrusions. Alcornocoso Hill is covered with these angular blocks, which gravitate down the hillside and increase the apparent extent of the outcrop. The thinness of the jasper mantle is shown by the fact that it has not been encountered in the cross-cut under the hill. The central portion of the capping is massive, and no directional structures can be observed, but along the margins the jasper appears as resistant dykes, the general trend of which is parallel to the regional strike. Still farther out, the dykes become narrower and follow closely the partially obliterated cleavage in the altered slate. Examined in detail, they are seen to have thrust their way along these cleavages, which were twisted by the pressure of the invading liquids. At greater distances, the jasper persists only as veinlets in the slate, but it seldom appears outside the zone of contact-alteration. In places (as at the western end of the open-cast) massive dykes of jasper pass down for short distances into the porphyry. In the underground workings the western of the south-wall porphyries is found to be separated from the slate by a narrow band of jasper, and a similar band appears in the Perrunal mine.

The jasper has been extensively fractured and recemented with clear quartz, which at some places contains crystalline hæmatite. In hand-specimens the jasperoid rocks range in colour from pink to bright brick-red and purplish-red, and in thin sections they are seen to consist of a mass of finely granular quartz, thickly powdered with hæmatite. The quartz-veins are more coarsely crystallized than the main mass of the rock, and the crystals are characteristically flattened in a direction perpendicular to the vein-walls. Angular fragments of completely altered and silicified slate occur throughout the jasper.

The restriction of the jasper occurrences to the aureole of the porphyry intrusions, and the progressive decrease in the size of the individual outcrops from the massive caps immediately over the intrusions down to the veinlets at greater distances from the contacts, leave little doubt that the jasper is genetically connected with this rock, and has crystallized from the residual solutions. These would be concentrated at the highest points along the upper edge of the intrusions, and the present contour of Alcornocoso Hill is in such a position. The progressive concentration of iron and silica during the crystallization of an acid magma is a well-established fact. The mantle of massive jasper overlying the intrusions may be explained by the arching and rupturing of the slates across the broad apex, and consequent infilling and replacement of fractured material by the magmatic residue. The existence of veins passing down for short distances into the porphyry shows that the jasper was a post-consolidation product of the porphyry magma, and it may be inferred that the well-defined contact-bands (as at Perrunal) occupied a peripheral space, formed by the shrinkage of the intrusion on cooling.

It has been suggested by several writers that the jasper has crystallized from siliceous solutions remaining after the deposition of the pyrites of the pyritic ore-bodies, but the foregoing shows conclusively that the jasper is genetically connected with the porphyry and its relationship to the ore-

bodies is only indirect. Minute quantities of pyrites appear in microscopic grains throughout the jasper and much of the porphyry, but this sparsely disseminated pyrite was probably deposited metasomatically by the migrating solutions emanating from the zones of pyritic mineralization. It is improbable that this thinly disseminated sulphide was derived from the porphyry magma, or from its emanations, as, according to Butler (1923), the physical and chemical conditions that favour the deposition of hæmatite (of the jasper) and of pyrite are different. Gilbert (1926) pointed out that hæmatite is rare as a primary constituent of sulphide deposits, and usually exhibits a tendency to pass over into magnetite.

Manganese Deposits.—Old manganese workings are scattered over the northern and eastern slopes of Alcornocoso and in other parts of the province. The manganese, as pyrolusite, is distributed throughout the jasper in ramifying indefinite veinlets, but only in a few places is the manganese sufficiently concentrated to be of economic value. The field-relationships suggest that the pyrolusite and the hæmatite were deposited simultaneously from the siliceous solutions emanating from the crystallizing porphyry. Manganese minerals commonly occur in the aureole of an acid intrusion. There is no immediate genetic relationship between the deposits of pyrolusite and the pyritic ore-bodies.

Pyritic Ore-Bodies.—The main ore-body outcrops only in the open-cast. The total length worked by the Tharsis company is 2000 metres, and the greatest width is 150 metres. The dip is practically vertical. The ore is massive pyrites, the sulphur values fluctuating between 47 and 52%, although they are usually nearer the latter figure. The associated minerals include chalcopyrite, galena, and blende, all of which occur sparsely and are concentrated near the walls. Quartz and calcite are present only in small quantities: the former occurs as stringers in the neighbouring country-rock, and the latter as veins filling joints in the ore, and along tension-cracks and shear-planes in the country-rock some distance from the ore-body. "Horses" are rare, and it is doubtful if any of the larger bodies of foreign matter are entirely isolated in the mass. "Vugs" occur only along post-consolidation-cracks, and are lined with crystals of calcite, chalcopyrite, galena, and blende, in addition to a late crop of cubes of pyrite. A small body of ore was found during the driving of a prospecting cross-cut under Alcornocoso Hill; it may prove to be the apex of a larger ore-body that occurs en echelon with the main mass at the eastern end of the mine. Recently another substantial mass has been proved in the latter locality.

The trend of the ore-body is practically east–west (magnetic), and the general trend of the rocks of the area is W. 20° N.–E. 20° S. The main ore-body lies along the southern side of the intrusion, and it is parallel to the side of the intrusion, but not to the axis. This is due to the pitching of the upper edge of the intrusion to the east and the consequent eastward narrowing of its wedge-shaped trace on a horizontal plane. The ore-body has its greatest lateral development below Los Silos, where it is irregular and encloses blocks of low-grade ore, or of country-rock. Further irregularity occurs on each floor (it is not shown on the plan of the fifth floor) on the southern wall, about half-way between Los Silos and the western end. It is significant that where the irregularities occur the country-rock is porphyry. The assay-plan reveals that where the contiguous rock is porphyry, the ore-minerals persist for considerable distances from the walls, but there is always a definite break in the values as they pass from the massive ore into the disseminated ore. At the slate-contacts, however, an entirely different condition prevails, and it is usually possible to determine the boundary of the ore-body to within a few inches, although stringers of ore appear in the slates, parallel to the cleavage, for several metres from the contact.

The ore-body shows a tendency in some places to swing round into a position of parallelism with the cleavage of the slates. No major faults have displaced the ore-body, although a system of small parallel faults, with a general north-westerly strike, may occasionally be discerned among the stringers of ore in the slate, at the extreme eastern end of the workings.

Processes connected with the secondary alteration and enrichment of the ore-body were not studied. They have been fully described by Finlayson (1910) and Bateman (1927). True gossan is limited to a small mass on the railway line behind Los Silos. "Toba" or "false gossan" occurs in the Algaida Valley. It consists of stream-rubble cemented by ferruginous material from the stream-water.

Structural Geology.—The sequence of tectonic events in the pyritic mineral province is as follows:—

i.—*Period of folding and igneous intrusion.* (*a*) The original sediments were thrown into a series of east–west folds by a northerly directed pressure.

(*b*) A continuation of this pressure induced a slaty cleavage parallel to the direction of folding.

(*c*) A series of porphyry intrusions invaded the slates, the orientation of the intrusions being controlled by the structures previously formed.

(*d*) A continuation of the regional pressure during and after solidification of the porphyries imparted a schistosity to the intrusions parallel to the regional trend.

ii.—*Movements associated with introduction of ore-solutions.* (*e*) The latest movements of the orogeny were more localized and less continuous than the earlier steady deformation; they twisted and fractured the slates and porphyries, and afforded passages for the ore-bearing solutions.

These tectonic periods are then fully dealt with by the author.

Genesis of Ore-Bodies.—The conclusions drawn from the study of a single ore-body do not warrant their speculative extension to the interpretation of other occurrences in the province. The writer shows, however, that the La Zarza ore-body occupies a tension-fissure, not a crush-zone as formerly supposed, and feels justified in discussing the bearing of this observation on current genetic problems. In a mineral province containing many ore-bodies showing similar mineral associations and lithological and structural relationships, it is probable that the ore-bodies have been formed by similar agencies, although the degree to which the various factors bringing about the distribution and deposition of the valuable minerals have contributed to the formation of the ore-bodies may differ from one mass to another.

The problems associated with the genesis of the pyritic deposits of southern Spain have attracted the attention of geologists for many years, and numerous hypotheses have been advanced to explain them. The voluminous literature on the subject has been reviewed many times and need not be

recapitulated here—a brief statement of the more important of these views will suffice :—

(1) The pyrites represents iron-ores deposited contemporaneously with the slates.

(2) The ore-bodies are cavity-fillings by ascending solutions.

(3) The pyrites has been concentrated in veins by lateral secretion.

(4) The ore-bodies were formed by replacement of crushed material in shear-zones by hydrothermal solutions.

(5) The ore has crystallized from injections of hydro-pyritic magma.

Of these hypotheses only the last two are now generally entertained by those who have studied the field. It is not necessary to repeat the conclusive evidence that has shown the first three views to be untenable.

The hypothesis of hydrothermal replacement of shattered material along crush-zones was first suggested by the late Professor Gregory (1905) and subsequently elaborated by Finlayson (1910), and has been adopted by Collins (1922), Professor Bateman (1927), and Mr. Douglas (1929). These writers maintain that complete gradations occur between massive ore and unaltered country-rock, and Bateman and Finlayson have shown, from a study of thin and of polished sections, that such replacement actually has occurred. But a thoroughly satisfactory explanation of the cleanness and homogeneity of the main mass of the ore in many mines has not yet been advanced by the exponents of hydrothermal replacement, and it has also been difficult to explain the sharp contacts of many ore-bodies assumed to have been formed in this manner. To overcome these difficulties, there has been a recent trend in favour of a hypothesis, first formulated by Vogt (1914) after a study of similar deposits in Norway. Amongst the supporters of this view are Krusch (1920), Hereza (1926), Rastall (1927), and Edge (1928). These writers believe the pyritic bodies to have crystallized from an aqueous pyritic magma - differentiate which invaded the slates and porphyries in much the same way as an igneous intrusion is forced along bedding and cleavage-planes.

It is difficult to visualize a replacement process which would produce a homogeneous and sharply defined mass such as the La Zarza ore-body. Moreover, it has been demonstrated in an earlier section that the structural conditions postulated by the exponents of this hypothesis did not exist. The sharp definition of the boundaries, the homogeneity of the ore, and the general shape of the ore-body are more readily explained by a process involving intrusion. The zone of disseminated ore in the country rock may be regarded as an aureole formed by interaction with the fugitive hydrothermal constituents of the intruded fluids. It is contended that all the ore-bodies can be satisfactorily explained by a combination of intrusive and hydrothermal processes. In some ore-bodies the former has accounted for more ore than the latter, and in others the reverse proportion may hold. At La Zarza the rôle of replacement has been subsidiary to that of intrusion. The ore-body is generally sharply defined against the slates, but wherever the porphyry is crossed it is wider, more irregular, and includes a zone of disseminated ore. It is obvious that the shape and character of the ore-body have been considerably influenced by the wall-rocks. This control has been both mechanical and chemical. To what extent is the bulging of the ore-body into the porphyry due to selective fracturing of that rock, and to what extent is it due to selective replacement of the minerals of the porphyry by the mineralizing fluids ?

The extent to which replacement could proceed would be determined by the mineralogical composition of the rock and the facilities for permeation. There seems little doubt that the mineral assemblage of the porphyry would be more readily replaced than that of slate, but it is also clear, from a study of the pyritic disseminations in porphyry, that the susceptibility of that rock to percolation and reaction with hydrothermal solutions was considerably increased by previous crushing. The fracture-cleavages, and tension-joints, associated with the opening of the main fissure, would provide channels for the passage of the mineralizing fluids from the main ore-body, and the minor shearing that accompanied the deformation of the porphyry would facilitate the intimate percolation of solutions among the partly crushed mineral grains. Such granulation would occur in the porphyry to a greater extent than in the slates, as the former is massive and the latter yielding. It is therefore maintained that the selective replacement of the porphyry may be ascribed to a combination of two factors—a preparatory crushing of the mineral grains and the susceptibility of the minerals to replacement.

Most so-called disseminations in slate seem to consist of large numbers of veinlets that have formed between the cleavages, the actual replacement having proceeded to a small extent only. The formation of these "disseminations" has been a mechanical process, for it is to be expected that when a fracture develops across a well-cleaved slate, at an angle of only 20° to the direction of the cleavage, that ragged wedges of slate would lie along the walls and that the solution would penetrate along the loosened cleavages close to the fracture.

It has been concluded that processes involving both fissure-filling and replacement have contributed to the formation of the ore-bodies. It now remains to discuss only the nature of the solutions that introduced the ores and the reason for their occurrence in this dual form.

According to the exponents of the replacement hypothesis, the pyritic material was introduced in hydrothermal solution. It is instructive to quote the views of several writers on the nature of these solutions. Finlayson (1910) made numerous allusions to hydrothermal solutions, but did not discuss their physical or chemical characteristics. Collins (1922) believed the solutions to have been "... highly alkaline, carrying metallic sulphides dissolved in excess of alkaline sulphides and carbonates." Douglas (1929) considered the solutions to have been "... tenuous and highly mobile hydrothermal solutions (or colloids) ...," which rose from the parent magma "... until they reached the zone of comminuted contact-rocks and there, under favourable conditions of temperature and pressure, the sulphides were deposited." He mentioned that at the Valle lode, Rio Tinto, and at the San Cornelio lode, Santa Rosa, the slates in which they occur "... are both bent and crosscut to make room for the ore," and adds that "this indicates considerable pressure, either as vapour-pressure before, or as liquid pressure during, the period of mineralization and replacement." Bateman (1927) made no detailed study

of the field relationships, his conclusions being based on an extensive investigation of the character of the mineral assemblage in the ore-bodies and adjacent country-rocks. He maintained that "the strongest indication of hydrothermal action is the conspicuous aureole of sericitic alteration that flanks the ore. Sericitic alteration is characteristically the work of hot waters." He described in some detail a suite of typical hydrothermal minerals and added that "all these are mineral combinations customarily formed under conditions of intermediate temperature and pressure."

On the other hand, the advocates of the magmatic injection hypothesis consider the pyritic material to have been introduced in the form of an aqueo-igneous melt. The nature of this melt has been most clearly indicated by Evans, in the discussion following the presentation of Collins's paper. He thought a melt was introduced at a temperature in the neighbourhood of 800° or 900° C., and contained possibly as much as 75% pyrites. The pressure was probably such that the volume of water-vapour was comparable to that of water and, under these conditions, he believed pyrites would be soluble in all proportions. He thought these pneumatolytic fluids might attack the minerals of the country-rock and form a mineral assemblage such as was later described by Bateman. In a paper strongly advocating the magmatic injection hypothesis, Edge accepted the physical data suggested by Evans, and submitted strong corroborative evidence obtained from a study of the field-relationships in many of the mines in the province.

The essential difference between the ore-forming fluids postulated by the two schools of thought is expressed only in the proportion of water which is thought to have been present and in the temperature of these fluids. The exponents of hydrothermal replacement suggest a pyritic content of, say, 10%, whilst the supporters of magmatic injection think 70 or 80% a more reasonable figure. The present writer does not agree with the fundamental distinction that has been drawn between the two classes of fluid. The figures are merely indications of the extent to which pyrites is thought to be soluble in aqueous solutions under two distinct temperature-conditions.

After injection, an aqueo-igneous melt would precipitate pyrites and leave a residuum becoming progressively richer in water as the temperature fell. If the mineralizing fluids were of the composition suggested by Vogt, Evans, and Edge, the residuum would approach more and more to the composition and temperature of hydrothermal solutions. It is quite conceivable that the end product would be a typical hydrothermal solution.

The absence of vugs and the cleanness of the ore suggest high concentration of sulphide in the original fluid. The writer believes, therefore, that the fluids, bearing possibly as much as 75% of pyrites, occupied the tension-fissure, at a temperature perhaps as high as 700° or 800° C., and with progressive fall in temperature and resulting crystallization the proportion of water in the remaining solution increased, and the cooler solutions were pressed outwards along the joints formed during the torsional movements in the surrounding rock by the hydrostatic head of the injected material. The subsidiary jointing produced during the deformation permitted an intimate percolation of the solutions, and the simultaneous crushing of the mineral grains rendered them susceptible to replacement by sulphides, thus forming the masses of disseminated sulphide, which appear wherever the main fissure crosses porphyry. The extent to which hydrothermal reactions occurred diminished with increasing distance from the main fracture, which was the immediate source of the solutions. With corresponding fall in the temperature of the solutions, the solubility of the pyrites diminished and deposition occurred. It seems probable, however, that the prevailing temperature of the rocks at the depth at which the ore-bodies were formed was sufficiently high to maintain small quantities of pyrites in solution. The impoverished aqueous remainder would thus migrate for great distances into the country-rocks, depositing the minute amount of pyrites which occurs throughout the rocks of the district (although it is admitted some of the pyrites in the slates may be syngenetic). It is possible that the ore-bodies were sufficiently massive to induce a low temperature-gradient along the immediate contacts, but any mineralogical effects of this gradient would be obliterated by reaction with the fugitive hydrothermal solutions.

These conclusions are substantially in agreement with the views expressed by Edge (1928), and with those implied by Rutherford and Gray in the discussion following the presentation of Collins's paper (1922). The concentration of copper along the margins of the ore-bodies, and in the masses of disseminated sulphide, may be explained by the lower melting point of chalcopyrite, and its consequent retention of the residual solutions, which passed outwards from the main ore-body.

Mode of Injection.—There is no necessity to postulate the existence of an open cavity 2000 m. long and 150 m. wide (excluding the zone of disseminated sulphide formed by replacement). The remarkable homogeneity of the ore and the general absence of banding suggest a single rapid process of injection. It is, it is suggested, not a case of lateral increment by spasmodic parting of the walls and successive additions of fluid, as in many hydrothermal veins. In the case of the La Zarza-Perrunal ore-body the walls have been pressed apart by the hydrostatic head of the fluids that have been thrust into and trapped under pressure in the original narrow fissure. The parting of the walls was actuated by this pressure alone, consequently the speed of opening did not exceed the rate of injection of filling. The process is analogous in some respects to that of the formation of the "pressure-lenses" at Broken Hill, N.S.W. (Andrews, 1931), where the ore-bodies are lenticular and there are no indications of feeding channels along which the ore rose. The existence of the original fissure (at La Zarza), representing only a small part of the width of the massive ore, is proof that the rocks were in a state of tension, hence there would be no great resistance to lateral pressure from the fluid-filling. The existence of unsupported inclusions is readily explained if filling and opening are simultaneous. Problems associated with fissure filling have recently been summarized by Berg (1932).

Origin of Sulphides.—Many different views have been expressed on this controversial question, but all recent writers agree that the sulphides are igneogenetic. Some writers have connected the ores with the porphyries, others with the diabases, but it has been explained that the close spacial

distribution of these rocks and the ore-bodies has probably no genetic significance. It is most probable that the sulphides were concentrated in the liquid phase from the parent magma from which the intrusive rocks of the district were differentiated. The constant occurrence of porphyries in mining fields cannot be fortuitous.

Conclusions.—The conclusions reached by the author from a study of the La Zarza ore-body are as follows :—

(1) The ore-body occupies a tension-fissure formed by torsional movements, and has not replaced a zone of intense shearing.

(2) The ore-body consists of (*a*) massive ore and (*b*) disseminated ore. The former has crystallized from the original pyritic fluids, and the latter has been formed by replacement of porphyry by hydrothermal solutions. Replacement of slate is insignificant.

(3) The selective replacement of the porphyry has been due to the more extensive granulation which this rock suffered, and to the greater susceptibility of its constituent minerals to replacement.

(4) The pyritic material was introduced as an aqueo-igneous melt, with a high proportion of pyrites and at high temperature. The melt occupied the tension-crack previously formed and to some entent enlarged it by lateral pressure. The aqueous liquid remaining after the crystallization of much of the pyrites was essentially a hydrothermal solution, which circulated in the country rock and replaced the porphyry adjacent to the main fissure.

The writer suggests, admittedly without a general knowledge of the field, that these conclusions may be applicable not only to the La Zarza ore-body, but also to the other ore-bodies in the province. The local differences in the character of the ore-bodies is, he thinks, due only to the varying extent to which these factors entered into the genesis of each ore-body. In some masses shearing and hydrothermal replacement have been responsible for a greater quantity of ore than fissuring and infilling, and in others the two processes have contributed in the reverse proportion. In a few of the smaller ore-bodies it seems likely that hydrothermal replacement has been the sole factor, due undoubtedly to the former existence in that locality of sulphide only in the form of hydrothermal solution.

GOLD ORE FLOTATION

In *Mining and Metallurgy* for September R. L. Kidd, assistant professor of ore-dressing research at Salt Lake City, Utah, writes on the application of flotation to the treatment of gold ore. The author says that, inasmuch as galena and sphalerite flotation concentrates are being produced that contain over 95% galena or sphalerite, it is not unreasonable to believe that a flotation concentrate assaying at least 80% of native gold can be secured provided the gold is free. As yet, little if any fundamental information has been published concerning the flotation of free gold either alone or in the presence of sulphides. So far, we are unable to make as complete a separation of gold from sulphide minerals by flotation as is possible in the separation of one sulphide from another by this method. An introductory study of the flotation of several free gold ores has been made in the Utah laboratories. For this study three general types of gold ores were chosen, namely : (1) Quartzite containing 0·26 oz. gold per ton in which no base metals were present ; (2) sulphide ore (2·04 oz. Au ; 1·31 oz. Ag) containing pyrite as the only sulphide present and the gold free ; and (3) oxidized ore (1·10 oz. Au ; 0·70 oz. Ag) from an oxidized zone of the vein from which sulphide ore (No. 2) was taken ; little sulphide iron was present.

In type (1) all of the gold is free and bright, the major portion ranging from 100 to the equivalent of 800 mesh. Over 95% of the gold is freed when grinding to 65% through 200 mesh. Only a trace of silver is present.

A microscopic examination of types (2) and (3) revealed that : (*a*) The gold was abundantly present as free gold, most of which was bright and untarnished. Roughly, less than 20% of the gold was tarnished. (*b*) The gold particles occurred in sizes from approximately 100 mesh down to extreme fineness but the major portion lay between 100 mesh and the equivalent of 800 mesh. The fractured and granular nature of the mineral associates indicated that grinding to minus 65 mesh should liberate most of the gold. (*c*) The mineral associates in the sulphide ore were principally small unit cubes of pyrite strongly tarnished, some to a decidedly black surface. Small amounts of magnetite, hæmatite, and limonite were present. The metallic minerals composed roughly 15% of the total material ; the remainder was principally quartz. (*d*) A test for tellurium proved negative. (*e*) The oxidized sample was of the same character as the sulphide sample except that the pyrite had been largely converted to hæmatite and limonite and more slime was present. The gold was more easily liberated.

The test work showed that the oxidized and gold-bearing quartzite ores were more easily treated and higher recoveries were obtained than was possible with the sulphide ore when either straight amalgamation, cyanidation, or flotation was employed. Amalgamation of the sulphide and oxidized ores gave poor recoveries whereas the gold-bearing quartzite ore responded quite readily to this method of treatment. Cyanidation of the gold-bearing quartzite and oxidized ores gave excellent recoveries, but poor recoveries on the sulphide ore. This was no doubt because the gold was intimately associated with the pyrite and, since the feed was only ground to 52% minus 200 mesh, all of the gold was not exposed. This was brought out quite clearly in straight flotation of the sulphide ore. The tailings from the straight flotation tests assayed quite high in gold, but when examined under a microscope no free gold could be found. As soon as the coarse pyrite present in the flotation tailing was removed by tabling and ground to pass 200 mesh the flotation tailing dropped from 0·54 to 0·03 oz. of gold per ton. Microscopic evidence also showed that the pyrite was highly tarnished, which accounted for the fact that it was not readily floated.

Combined flotation and gravity concentration tests gave much higher recoveries of both gold and silver than were obtained by straight flotation. Also, the grades of the rougher and cleaner concentrates were higher than in the straight flotation tests. This was because of the substitution of amino pentanol xanthate (which produces a much cleaner concentrate) for K-pentasol xanthate. By tabling the flotation tailing, and regrinding the table con-

centrate along with the cleaner tailing, a fairly coarse flotation feed was possible. The regrinding of these products along with the cleaning of the rougher concentrate permitted the production of a high-grade concentrate.

No difficulty was experienced in floating bright free gold either in the presence or absence of pyrite. In tests on the gold-bearing quartzite ore the gold appeared to float as well as it did in tests on the sulphide ore, which contained considerable pyrite. The physical characteristics of the froth for both ores appeared to be about the same. Thus it is probable that the presence of pyrite or any other sulphide mineral is not always necessary to give body to, or stabilize, the froth.

The tarnished gold did not respond to the straight flotation, but, after it had been concentrated by tabling the flotation tailing and reground, it floated readily. A probable explanation for the floating of this tarnished gold is that the tarnished surface had been somewhat altered or worn away by the regrinding of the cleaner tailing and table concentrate.

With either straight flotation or combined flotation and gravity concentration finished concentrate assaying over 1,000 oz. of gold per ton could be produced by proper cleaning of the rougher concentrate, without lowering the recovery.

If a rougher concentrate assaying 40 oz. of gold and 25 oz. of silver is produced it may be shipped to the smelter without further treatment or it may be treated by cyanidation to produce bullion. If, by adding a series of cleaner cells to the flotation circuit, the grade of the concentrate can be raised to over 7,000 oz. of gold and 4,000 oz. of silver, as could be accomplished with the oxide ore, this product can probably best be treated by fluxing and melting at the mill to produce bullion, thus eliminating cyanidation. The cost of the additional flotation equipment, compared with the cyanidation equipment required to handle the rougher concentrate, would be small. The economic extent to which the grade of cleaner concentrate can be increased depends entirely upon the cost of production, treatment, marketing, and such factors. Theoretically it is possible to produce a concentrate containing only native gold. After a more thorough study has been made of the fundamentals of the flotation of free gold alone and in the presence of various sulphides and gangue minerals considerable progress in practice can be made toward this goal.

The conclusions arrived at from the study were as follows: (1) Bright free gold is easily floated regardless of whether the ore contains pyrite or not. (2) It is possible to float tarnished gold after the tarnished surface has been partially altered or worn away by intensive grinding. (3) In treating free-gold ores it is possible to produce a high-grade gold concentrate or gold-silver concentrate with high recoveries by combined flotation and gravity concentration.

THE BANNOCKBURN GOLD AREA

An account of the Bannockburn gold area of Ontario, by H. C. Rickaby, appears in the *Canadian Mining and Metallurgical Bulletin* for September and full extracts from this article are given here. The author reminds us that the Bannockburn gold area covers the four townships of Bannockburn, Argyle, Hincks, and Montrose, lying in the western part of the Matachewan district of Ontario. In the autumn of 1930 a rich gold-bearing quartz vein was discovered in the north-west part of Bannockburn by B. S. Ashley. A prospecting rush followed the discovery, many claims being staked in the Bannockburn area and, during the summer of 1931, a considerable amount of prospecting was done.

General Geology.—The table of formations may be summarized as follows, the arrangement being in the order of geological succession :—

Keweenawan (?)	Olivine diabase.
Cobalt Series	Conglomerate, greywacke, argillite.
Matachewan Series	Quartz-diabase dykes.
Algoman	Granite, syenite, porphyry, lamprophyre.
Haileyburian (?)	Peridotite, pyroxenite, gabbro, diabase.
Timiskaming Series	Arkose, slate.
Keewatin	Rhyolite, andesite, basalt, tuff, and iron-formation.

The oldest rocks in the area are Keewatin in age and consist of volcanic flows and tuffs of acid to basic character. Overlying these in the south-west part of the area are steeply tilted sediments, which are thought to belong to the Timiskaming Series. A series of basic to ultra-basic rocks, intrusive into the Keewatin, are considered to be Haileyburian in age. Algoman intrusives are represented by bosses of granite and syenite and by numerous dykes of porphyry and lamprophyre. Quartz-diabase dykes of the Matachewan Series cut all the above rocks. Flat-lying sediments of the Cobalt Series form the latest sediments of the area. Olivine-diabase dykes noted in two places may represent the Keweenawan.

Keewatin.—The Keewatin is represented by andesite, basalt, and rhyolite, in the form of flows and pyroclastics. Rocks of the composition of andesite make up the largest part of the greenstone area, occupying Argyle and Hincks townships and the northern part of Bannockburn and Montrose. Rhyolite is prominent to the east and west of the boundary line between Montrose and Bannockburn. No sharp line, however, can be drawn between areas of the two types. There is considerable interbedding between andesite and basalt and between andesite and rhyolite and all three types are interbedded with their tuffs and agglomerates. On the map two main types are distinguished, one of which is largely andesite and basalt with thin rhyolite flows and the other rhyolite with andesite interbedded. Throughout Hincks township, the south-west part of Argyle, and the north-west part of Bannockburn the attitude of the flows and interbedded tuffs indicates a succession of beds now dipping at steep angles to the north-east.

Timiskaming Series.—A series of much-folded sediments, consisting chiefly of arkose, slates, and tuffaceous rocks, lies in the south part of Montrose township and forms part of a large area of sediments extending into Midlothian township to the south. They are well exposed at the west end of Midlothian

Lake, where they are seen to consist of conglomerate, greywacke, arkose, and slate, dipping at steep angles to the north. These rocks are schistose and much of the material is composed of worn-down greenstones. H. C. Cooke shows that there is positive evidence of an erosional unconformity between these sediments and the underlying Keewatin and it is thought that they may be classed with the Timiskaming series.

Haileyburian (?).—The rocks under this heading consist of a series of basic to ultra-basic types, including peridotite, pyroxenite, gabbro, and diabase. They occur in the form of small bosses and lens-shaped bodies or dykes clearly intrusive into the greenstones. Because of marked resemblances to basic intrusives of Haileyburian age described by C. W. Knight in Strathy township, and by later writers in other areas, they are classed here with the Haileyburian.

Algoman.—Rocks of Algoman age in this area include granite, syenite, porphyry, and lamprophyre, with intermediate types. Two large granite bosses occur, one in the centre of Hincks township and the other on the east boundary of Bannockburn. There are also a number of smaller bosses or plugs, mainly in the south half of Argyle. A great number of dykes of porphyry, porphyritic granite, and lamprophyre intrude the greenstones throughout the area. They are especially numerous in the vicinity of the four corners of the townships and for three miles north. They strike in all directions, with, apparently, no relation to the strike of the greenstone or to any other structural feature.

Matachewan Series.—Diabase dykes of the Matachewan Series are well represented in this area and are most persistent and numerous in the vicinity of the Algoman intrusives. They are normal quartz-diabases, consisting of augite, plagioclase, and quartz, and, as in other areas, they have a north-south strike. A. G. Burrows describes very similar diabases in Powell township to the east and he shows that they are post-Algoman and pre-Cobalt in age.

Cobalt Series.—The Cobalt Series consists of a basal conglomerate followed by argillites, greywacke, and arkose, more or less interbedded. The series is for the most part comparatively flat-lying, with dips not more than 10 to 15°. The basal conglomerate, which is a red granite conglomerate, did not show a thickness greater than 50 ft. The argillite is a dense, fine-grained rock with fine bedding, along which it splits readily. It might be more properly called a siliceous shale. Reddish arkose layers are frequently interbedded with the argillites and greywacke and the presence of these red beds is characteristic of the Cobalt Series in this area.

Faulting.—Direct evidence of faulting on a large scale in the Bannockburn area was not noted except in the south-western part of Montrose, where a wide sheared zone striking slightly north of east indicates a fault. It is probably post-Timiskaming in age as it affects the sediments of that area. The course of the rivers and lakes in some parts of the area suggests regional faulting in a north-south direction. A few small north-south faults seem to be connected with the intrusion of the Matachewan diabase dykes.

Economic Geology.—Previous to the discovery of the Ashley vein comparatively little intensive prospecting had been done in the Bannockburn area. The only evidence of previous development work noted was in connexion with some asbestos showings on Rahn lake and on a pyrite body associated with iron-formation in the south-west part of Montrose township. Following the discovery of the Ashley vein many claims were staked in the area and during the summer of 1931 a number of these were prospected for gold.

Gold Deposits.—A large number of quartz veins, some of which carry gold values, were uncovered, chiefly in the north-west part of Bannockburn, the south-west part of Argyle, and the east half of Hincks, townships. This area shows the greatest concentration of the porphyry dykes and small masses of granite and syenite and a genetic connexion between these acid intrusives and the veins is evident. The veins discovered to date are, in general, comparatively narrow, and are of the fissure type, occupying fractures or faults of only slight displacement. Consequently they are frequently irregular in dip and strike and in width, and gold values are erratic. They occur for the most part in the greenstones, but were also seen cutting granite and porphyry, without any marked difference in appearance. Alteration of the wall-rock does not usually extend for more than a few inches from the joints formed by fracturing. It consists chiefly of carbonatization, silicification, and pyritization. Ankerite is very common amongst the carbonates, replacing the wall-rocks. Within the vein orthoclase and specularite are almost invariably present, but no high-temperature minerals other than specularite were noted. The orthoclase is reddish in colour and a chemical analysis of some of this material from the Ashley vein showed it to be an almost pure potash feldspar. Pyrite is abundant and is of two generations: A fine-grained variety characteristic of the wall-rock, and a coarse variety occurring along fractures in the quartz. Galena and a little sphalerite and chalcopyrite are usually present. Gold is present in the native state and, in the richer veins, altaite (PbTe) is also common. Fractures and minor faults cut the greenstones, granite, and porphyry and provided the openings along which solutions deposited the vein-forming minerals. The source of these solutions was probably the granitic magma from which the granite, porphyry, and lamprophyre crystallized, and the formation of the veins is probably the last phase of Algoman activity.

Claims of the Mining Corporation of Canada.—The claims of the Mining Corporation of Canada comprise a group of 23 surveyed claims lying near the west end of the boundary between Bannockburn and Argyle townships, 11 of the claims being in Bannockburn and 12 in Argyle. The Mining Corporation also has under option nine claims lying to the north of this group, staked by A. Mosher, of Haileybury.

In the early stages of prospecting two veins were uncovered, the Ashley vein and the Garvey vein. Trenching carried on during the summer of 1931 disclosed a number of smaller veins, none of which, as yet, appears to be of importance. During the winter of 1930–31 the two main veins were diamond-drilled and, as a result of the drilling, an inclined shaft was sunk on the Ashley vein and driving done on four levels at 125-ft. intervals down to 500 ft. The amount of driving on the levels is as follows: 125-ft. level, 367 ft.; 250-ft. level, 362 ft.; 375-ft. level, 222 ft.; 500-ft. level, 182 ft. Ore-pockets have been constructed below the 500-ft. level and rises have been put up to

handle the ore. A mill is now in process of construction. It is to have an initial daily capacity of 75 tons, but, with slight additions, will be capable of handling double this tonnage. A transmission line has been built by the Northern Ontario Power Company, which will supply electric power to replace the steam plant which has been used up to the present.

Description of the Ore-body.—The Ashley vein occurs on claim M.R. 8194, the north boundary of which is the boundary line between Argyle and Bannockburn townships. Very little rock outcrops on the claim and, consequently, what is known of the geology of the immediate vicinity has been learned from the trenching and diamond drilling. The vein outcrops for a length of approximately 100 ft. on the west side of a knoll and is visible again in a trench 200 ft. to the north of this. Its actual outcrop is in the low ground along the west side of the knoll. The vein, which is of the fissure type, is a series of more or less connected lenses of quartz cutting Keewatin greenstones. The greenstones consist of basalt flows showing good pillow structures, the flows standing on end and striking approximately north-east—south-west. Near the south end of the claim and on the strike of the vein a thick member of the flows is a coarse-grained rock having the appearance of gabbro or diorite, but its chemical composition is almost identical with that of the adjacent fine-grained material, which is undoubtedly part of a flow. Four hundred feet north of the shaft, a dyke of porphyritic granite and two small dykes of lamprophyre cut the greenstone. The granite dyke is about 30 ft. wide and strikes N. 70° W. It outcrops entirely in the foot-wall of the vein, but a diamond-drill hole to the west in the hanging-wall started in granite, which is probably the westward extension of the dyke. Seven hundred feet west by 150 ft. north of the shaft, a diamond-drill hole, sunk to a depth of over 600 ft. was in porphyry throughout its length, while another hole, 200 ft. south of this one, showed several narrow porphyry dykes, evidently in the foot-wall of the vein. Associated with the granite dyke that outcrops to the north of the shaft is a dioritic rock, which is thought to be a border phase of the granite. The two lamprophyre dykes occur just to the south of the granite, the larger one being 5 ft. wide and striking N. 50° W. It appears to cut the dioritic rock and is probably slightly later than the granite. It is a mica lamprophyre, biotite being the most prominent mineral occurring as phenocrysts, with some augite. The strike of the main vein is N. 10° W., and the dip is approximately 50° to the west. Diamond drilling has indicated that there is more than one fracture containing quartz with gold values and has proved a length of 1,200 ft. of vein material in a north–south direction, with possible extension both north and south.

The vein shows up well in the driving on all four levels with a width rarely exceeding 2 ft. of quartz. In places it splits into two or more parallel veins and in others it narrows to a few inches, but for the most part it is fairly persistent along the strike. The dip varies from 45° to 55°, with an average of 51°, to the west, except at the southern end, where the vein flattens considerably, showing dips as low as 30°. At the southern end, on the 125 and 250-ft. levels, it is represented by a number of narrow, flat-lying lenses or stringers which do not make ore. On the 375-ft. level the dip changes from 50° at the cross-cut to 35° at the south face, while on the 500 ft. level the dip throughout, from the cross-cut to the south end of the drift, is low, from 30 to 35°, but the vein is strong and high-grade. This flattened condition of the vein at the south end of the present workings is probably due to a roll in the fault plane and is also probably a local condition, since a drill-hole 350 ft. south of the present workings showed a good intersection of the vein.

There is considerable alteration of the wall-rock, with a rather marked contrast between that of the hanging-wall and foot-wall on the two upper levels. The foot-wall alteration consists mainly of silicification, carbonatization, and pyritization. Fractures in the foot-wall are occupied by narrow stringers of quartz, which parallel the main vein and dip at low angles into it. The greenstones bordering both the main vein and the small quartz stringers have been replaced by ankerite and fine pyrite. They carry low values in gold, but only rarely are they sufficiently high grade to make ore. Extreme brecciation and carbonatization is characteristic of the hanging-wall rocks.

The minerals of the main vein include pyrite, galena, sphalerite, chalcopyrite, altaite, native gold, and specularite, all of which occur along fractures in the quartz. The pyrite is coarse-grained and its presence generally indicates high-grade ore. Fine-grained galena and altaite, and occasional coarse crystals of sphalerite, make up the rest of the minerals of the quartz vein. Native gold, usually in fine particles, is associated with the pyrite and altaite. A narrow high-grade stringer in the foot-wall showed a very small amount of a gold telluride, and Prof. E. Thomson, of the University of Toronto, who is making a mineralographic study of the Ashley ore, has identified krennerite, $(Au, Ag)Te_2$, occurring very sparingly in association with the altaite.

Movement subsequent to the formation of the main vein is represented by a mud seam, on the hanging-wall side of the vein, which shows prominently on the two upper levels. On the 125-ft. level it parallels the main vein throughout the length of the drift. At the north face this slip and the vein are contiguous, whereas at the cross-cut the former is 6 ft. to the west, in the hanging-wall. Well-marked striations on the slicken-sided face of the slip indicate that the movement is in the form of an oblique slip-fault, with a low horizontal component. The actual displacement, however, does not appear to be great. On the 250-ft. level the slip and the vein are side by side at the north face, but at the cross-cut the former curves sharply into the hanging-wall. This later movement is characterized by the deposition of quartz and calcite and small quartz-calcite stringers were frequently noted cutting the earlier veins.

Paragenesis.—The genesis of the gold veins at the Ashley mine would appear to be as follows: Following the intrusion and consolidation of the porphyries and porphyritic granite, shearing stresses caused the development of fractures in a north–south direction. Hydrothermal solutions from an underlying granitic magma penetrated these fractures, depositing quartz and replacing the wall-rocks by carbonates, chiefly ankerite and pyrite. Later, the fracture was reopened and further deposition of quartz took place along the main vein, accompanied by pyrite, galena, sphalerite, altaite, and native gold. Still later

movement gave rise to the mud seam, and minor slips, attended by the deposition of quartz and calcite.

A number of other gold-bearing quartz veins have been discovered, chiefly in the area to the north-west of the Ashley mine. Two of these—the Garvey vein on the property of the Mining Corporation and the Davidson vein on the property of McGill Gold Mines, Ltd.—have been explored by diamond drilling. Both of them are comparatively flat-lying, with dips of from 15° to 25°, and their widths and gold values are erratic. In other respects, such as the nature of the wall-rock and its alteration and the minerals of the veins, they resemble the Ashley vein.

The Ashley vein shows that conditions in the area are favourable for high-grade gold deposits. These conditions, as far as can be seen, consist of basaltic lavas intruded by Algoman granite and porphyry, combined with a favourable structure in the form of a narrow faulted zone. The first part of these conditions applies to a large part of the Bannockburn area, particularly in the north half, and it is not unreasonable to hope that further prospecting here may lead to the discovery of other high-grade deposits.

GOLD MINING IN RUSSIA

The potentialities of Soviet Russia as a gold mining country are described in the *Far Eastern Review* for July by L. Schlounde. The author says that gold is found in the Urals, Caucasus, Western, Central, and Eastern Siberia and in many other parts of Russia and that, before the War, Russia ranked fourth amongst the gold-producing countries of the world. The principal gold-mining districts are the Urals, Lena district, Far Eastern district, Altai-Marinsk, Kazak A.S.S.R., Angaro-Baikal district, Yakut A.S.S.R., Maritime-Priamoursky district, Uzbekistan, and Turkmenistan districts, Archangel, and several districts in the Caucasus.

The Ural gold-mining region is situated in the provinces of Perm, Orenburg, Viatka, Ufa, and Turgai and represents the oldest gold-bearing region of the U.S.S.R. Gold was discovered there in 1742 in the Beresovsky gold mines, near Ekaterinburg (now Sverdlovsk). In 1771 alluvial gold was discovered in the River Chussovoi. In the neighbourhood of Sverdlovsk in the Governments of Perm, Tobolsk, and Orenburg there are a number of goldfields, which border on the Ural mountains and which spread out in a wide plain from north to south and extend for hundreds of square miles. The gold areas start north of the Urals in the basin of the River Soswa and extend to the South Urals close to the Mugodjar mountains. The gold strata of the alluvial bed are not deep and in their yield and extent are inferior to those of Siberia. They have already been largely exploited and many of them are exhausted. The gold territories in the districts of Bogoslov, Nishni-Tagil, Naviansk, in the valley and rivers Novia, Eltschanka, Miassa and Kotschkar system, Shigirsky Lake and Langur-Ekaterinsk region, in the valley of the Kanatz and Shulgatan Rivers are the principal territories giving the Ural mountains the reputation of a gold-bearing country. Up to now, the largest amount of capital has been invested in the treasures of the Ural mountains. In the pre-war period many Belgian, French, German, and English groups took over various grounds and numerous expeditions were made. Although the Urals have been known for more than 200 years, only a small portion of their mineral deposits has as yet been worked. The average pre-war annual production of the Urals was about 10,500 kg. of gold and 4,000 kg. of platinum, of the approximate value of £2,000,000 gold and £1,500,000 platinum. In 1913 the official output of gold was about 232,176 troy oz. of the present value of £1,393,056.

It is important to know that in accordance with official information given by the eminent authority of A. K. Meister on the mineral resources of the U.S.S.R. (published by the Geological Committee of the U.S.S.R.) the reserves of alluvial gold are estimated at 98,630 kg. of gold of the approximate value of £20,000,000. This represents only a portion of a half-a-dozen gold-bearing regions. There are numerous gold-bearing conglomerates, similar to the South African, in the Bogoslov region, containing from 4 to 12 gr. and more per ton of ore.

Other original gold reefs are situated in numerous parts of the Urals. It should be noted that up to the present neither the southerly nor the northerly parts have been exploited. The output is relatively small, because, where workings have been made, gold has been obtained by primitive means. Gold on the Urals now, as before, is worked mostly by individual labour. Auriferous areas are leased to so-called "Starateli," contractors of private enterprise, to exploit, or on licence to individual diggers, without a lease on the land. Undoubtedly under modern conditions and with modern machinery and greater metallurgical knowledge the wealth of these mountains will be brought to light.

In connexion with the organization of the All-Union Trust "Soyus-Zolato," the production of gold (to which considerable attention has already been given by the Soviet Government) will increase in output and new fields will be opened for exploitation. If one takes into consideration the erection of the wonderful new town of Magnitogorsk, as a metallurgical centre in the Urals, the latest achievement of the Soviet Government, of the great creative energy of its population, and of the Ural railway, of which 1,500 km. have already been laid, it can easily be seen that the future industrial progress of these goldfields is assured.

After describing the mines of the Urals, which is known as the oldest gold-bearing territory in the Soviet Union, the author turns to the Western District of Siberia. The goldfields of the Province of Tomsk, the mining districts of Mariansk, Briansk, and Kusnetzk were in pre-war times private Crown lands, but have now been nationalized. Concessions can be obtained from the Soviet Government. Gold-mining has been carried on in a very primitive manner, but, nevertheless, the workings proved highly productive. The alluvials in this district are very rich and the mineral veins frequently contain from 20 to 33 gr. of gold per ton. The Trans-Siberian Railway, which runs through this province, and the coal

beds which are in the proximity will promote and greatly facilitate the development of the mining industry.

Equally important are the gold beds of the Altai mountains, Atschinsk and Minusinsk. The gold strata, which are from two to three metres thick, are spread out over a wide surface. In the Altai-Marminsk region of the district of Bisk and of the autonomous Province of Oriat the gold alluvials are situated in the river systems of the Toma, Kondoma, Balik-cu Lebed, Bia, and other systems of many rivers. Up to 1923 the production of gold obtained in this region was 220,170 kg. In the district of Mariinsk gold is obtained not only from alluvials but from gold-ore from reefs in the Altai mountains, such as the gold mines of Zmeinogorsk, Riddersk, and Zeirianovsk. In the district of Egorevsk in the basin of the Ika and Suengi Rivers gold was extracted from the N.E. ridge and in the valleys of the rivers are numerous placers suitable for dredging. In many other regions there are large reserves, Kuznetzki-Altai being the principal gold producer. Up to 1917 its production amounted to 142,920 kg. of gold. The most productive districts are on the Rivers Mrassa, Kondoma, Balyk-Su, Lebed and others, where 72,000 kg. of gold have been extracted and there are large reserves in store. The basin of the River Kii is an important field for exploitation. Up to 1922 49,440 kg. of gold have been recovered and reef gold mining is its future. In Zmeinogorsk there is a hornstone very rich in gold content. The navigable river Yennissey, the Trans-Siberian Railway, and the abundance of labour, are great assets for the future development of gold mining in the Altai gold region.

The Yennissey goldfields are situated in the district of Krasnoyarsk and Atchinsk. They are some of the oldest known Siberian gold placers. In the neighbourhood of Atchinsk gold was discovered in 1832. Abundant wealth lies in the Province of Irkutsk, on the right side of the Yennissey River in the mountains of Syriam. On the Rivers Niabe, Kolamy, Narkosowka, Talia, and Uderey the ground is highly mineralized. The gold strata are very regular and the numerous coal beds which are situated there are naturally of great importance. The geological formation is of metamorphic slate and clay slate, which are accompanied by gneiss, diorite, porphyry, limestone, conglomerate, and alluvium. The gold bed is from three to five metres thick and contains from 6 to 10 gr. of gold per ton. These alluvials adapt themselves to dredging. Up to 1923 the production in the Yennissey region was 558,080 kg. of gold, equal to 20% of the total production of the U.S.S.R. The gold-bearing alluvials are mostly situated on the right tributary streams of the River Angara and the left tributaries of Tunguska and Pit Rivers, which divide the whole region into north and south systems of gold territories. The south system of goldfields stands out for its high gold contents. The alluvials in the upper part of the Rivers Uderey and Bolshoi Marojney and, in the north system, the alluvials of the Kalami, Sevaglikone Aktolika, Wangascha Rivers, and others are of importance. In the South Yennissey district there are the gold-mining reefs of the "Gerasimo-Fedoroff," "Ural," "Kommunar," "Seralinsk," and "Soviet" gold mines.

In the Irkutsk district of Central Siberia are the gold districts of Burisinsk, Pre-Baikal, and the north slope of the mountains of Sajan. The Burisinsk district is eminent. Up to 1917 the gold production was 36,090 kg., leaving a reserve of 18,300 kg. of gold. The gold industry there was concentrated mostly in the district of the River Nurioundukan and on the River Krestovka, a stream of the Baikal Sea. The district has great mining prospects, as also has the whole western country of the Baikal Sea.

In the Lena region gold was discovered in 1846, and in 1860 the rich alluvials of Boidabo produced 56% of the gold recovered in the district while the alluvials on the river systems of Neigri and Vachi produced 30% of the gold of the district. The River Vitim and its tributaries contain also very large alluvial goldfields. In 1915 the production of the Lena district was 17,263 kg. of gold. Up to 1923 the output of the district was about 600,788 kg. of gold, equal to 21·8% of the total production of U.S.S.R. The whole region of the Lena goldfields is still very rich in gold and the Taiga (the vast marshy forests) has not yet been explored.

Next to the Lena region in production of gold is the Far East region, which represents the Trans-Baikalien (Buriat Autonomous S.S.R. Amur Provinces, Premorski (Maritime) Province and Kamchatka). The principal ones are the Trans-Baikal and Amur regions.

The Trans-Baikal region is situated in the district of Bargusinsk, Nerchinsk. The principal alluvials are on the Rivers Ingod, Onon, Shilki, and Arguni. There are large reserves, estimated, in 1917, at 15,750 kg. of gold. A characteristic of the gold alluvials in this district is the presence of large nuggets.

The Amur region is situated on the Amur River and its tributaries, Zea, Selendji, and Burea. Up to 1923 the production of the Amur region was 281,679 kg. of gold, presenting 10·25% of the total production of U.S.S.R. There are, in the Jedrinsk placers, many quartz veins carrying 30, 100, and up to 200 gr. to the ton of ore. On the River Chargu Chudger and many others there are gold-quartz veins exposed carrying visible gold. There is here the so-called "Golden Mountain," where quartz veins exist disseminated with heavy gold. Some of the alluvials are worked out, but large reserves are still available for exploitation.

This region is the Province of Nikolaievsk and is situated on the system of the River Amgun. Up to 1923 the production of this district was 51,660 kg. of gold. In the alluvials of Udelsk and Limuresik the gold reached 90 gr. per ton. The gold-bearing "White Mountain" is famous. In the gold mines of Askold Island, in 1898 to 1923, 800 kg. of gold were recovered from quartz veins, some parts of the veins proving by assay to carry 500 to 1,000 gr. per ton. There are large reserves on this island.

The Kamchatka region is also very auriferous. Up to 1919 the production of gold was 1,376 kg. and it has been estimated that 10,400 kg. is in store. The country is little known, not having been explored, but some prospectors proved the presence of rich gold-bearing alluvials on many of the rivers. On the Chukatzu Peninsula, American prospectors discovered ground on the River Nado containing 15 gr. of gold to the ton and nuggets of 136·5 gr. The region of Kamtchatka is similar in geological formation to Alaska.

With regard to the Trans-Baikal and Amur gold

regions the author adds that the whole district of the river basins of Shilka and Arguni, Onon, Zeija, Oldai, Bureia, and Amguni, which is situated on the railway line of Tschita, Nertschinsk, Blagovestsensk, Nikolayevsk, and Chabarovsk, is highly mineralized and is rich in gold alluvials and gold veins. From a geological standpoint it would appear probable that the Yablonovoi Chrebet mountains, which run through the whole district from north to south, are a continuation of the Andes. The mines in the Amur appear favourable for exploitation as they lay at no great depth.

In the Province of Yakutsk are situated the richest goldfields of Siberia. These territories, up to the present, are still virgin ground. The richest part of the province, so far known, is the celebrated Alokina (which is one of the richest gold mines in the world), the gold-bearing beds being 15 to 20 ft. in thickness with gold values from 15 to 30 gr. per ton. It is possible to produce up to 15,000 kg. of gold per annum there. No railway has yet been built in this region, but the construction of one in the direction of the Stanovoy mountains should only be a question of time.

The total gold production of Siberia in the last fifty years was 1,940,122 kg., representing a value of £360,852,372.

Gold mining in Siberia has always been constant and flourishing, gold production in pre-war days being principally the result of private enterprise. Already in the year 1877 the gold production of the Crown amounted to 168¾ pd. or 6·7%, while the private production was 2,334 pd., or 93·3%.

In California, Australia, and New Zealand, where labour is dear, alluvials containing 2s. per ton in gold are considered profitable for exploitation. In Siberia, however, where labour is cheap and plentiful, until now such alluvials have been completely neglected because others, considerably richer, were available, e.g. in the year 1864 in the Valley of Uderey, in the province of Jenissey, 17,800,000 tons of alluvials were washed and from these 70,000 kg. of gold were extracted, i.e. about 6 gr. of gold per ton, in value 15s. per ton. On the same basis it has been calculated that in the Jenissey district alone, from the year 1834 until 1874, 130,000,000 tons of alluvials were washed, the product in gold amounting to 400,000 kg., a value of 8s. per ton.

From this will be perceived that up to the present time there has been no necessity to work upon material of a lower grade than the above and the alluvials washed have always been of high values. The methods for gold exploitation until now have been very primitive. This industry stands on the brink of an economic evolution. Through the application of dredges, mining machinery, and modern methods of gold extraction, the gold-mining industry of Siberia will become important and will rival the production of many other gold-bearing countries in the past. Taking into consideration the geological formation of the goldfields in Siberia, the mineralogical structure of the alluvial strata and veins, together with their size, abundance, and richness, the author considers that there is a great future for the gold-mining industry in Russia.

ORE TREATMENT AT McINTYRE PORCUPINE

In the course of an article on gold milling developments in Northern Ontario, by W. F. Boericke, which appears in *Mining and Metallurgy* for September, a description is given of the new McIntyre mill. The author says that an innovation from the more or less conventional cyanidation treatment of the Porcupine field is found in the work at the new McIntyre mill. This well-designed plant, one of the show mills of the North, was completed and put into operation May 27, 1931, at the rate of 1,000 tons per day and gradually brought up to 2,000 tons per day by November 15. The last ore was sent to the old mill on July 22, 1931. From the time the resulting solutions were precipitated until November 15 efforts were directed to cleaning up preparatory to complete abandonment of the old unit. During this period much equipment was transferred from the old mill and installed in the new plant.

As early as 1928 it had become apparent that the old all-cyanidation plant had become inadequate to handle economically a tonnage exceeding 1,400 tons daily; in fact, to continue at that rate, considerable expenditure would have been required for remodelling the building and replacing the equipment. The crushing and transport system at that time was uneconomical and it was determined, in view of all these factors, to build a new mill at a central point for the mine's future development. After careful consideration, and much trial and experiment in a pilot mill, plans were drawn up for a combination flotation-cyanidation treatment of the ore in a large new mill that would be a pioneer in this field.

Several factors influenced the management in choosing a flotation-cyanidation mill. First, capital expense for building and equipment would be less, compared with the cost of a cyanide mill of equal capacity. Mill space to be lighted and heated would be less, a factor of no small importance in a country where the winters are severe, and other economies would be obtained in insurance, depreciation, and maintenance. It was expected that savings in operating costs would be considerable and that future metallurgical developments in flotation could reasonably be counted on to show even better results, whereas the same optimism could not be held for progress in cyanidation, which has already reached a high stage of development.

McIntyre ore contains about 8% of sulphide, principally pyrite, and averaged about $8 during 1931. Gold occurs both free and imbedded in the pyrite. The country rock, which may be mineralized, is schist with quartz. Compared with Kirkland Lake ores the gold is coarser and the percentage of sulphide is considerably higher, thus making it more suitable for flotation. Some doubt has been expressed about the ability to float coarse gold. Research work at McIntyre has definitely proved that gold coarser than 35 mesh can be floated, as

is shown by slides prepared by the company from actual operations in the flotation cells. Under the microscope, particles of this gold appear ragged rather than smooth or rounded.

The new mill is built of reinforced concrete with hollow-tile facing and insulating material. This construction has proved highly effective in winter and no inside heating has been required. The mill is rated at 2,000 tons of ore per 24 hours and is actually milling this tonnage daily. About 55 men are required. Horse-power used per ton of ore is approximately 1·1.

The general scheme of treatment consists of crushing, grinding in tube-mills, flotation of sulphide and free gold, filtering of flotation concentrate, further grinding of the latter in tube-mills to 95% minus 325, classification, agitation, and thickening of the pulp, and a final three-stage filtration.

In the necessarily brief resumé of the flowsheet that is given, the author says that it must be remembered that the procedure, though satisfactory, is by no means final, nor is it so regarded by the management. Minor changes will unquestionably be made, but the metallurgical results to-day, in his opinion, give good cause for congratulation.

The ore is crushed underground in 48 by 36-in. jaw crushers and from the surface bins goes to a 7-ft. Symons cone crusher, giving a minus-1½-in. product. Tramp iron is removed with a magnet. It is then conveyed by a 36-in. belt conveyor, equipped with a Merrick weightometer, to a 100-ton bin, then to six Hum-mer screens with $\frac{5}{16}$-in. openings. A Link-Belt tripper is used for distributing ore to various bins. As considerable dust arises from operation of the Symons crusher and rolls, a Sly dust-collecting system has been installed, which drops the dust, amounting to a considerable quantity, to the bins below. This makes a clear atmosphere in the crushing room, with benefit to men and machines. Oversize from the Hum-mers goes to a set of 78 by 18-in. Traylor Ajo-type rolls, driven with two 150-h.p. induction motors which reduce the ore to $\frac{5}{16}$-in. Rolls are equipped with chrome-steel shells and are in closed circuit with the screens. The undersize from the screens goes to a bin with a capacity of 4,500 tons, then to five 5 by 16-ft. tube mills using 2-in. forged steel balls. Power requirements are 150 h.p. per mill. About 800 lb. of balls are added every day to each mill.

An interesting feature is the bleeding of about a quarter of the discharge from each tube-mill to a single Denver Sub-A flotation unit, while the other three-quarters joins the product from the secondary flotation cells and goes to five Dorr classifiers. The purpose of this is to pull down the gold content of the tube-mill circuit at the earliest opportunity and take some coarse gold out at once before it gets concentrated in the circuit. The plan has succeeded in bringing down the gold content of the classifier overflow approximately 25%. The froth on this bleeder cell appears to be much heavier than that on the primary series that follows, and carries a higher-grade concentrate. Overflow from the classifier runs about 12% plus 65, 23% plus 100, 20% plus 200, and 45% minus 200 mesh. This, incidentally, would be regarded almost as coarse crushing in the Kirkland Lake area.

Collecting reagent at the rate of approximately 0·12 lb. per ton of ore is fed to the tube-mills. Classifier overflow goes to a primary series of 48 Denver Sub-A flotation cells. Frothing is good and the concentrate carries 60 to 70% of sulphide, with $60 to $80 in gold, depending on the grade of ore. About 250 to 300 tons of primary concentrate is made per 24 hours. Concentration ratio is 7 : 1.

The tailing from the primary flotation cells goes to a secondary series of 48 Denver Sub-A cells where frothing reagent at the rate of approximately 0·08 lb. per ton is added to the feed. The gold in the feed to this secondary series is about $1 and the froth concentrate assays about $15. This is returned to the primary flotation cells for re-treatment. Final tailing goes to waste from the last cell of this series.

Concentrate from the primary flotation machines goes to two American filters for dewatering. The cake is sprayed with water to displace as much frothing reagent as possible, to reduce trouble with frothing in subsequent treatment in the cyanidation cycle. The filtrate is returned to the tube-mill feed.

This is the flotation cycle. The rest of the work has to do with cyaniding the flotation concentrate and follows generally accepted practice, though several interesting situations arise owing to the slight inclusion of flotation reagents and the necessity for extremely fine grinding.

The filter cake, with 20% moisture, is repulped with barren solution, 4 lb. KCN per ton of solution, with 1½ to 2 lb. CaO to provide a high alkalinity. It goes to two 5 by 16-ft. tube-mills, rubber-lined, with 1¼-in. balls, where it is ground in cyanide solution. It has been found that most of the cyanide consumption is in the tube-mills. The final product is 95% minus 325. The discharge, with a 1 : 1 composition, goes to Dorr classifiers. Dilution must be kept low on account of liability of frothing. This factor also makes it necessary to employ air lifts instead of pumps to get the classifier overflow up to the agitators. As is the usual practice the agitators use a large amount of auxiliary air, the air lift being totally inadequate to give the required aeration. A froth still persists in the pulp, owing to traces of frothing compounds, but is handled without much difficulty through a series of by-passes from one agitator to another. From No. 6 agitator the pulp is pumped to a Dorr classifier with a 6-in. Morris pump.

Overflow from the classifier goes to a tray thickener and the sand returns to the cyanide tube-mills. Successful handling of the heavy froth that builds up in the thickener calls for ingenuity, but the problem has been solved by drawing solution for clarification from the bottom tray only, while the froth on the top passes to the filters along with the pulp. The bubbles are extremely fine and resist breaking up, though readily disposed of on the filter.

The overflow, after clarification, goes to Merrill filter presses for precipitation. The underflow goes to six American filters, working in three stages of two each, the repulped cake passing to the following pair, until the final cake is discarded as waste.

Consumption of cyanide, zinc, and lime per ton of ore is about 60% of that at the old plant. The time needed for the cyanide treatment is about 36 hours. The assay value of the combined flotation and cyanide tailing is 37 c. Extraction of gold from the ore is 95%.

All-Flotation Treatment of Silver-Lead-Zinc Ore.—Milling methods and costs at the Morning concentrator at Mullan, in the Cœur d'Alene district of Idaho, are described by M. P. Dalton in Information Circular 6587 of the United States Bureau of Mines. The Morning ore is of complex character, containing argentiferous galena and sphalerite in intimate mixture, with siderite and quartz associated with them as gangue minerals. Fine grinding is necessary to liberate the ore minerals.

The ore was treated originally by gravity methods, which effected a recovery of only 50% of the lead and none of the zinc. A flotation plant installed in 1911 comprised 248 tubes and remained in service for nine years. It was quite efficient on a feed of selected table sands, but was very bulky for its capacity. This was the only large-scale plant of its kind ever built. All-flotation methods completely displaced the former flow sheets in 1926 and have been used ever since. After reduction to minus 1 in. size in a jaw crusher and a cone crusher, the ore is ground in mills in two stages to 81·4% minus 200 mesh and sent to flotation, which is conducted in two circuits; the first produces lead concentrates, the second zinc. The machine, which is of the rotor type and which was developed at this plant, is used in the lead circuit for roughing operations and in part for cleaning. Other type machines are used for cleaning only. Rougher middlings are reground before being returned to flotation. Lead circuit tails comprise the zinc circuit feed. Treatment in this circuit involves roughing in machines, thickening and regrinding of rougher middlings, and triple cleaning in cells. Flotation reagents used in both circuits have a total cost of 13·8 cents per ton of ore treated. All concentrates are thickened and further dewatered on filters before shipment.

During the year 1930 the concentration ratios for lead and zinc were 9·1 and 10·0 respectively; 39,833 tons of lead concentrates and 36,008 tons of zinc concentrates were produced; recoveries in the lead concentrate were 81·1% of the silver, 91·0% of the lead, and 9·7% of the zinc, with 14·2% of the silver, 3·1% of the lead, and 85·7% of the zinc in the zinc concentrates; and the milling cost per ton of ore was $1·029.

Fluorspar Milling.—The milling of fluorspar ores presents some problems in wet concentration not common to ordinary concentration practice. E. C. Reeder, in Information Circular 6621 of the United States Bureau of Mines, describes the methods used in the wet concentration of Illinois fluorspar. The report also covers operating data, including costs of operation. The process described involves close screening of the mill feed and treatment of the sized products over jigs, and tables with a jig used to clean the tailings.

SHORT NOTICES

Shaft Sinking.—S. E. Lavrov describes the sinking of an inclined shaft at the Page mine of Federal Mining and Smelting Co., Idaho, in the *Mining Congress Journal* for July–August.

Winding.—J. D. Griffin describes safety devices for three-phase winders and gives some notes on reverse current and hydraulic braking in the *Journal* of the South African Institution of Engineers for September.

Power. — A combination waste heat and pulverized fuel unit installed by the Consolidated Mining and Smelting Company of Canada at Trail, B.C., is described by W. H. D. Clark in the *Canadian Mining Journal* for September.

Copper Smelting in the U.S.S.R. — Some details of the Lake Balkhash copper works in eastern Kazakstan are given in the *Far Eastern Review* for August.

Oil Prospecting by Resistivity Methods.—In Technical Paper 521 of the United States Bureau of Mines, J. H. Swartz gives the results of the application of resistivity methods to prospecting for oil in Kentucky.

Magnetic Surveying.—E. F. Stratton and J. Wallace Joyce give the results of a magnetic study of some iron deposits in Technical Paper 528 of the United States Bureau of Mines.

Ore Genesis.—Microscopic criteria of hypogene and supergene origin of ore minerals are discussed by G. M. Schwartz in *Economic Geology* for September–October.

Casapalca, Peru.—H. E. McKinstry and J. A. Noble give an account of the veins of Casapalca, Peru, in *Economic Geology* for September–October.

Californian Gold Mining.—An account of recent gold mining activities in California is given by W. W. Bradley in *Mining and Metallurgy* for September.

Alaska Juneau.—The September issue of the *Engineering and Mining Journal* is devoted to a comprehensive description of the Alaska Juneau enterprise.

Siscoe Gold.—The Siscoe gold deposit is described by J. E. Hawley in the *Canadian Mining and Metallurgical Bulletin* for September.

Transvaal Coal.—J. Mendelsohn goes into the question of washing, blending, and carbonizing coal, with particular reference to Transvaal coal, in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for July.

Mining Research.—The trend of mining research is discusssed by P. B. Bucky in the *Mining Congress Journal* for July–August.

Gold in Manchuria.—G. T. Eve points out the vital importance of gold mining to Manchuria in the *Far Eastern Review* for July.

Copper.—The copper situation is discussed by Arthur Notman in the *Canadian Mining and Metallurgical Bulletin* for September.

Screened Pipe. — In Technical Publication No. 490 of the American Institute of Mining and Metallurgical Engineers, C. S. Wilson discusses the selection and use of screened pipe for use in oil pipe-lines.

RECENT PATENTS PUBLISHED

☛ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending* 1s. *to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.*2, *with a note of the number and year of the patent.*

8,300 of 1931 (378,903). Colorado Iron Works, Co., Denver. Ores, graded according to their resistance to the desired reaction, are roasted while travelling in an enclosed space containing the requisite gaseous atmosphere.

9,245 of 1931 (378,056). H. Tinsley, D. C. Gall, and A. B. Broughton-Edge, London. Methods of electrical prospecting involving the employment of what are termed "iso-in-phase" and "iso-quadrature" lines.

10,745 of 1931 (377,220). Dorr Co., New York. Movement is applied to the rakes of a classifier at

two suspension points, by using eccentric or crank-driven links.

10,880 of 1931 (378,890). Dorr Co., New York. Improved sedimentation apparatus.

11,199 of 1931 (377,260). Trent Process Co., New York. A process for ore concentration, wherein the mixture of metallic material and gangue is allowed to flow over a concentrating table in a body of hydrocarbon oil, the metallic material becoming separated from the gangue and collected in the oil.

12,060 of 1931 (377,705). Meyer Mineral Separation Co., Pittsburgh. A chloridizing process for the recovery of metals from their ores found to be particularly suitable for the treatment of oxidized material.

12,298 of 1931 (377,298). P. W. Davis, Cambridge, Massachusetts. A process for refining scrap lead wherein pure lead and antimonial lead are separated.

12,437 of 1931 (378,063). Minerals Separation, Ltd., London. A froth flotation process for mineral concentration characterized by the conjoint employment as reagents of a soluble sulphide and a soluble alkali silicate.

13,593 of 1931 (378,085). Newman, Hender and Co., Ltd., and C. P. Newman, Woodchester. The core-box of a core drill is mechanically shaken to loosen the core.

21,557 of 1931 (377,435). W. S. Cripps and J. Stormonth, New South Wales. Apparatus for the retorting of shale and other minerals for the production of oils and incidental by-products.

22,790 of 1931 (377,451). Metallgesellschaft A.-G., Frankfort-on-Main, Germany. Materials containing volatilizable metals are mixed with solid carbonaceous reducing agents and charged into a rotary tube furnace, the volatilized metals and gases being drawn off and the carbonaceous residues being further treated in gas producers.

25,104 of 1931 (378,668). R. F. Bacon, New York. Process for the recovery of elemental sulphur from sulphur-containing gases.

30,344 of 1931 (377,858). Beryllium Development Corporation, New York. A process for the manufacture of beryllium in which beryllium chloride vapour is led into bath, which is subsequently electrolyzed.

1,890 of 1932 (377,895). Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij, The Hague. Mud flush coming from a bore-hole is subjected to a partial vacuum in order to release gases brought up from the hole.

9,451 of 1932 (379,247). Dr. C. Otto and Comp., G.m.b.H., Bochum, Germany. A dry process for removing sulphur from gases which are to be compressed for transmission to a distance.

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.

Chemical Encyclopaedia. By C. T. Kingzett. Fifth Edition. Cloth, octavo, 1,014 pages, illustrated. Price 40s. London: Bailliere, Tindall and Cox.

Handbuch der Geophysik. Vol IV, Part 3, Erdbebengeographie, by Dr. A. Sieberg. Paper covers, pp. 687–1,004, illustrated. Subscription price RM. 56, ordinary price RM. 84. Vol IX, Part I; Der Aufbau der Atmosphäre, Die Schallausbreitung der Atmosphäre, by Dr. B. Gutenberg; Wärmehaushalt der Stratosphäre (Pt. I), by J. Tichanowski; Wärmehaushalt der Stratosphäre (Pt. II), by Dr. R. Mügge. Paper covers, pp. 1–171, illustrated. Subscription price RM. 24, ordinary price RM. 36. Berlin: Gebrüder Borntraeger.

The Mineral Industry during 1931. Vol. XL. Edited by G. A. Roush. Cloth, octavo, 735 pages. Price 72s. New York and London: McGraw-Hill.

Reports of H.M. Inspectors of Mines, 1931: 1.—Scotland Division, by J. Masterton; 2.—Northern Division, by T. Greenland Davies; 4.—North Midland Division, by J. R. Felton; 5.—North Western Division, by W. J. Charlton; 6.—Cardiff and Forest of Dean Division, by J. Macleod Carey; Midland and Southern Division, by W. E. T. Hartley. Paper covers, each price 1s. London: H.M. Stationery Office.

Lithium. Imperial Institute Monograph. Paper covers, 27 pages. Price 6d. London: H.M. Stationery Office.

Quebec: Annual Report of the Bureau of Mines, 1931, Part A, Mining Operations and Statistics. Paper covers, 154 pages, illustrated. Quebec: Bureau of Mines.

The Geology of South-West Ankole and Adjacent Territories with Special Reference to the Tin Deposits. By A. D. Combe, with an appendix on the petrology by Dr. A. W. Groves. Geological Survey of Uganda Memoirs No. II. Paper boards, 236 pages, illustrated, with maps. Price Shs. 35. Entebbe: Geological Survey.

Gold Coast Colony: Report on the Mines Department, 1931–1932. Paper folio, 21 pages. Price 2s. London; Crown Agents for the Colonies.

South Australia: Mining Review for the half-year to December 31, 1931, No. 55. Paper covers, 98 pages. Adelaide: Department of Mines.

Safety Organizations at Lake Superior Iron Mines. United States Bureau of Mines Technical Paper 515. By F. S. Crawford. Paper covers, 32 pages. Washington: Superintendent of Documents.

Mineral Resources of the United States, 1930. Part I, pp. 691–748, Copper, by C. E. Julihn and H. M. Meyer. Part II, pp. 775–876, Petroleum, by G. R. Hopkins and A. B. Coons. Washington: Superintendent of Documents.

Comité Spécial du Katanga: Annales du Service des Mines, Tome I, 1930 and Tome II, 1931. Paper covers, large quarto, illustrated. Price, each part, 30 francs. Brussels: Office de Publicité, Comité Spécial du Katanga.

Brigade Signals. By J. B. Scrivenor. Cloth, octavo, 176 pages. Price 6s. Oxford: Basil Blackwell.

COMPANY REPORTS

Rooiberg Minerals.—This company was formed in 1908 and operates tin-mining properties in the Waterberg district of the Transvaal. The report for the year to June 30 last shows that operations were confined to the alluvial plant. The tonnage of material treated amounted to 72,315 short tons, the plant running for 314 days. The concentrates produced totalled 119·3 tons, containing 60·35%

of metallic tin. The balance brought in from the previous year was £3,510 and the reserve account of £16,000 was transferred to appropriation account, as well as £154 representing unclaimed dividends, the sum available being £19,304. From this sum the loss for the year, £8,975, and £50 in taxes were deducted, leaving a balance of £10,279 to be carried forward.

Cam and Motor.—Formed in 1919, this company operates gold-mining property in the Hartley mining district of Southern Rhodesia. The report for the year to June 30 last shows that 295,000 tons of ore was milled, the total revenue amounting to £515,585, as compared with £540,219 from 292,000 tons in the previous year. Working costs, however, showed a considerable reduction at £287,809, against £321,607, and the net working profit, after allowing for the B.S.A. Co. royalty, was £201,985, against £191,601. Dividends paid during the year absorbed £168,750, equal to 22½%. The total ore reserves at June 30 last were estimated to be 1,000,000 tons, averaging 44s. per ton, as compared with 878,000 tons, averaging 48·1s. per ton, at the end of the previous year.

Anglo-Nigerian Corporation.—This company, formed in 1929, has extensive interests in Nigerian tin-mining companies in addition to mining itself on the Bauchi plateau. The report for 1931 shows that 632 tons of tin concentrates was recovered during the year, as compared with 869 tons in 1930, the average price realized being £67 12s. 1d. per ton, against £80 9s. 4d., the reduced output being due entirely to the restriction of output imposed by the Nigerian Government. The accounts for the year, after providing for unpaid debenture interest amounting to £14,000 and writing off development and prospecting expenditure and depreciation amounting to £13,575, show a net loss of £27,464. The silver-lead areas held by the company are now in charge of caretaker, but a new area some 38 miles north of the main areas was pegged during the year.

Naraguta (Nigeria).—This company was formed in 1910 and works alluvial tin property in Northern Nigeria. The report for the year to March 31 last shows an output of tin concentrates amounting to 223 tons, as compared with 357⅓ tons in the previous year, the price realized being £70 10s. 2d. per ton, against £69 17s. 11d. The accounts show a net profit of £2,252, which, added to the sum of £35,277 brought in from the previous account, gave an available total of £37,529, which was carried forward.

Naraguta Korot.—This company was formed in 1925 to work alluvial tin property in Northern Nigeria. The report for 1931 shows that 120·15 tons of tin concentrates was recovered, against 187½ tons in the previous year, the concentrate realizing £71 9s. 6d. per ton, as compared with £74 4s. 4d. for the 1930 output. The year's working shows a profit of £2,113, as compared with a loss of £2,399 in the previous year, decreasing the debit balance carried forward to £56,887. One new mining lease and one new water right were granted the company during the year.

Naraguta Durumi.—This company, formed in 1929, operates alluvial tin property in Northern Nigeria. The report for the year to March 31 last shows an output of 54 tons of tin concentrates, against 133¼ tons in the previous year. Of this amount 40 tons was produced up to September, 1931, when the main plant was closed down. The average price realized for the year's production was £73 7s. 5d. per ton, as compared with £70 12s. 10d. for the output of the previous year. As from April, 1932, the property has been completely closed down, the company's quota having been grouped with that of the Naraguta company. The accounts for the year under review show a loss of £180, increasing the debit balance carried forward to £8,220.

Selayang Tin.—Formed in 1924, this company works alluvial tin property in the Kuala Lumpur district, F.M.S. The report for 1931 shows that 713,000 cu. yd. of ground was treated by the dredge in the period April 1–December 31, the tin concentrate recovered amounting to 142·6 tons. The output realized an average of £71 3s. 5d. per ton, the year's working resulting in a loss of £6,158, so that, after allowing for the credit balance of £3,777 brought in, there remained a debit of £2,381 to be carried forward.

Renong Tin.—This company was formed in 1913 to work alluvial tin in Southern Siam, but, since 1926, operations have been confined to newer areas in the F.M.S. The report for the year to June 30 shows that, under restriction conditions, 836,371 cu. yd. of ground was treated, the tin concentrates recovered amounting to 342·31 tons, which realized an average of £91·5 per ton. The trading profit for the year was £8,156 and, after allowing for sundry credit items and adding the balance of £22,493 brought in from the previous account, there was an available total of £36,809. Of this amount £3,750 was taken for preference dividend, while £3,357 was absorbed in paying a dividend of 2½% on the ordinary share. Other items, including special expenditure on the repair and overhaul of No. 2 dredge, absorbed £11,471, leaving a balance of £18,231 to be carried forward.

DIVIDENDS DECLARED

Central Provinces Manganese.—4%, less tax, payable October 1.

Champion Reef.—1s. 3d., less tax, payable October 15.

Changkat Tin.—6d., less tax, payable September 30.

Chosen Corporation.—3¾d., less tax, payable September 15.

El Oro.—4d., less tax.

Gopeng Consolidated.—3d., less tax, payable September 30.

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

Minerals Separation.—1s., less tax, payable October 20.

Murex.—20%, less tax.

Mysore Gold.—6d., less tax, payable October 22.

Renong Tin.—6d., less tax, payable October 10.

Waihi.—1s., less tax, payable November 1.

West African Diamond.—1½d., less tax, payable October 4.

NEW COMPANY REGISTERED

Uraba Gold.—Capital: £30,000 in 2s. shares. Objects: To acquire in any part of the world any lands, concessions, etc.; to search for auriferous quartz, ore, petroleum, and other products, and mineral substances of all kinds, including diamonds. Office: 20, Copthall Avenue, E.C.