The Mining Magazine

Managing Director and Editor : W. F. WHITE. *Assistants :* ST. J. R. C. SHEPHERD, A.R.S.M., D.I.C., F.G.S. F. HIGHAM, A.R.S.M., M.Sc., F.G.S.

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EDITORIAL

A COURSE of seven lectures on tropical hygiene, arranged by the British Red Cross Society, will commence at the London branch office, 9, Chesham Street, Belgrave Square, S.W. 1, on September 22. The fee for the course for non-members is 7s. 6d.

SILVER jubilee celebrations will mark this year's meeting of the Institute of Metals, which is to take place at Birmingham from September 18 to September 22. The autumn lecture, which is to be given by Mr. W. R. Barclay, will be devoted to a review of 25 years' progress in metallurgical plant.

PLANS were put forward last month by the Australian Government that have in view the development of Northern Australia as a "white man's country." It is proposed to grant chartered rights to two approved companies prepared to undertake the opening up of these vast territories, much of which is comparatively unexplored and may well be rich in mineral wealth. The Commonwealth Government will undertake to obtain the co-operation of the British and Western Australian Governments in order to give effect to its policy.

READERS of the MAGAZINE are familiar with the contributions made by metallurgists to the elucidation of the problems confronting the archæologist and historian, as witness the valuable work of Sir Harold Carpenter and his collaborators. Another link in the chain has been forged as the result of investigations by Dr. C. H. Desch, of the National Physical Laboratory, who has been able to show that the fragment of a dagger recovered from the excavations at Tell Asmar, near Baghdad, is of nickel-free iron, and therefore not of meteoric origin. This significant discovery places man-made iron in an earlier age than has hitherto been claimed for it.

AN article in *The Times* last month by Mr. W. M. Macmillan, of the University of the Witwatersrand, was loud in its praise of the efficient organization of gold-mining on the Rand and of copper mining in Northern Rhodesia and the Belgian Congo, but was inclined to be critical of the work being done for the natives in other African goldfields, particularly those on the Gold Coast. This view was combated by Mrs. Malcolm Maclaren, who, speaking from personal experience of the Rand and the Gold Coast, was emphatically of the opinion that the natives on the latter are the stronger, healthier, and happier community and that the treatment of the natives on Gold Coast lines is preferable to that necessitated on the Rand by its rapid growth and intensive development.

WHILE it is not difficult to be critical of the Government's scheme for the protection of the oil-from-coal industry on economic grounds, there will be many who see in this a just reward for many years' patient research and much capital expenditure by the organization largely responsible for the progress made in this country—Imperial Chemical Industries. Unemployment in the coal and iron and steel industries will also be relieved, while the moral effect of this revival of activity in a particularly depressed area is of unquestioned value. Government assistance is to be afforded in the form of a preferential rate of 4d. per gallon over the imported product for a period of nine years from April, 1935, at an estimated cost of £1,000,000 annually by the loss of Customs' receipts. The projected plant for the conversion of coal into oil by hydrogenation, work on which is stated to have been begun already, will be capable of treating 500 tons of coal per day, a further 500 tons at least being consumed in the process, with an estimated annual yield of 100,000 tons of first-grade petrol—figures derived from the results of a pilot plant which has been working for some time past, treating 10 to 15 tons daily. It is worthy of note that a participating interest in the Imperial Chemical Industries subsidiary controlling these developments is held by two of the largest oil companies. There are indications that other oil-from-coal industries are likely to come into being—for example, in South Wales—as a consequence of the promised protection and low-temperature carbonization activities are also expected to increase, since the plant referred to will be capable of dealing with products of that process as well as raw coal.

Silicosis

Miner's phthisis, or "silicosis," has always been the bane of the underground worker and it has long been held to be one of the inevitable health risks to be faced by the "hard-rock" man all over the world, its onslaught having become the more marked with the advent of machine drilling, particularly with compressed-air machines. In the General Report of the Miners' Phthisis Prevention Committee for the Union of South Africa, issued in 1916, the malady was defined as primarily a fibrosis of the lung, the essential factor producing the condition being the "more or less continuous inhalation, over long periods, of fine rock dust"; at later stages of the disease tuberculosis sets in and death results from the effects of a "tubercular infection in a fibroid lung." At the International Congress on Silicosis, held in Johannesburg in August, 1930, the definition finally accepted was that silicosis is "a pathological condition of the lungs due to the inhalation of silicon dioxide," resulting from silica reaching the lungs in a "chemically uncombined state." It will be seen, therefore, that the researches continuously conducted during the intervening period did not alter the general conception that silica dust is the irritant cause of the disease. It has to be remembered, too, that it is not only in the pursuit of metal-mining that silicosis occurs; the coal-miner also is liable to contract the disease, while pottery men, stonemasons, clay workers, and labourers in asbestos works are all subject to infection. What promises to be the most important contribution to our knowledge of this dread disease is revealed in a paper published this month in the *Journal of Hygiene*,[1] which embodies research carried out by Dr. W. R. Jones, of the Geology Department of the Imperial College, whose conclusions seem to be so far-reaching in their effects, particularly in relation to government regulations and having in view the compensation arising out of silicosis cases, as to deserve detailed consideration here, in addition to the summary published elsewhere in this issue.

During the past two years Dr. Jones has had occasion to visit certain collieries in the anthracite district of South Wales in order to collect and examine specimens of rock from working places where men formerly employed had contracted silicosis. Some of the specimens could be regarded as coming within the legal definition of silica rock (usually held to contain over 50% free silica), but others could not. These latter naturally aroused the author's interest, for it was evident that rocks other than those embraced in the Silicosis Scheme were responsible for the prevalence of dangerous dust and it was obviously a matter for further inquiry. Pursuing his investigation Dr. Jones went on to the examination of silicotic lungs and the actual minerals they contain. A precise technique was developed, the lungs being first digested in strong nitric acid, the slime filtered, dried, removed from the filter paper, and calcined. Light materials were removed by separation in a mixture of bromoform and benzine having a specific gravity of 2 and the heavier minerals were washed, dried, mounted in Canada balsam, and examined under a petrological microscope. Under high power it was speedily evident that the greater part of these mineral residues consisted of minute fibres of sericite, or "secondary white mica." Chemical work carried on at the same time fully supported this conclusion, the results of the combined investigation showing that silica in an uncombined state is present in a silicotic lung in amounts subordinate to sericite, and the author is now convinced that the latter mineral must be the chief cause of the disease. The fact that the Rand "banket"—which is full of sericite—is a well-known dangerous rock from the silicosis point of view, while the quartz mined in the Kolar goldfield of Mysore—practically free of sericite—is not known to have caused a single case of the disease supports the author in his conclusion, and other similar comparative cases are quoted. At Broken Hill, for example, rocks containing a relatively low percentage of quartz, but which do contain fibrous silicates such as sericite and sillimanite, produce a dust that has caused a large number of silicosis cases. Another point of some significance is that free silica present in the residues examined by the author occurred as relatively coarse granular particles such as might lodge in the bronchi or bronchioles, whereas the minute fibres of sericite were fine enough to penetrate much farther into the lung itself. The author's final conclusion is, therefore, that it is mainly the presence in the exploited rocks of fibrous minerals, which during drilling become

[1] Silicotic Lungs: The Minerals they Contain. W. R. Jones, *Journal of Hygiene*, Vol. XXXIII, No. 3, August 4, 1933.

freed into the atmosphere as individual fibres, that enables sufficient material, in course of time, to enter the lung and cause "silicosis."

Regulations affecting the miner working under conditions that might induce "silicosis" have all been based on the idea that it was free silica dust that caused the trouble, so that it will be readily seen that Dr. Jones's work may demand their drastic revision. It is certain, however, that further investigation is urgently necessary and mining engineers should be in a position to help by the collection of precise data relating to mines where quartz has been worked for long periods without giving rise to any authenticated cases of silicosis or of mines where "silicosis" cases have occurred although no "silica rocks" are mined. In conclusion, it is interesting to note that earlier work has been done on the doubly-refracting particles found in microscope sections of silicotic lungs. The presence of these minerals has been noted before, but it is not until now that their true significance has been realized.

The Economic Conference

Towards the end of last month the World Economic Conference "went into recess," the result of its deliberations being held—on all sides—to be disappointing. In announcing the opening of the Conference the MAGAZINE stated that there was a general feeling that if its work was to be of permanent use and of immediate benefit it was probably necessary that existing trade barriers should be considerably modified and that the principle of national economic self-sufficiency should, in part at any rate, be thrown overboard. The comparative failure of the Conference can only be due to the refusal of certain countries to entertain proposals that in any way limited their freedom of individual action, a matter well emphasized by President Roosevelt's attitude towards currency stabilization. The President abruptly rejected all proposals which would prevent the manipulation of the dollar to America's advantage and since it seems evident that some sort of currency stabilization is an absolutely essential prelude to a free interchange of goods the proceedings of the Conference gradually faded away to an ignominious close, since "exchange dumping" was not one of the evils to be recognized by the American delegation. Meanwhile, although pious hopes are entertained for the reassembly of the Conference at some future date—and the new Geological Museum at South Kensington is probably to be kept available for this purpose—it seems necessary here to take note of two results of the recent meeting which are of importance to members of the profession—the silver agreement and the effort that is being made by the International Tin Committee to secure world-wide adherence to its plans.

Schemes for the rehabilitation of silver have been frequently to the fore during the past few years, but the possibility of a general remonetization of the metal was rejected by both the Ottawa and the World conferences at the outset. To the silver-producing and silver-using countries, however, the matter remained of supreme importance and it is satisfactory that the delegates from those countries were able to arrive at a definite agreement on policy while the Conference was sitting. The agreement, which is to run for four years, provides that India shall not, except for war-debt payments, dispose of more than 140,000,000 oz. of silver during that period and that the producing countries shall not during the agreement sell any silver, but shall withdraw from the market 35,000,000 oz. in each year. Silver from demonetization in China is not to be sold and Spain agrees not to dispose of more than 5,000,000 oz. a year. It is evident, therefore, that during the period of the agreement the position of silver is likely to be improved, but the colossal stocks that will be built up by the producing countries will continue to menace the future position of the metal and it is to be hoped that World conditions will so improve during the time of the agreement that its extension will either be easy to arrange or become unnecessary.

One of the most satisfactory features of the metal markets during the past few months has been the steady rise in the price of tin to over £200 per ton and this at a time when consumption could hardly be regarded as good. This pleasing aspect of the effect of restriction measures has emboldened the International Tin Committee to put forward a strong recommendation that all tin-producing countries not yet participating in the international restriction agreement should join in the scheme of control without delay, a recommendation that was endorsed by the Sub-Committee on Tin at the World Economic Conference. The Sub-Committee

attached great importance to early action being taken in the matter, as the negotiations which are in hand for the new three years' control agreement cannot be very well concluded until the intentions of the various governments in this matter have been made clear. The countries concerned are Australia, Belgium, China, France, India, Japan, Mexico, Portugal, the United Kingdom, and the Union of South Africa, all of whom have been urged to nominate a representative who can negotiate with the International Tin Committee with the object of determining a quota agreement. How far this effort to secure all-embracing restriction for tin will be successful remains to be seen.

The Petroleum Congress

The World Petroleum Congress—the first held since the War—took place in London last month. The countries represented by official delegates numbered 33, well over a thousand members taking part in the proceedings. On July 19 members were welcomed by the president, Mr. T. Dewhurst, at the Science Museum, South Kensington, the work of the Congress commencing on the following day. Sessions were held daily in the Royal School of Mines, while two special lectures were given at the Royal Institution, by Mr. J. B. A. Kessler on "Rationalization of the Oil Industry" on July 20 and by Sir John Cadman on "Science in the Petroleum Industry" on July 21. Following Mr. Kessler's lecture a reception was held by the Government at Lancaster House, delegates and members being received by the President of the Board of Trade. In addition to other social functions visits were paid to various industrial works during the period the Congress was sitting.

The work of the Congress was divided into three main sections: Geological, production, and refining, chemical, and testing. The first section considered the geological significance of the regional distribution of oilfields and then went on to discuss the geological aspects of oilfield development, in this connexion paying special attention to general development schemes, unit development, the evidence provided by coring and flush sampling, electrical logging, and methods of increasing oil recovery. Modern developments in geological exploration were also considered, the value of geophysical exploration, aerial reconnaissance, and current field methods being discussed. Summaries of several of these papers will be found elsewhere in this issue. The production section first made a survey of modern drilling methods, going on to discuss the transport and storage of oil, while further sessions were devoted to actual production methods and to the measurement of oil in bulk. A very full programme of papers was arranged for the last section, that devoted to refining, chemical, and testing. Hydrogenation, the subject first discussed, naturally attracted a great deal of attention in view of the Government's recently-declared policy. Other work before this section included discussions on bituminous materials and emulsions, the determination of gum in gasoline, viscosity and its expression, fuels for high-speed compression-ignition engines, and problems connected with kerosine, lubricating oils, the refining of cracked gasolines, oil-coal fuels, knock-rating, and alternative fuels, a final session being devoted to a consideration of petroleum as a chemical raw material.

To conclude the business of the Congress a joint meeting of all sessions was held to discuss international co-operation in standardization. Here the lack of an accepted international nomenclature for petroleum products was emphasized and the need for co-operation between all the existing standardization bodies urged. It was considered that co-ordination of opinions among these bodies was an essential first step towards the achievement of an international terminology and complete agreement on testing methods, while the institution of regular channels through which information could be readily exchanged by the different countries was regarded as urgent. At this meeting it was proposed and adopted that, in order to avoid any overlapping or duplication of work, national petroleum nomenclature and methods of testing should be arranged through the medium of an international body—that is, through Committee 28 of the International Standards Association. The Congress closed on a note of optimism, it being generally felt that its purpose had been fulfilled by bringing together specialists in all branches of the industry and by affording the opportunity for frank discussion of the many important problems that had arisen through the rapid development of petroleum technology, particularly in recent years. It was held that if the constructive work of the 1933 Congress was to be carried on arrangements should be made for meeting more often and a proposal favouring triennial congresses was unanimously approved.

REVIEW OF MINING

Introduction.—The failure of the World Economic Conference has apparently had no effect on business generally and conditions may be described as firm, metal prices showing little change. The position with regard to zinc has been clarified to some extent by the decision to continue the Cartel for a year, while the silver agreement has so far made no impression on prices. The figures relating to unemployment in this country issued this month show that the position continues to improve.

Transvaal.—The output of gold on the Rand for July was 872,695 oz. and in outside districts 50,976 oz., making a total of 923,671 oz., as compared with 918,633 oz. in June. The number of natives employed in the gold mines at the end of July totalled 230,306, as compared with 229,751 at the end of June.

Reports from the Union last month indicated that South Africa was seeking drastic revision of the Mozambique Convention relating to the supply of native labour from Portuguese territory. It has been stated that, failing agreement on the suggested revision, the Convention will cease on six months' notice.

An interesting feature of the reports of the Rand companies covering the three months to June 30 last is the decision of some companies to issue calculations of ore reserves based on a price of £6 per oz. for gold. As an example calculations for the Robinson Deep might be quoted. For this mine the reserves at June 30 last, with gold at 84s. 9d. per oz., were estimated to be 3,128,000 tons averaging 5·8 dwt. over a stoping width of 58 in., whereas with gold at 120s. per oz. there were estimated to be 4,089,000 tons averaging 5·4 dwt. over the same width. It is probable that similar calculations will soon be made available for all the Rand mines.

Shareholders of Modderfontein East have been informed that the Government has accepted the company's application for the lease of the under-mining rights of an area equal to approximately 625 claims adjoining its eastern boundary on the Farms Klipfontein No. 11 and Welgedacht No. 2.

In the report covering operations for the three months ended June 30 last shareholders of Geldenhuis Deep were informed that the repairs to the damaged No. 2 Shaft caused by the pressure burst mentioned in the last report have been hampered by further movements in the vicinity of the shaft. Work is stated to be proceeding, however, and the 16th and 17th level stations have now been reclaimed.

Further results from the boring on West Witwatersrand Areas were announced last month, Bore-hole No. 11 Venterspost intersecting a narrow band of reef at 3,588 ft. and a wider reef channel at 3,743 ft. The second intersection is approximately at the expected horizon of the West reef, but definite correlation will not be possible until the underlying basal shale has been penetrated.

It was announced last month that the Main Reef had been intersected in No. 36 level cross-cut from the South shaft of West Rand Consolidated Mines. At this point the reef was dipping at 26° and averaged 11 dwt. in value over a width of 42 in.

A circular to shareholders of East Rand Consolidated last month stated that the company had acquired the right over the Farm Poortje No. 123, adjoining Tulipvale, while later the acquisition of the Farm Spaarwater from Lace Proprietary Mines was announced. The price paid for the last-named property is stated to be £250,000 in 5s. shares of East Rand Consolidated and an extraordinary meeting will be held shortly to sanction the increase of capital necessary to complete the purchase. The company has commenced boring operations on Marais-drift, near the boundary of the Sub Nigel properties.

Shareholders of Glynn's Lydenburg have been informed that the cash position will enable the company to pay its accrued liability to the Government under the power agreement, amounting to £13,600, and excess profits duty, amounting to £6,028, but that there will be no surplus for the payment of a dividend.

The report of the Rooiberg Minerals Development Co. for the three months ended June 30 last states that the Old School Workings have been re-opened. The alluvial plant is said to be working satisfactorily.

The accounts of the Johannesburg Con-

solidated Investment Co. for 1932 show a profit of £359,675, making, with the sum brought in, an available total of £526,360. A dividend equal to 1s. 6d. per share will absorb £220,706, while £150,000 has been placed to reserve, leaving £155,654 to be carried forward. The assets of the company include £1,000,000 in British Government securities.

Southern Rhodesia.—The output of gold from Southern Rhodesia during June was 54,442 oz., as compared with 53,358 oz. for the previous month and 48,441 oz. for June, 1932. Other outputs for June were : Silver, 8,662 oz. ; coal, 46,838 tons ; chrome ore, 935 tons ; asbestos, 2,703 tons ; iron pyrites, 682 tons.

The report of the Gold Fields Rhodesian Development Co. for the year to May 31 last shows a profit of £161,301, reducing the debit balance brought in to £55,527. The value of the company's investments at the close of the year under review showed an appreciation of £204,194, as compared with the substantial depreciation shown at the end of the previous year.

The accounts of Falcon Mines, Ltd., for the year to September 30, 1932, show that a sum of £143 was received during the year from the tributing arrangements made in respect of the Falcon and Athens properties. There was a loss of £812 for the year, increasing the debit balance brought in to £176,480.

Northern Rhodesia.—The output of gold from Northern Rhodesia for June was 214 oz., as compared with 256 oz. for the previous month and 467 oz. for June, 1932. Other outputs for June were : Copper, 8,079 tons ; zinc, 1,600 tons ; manganese ore, 945 tons ; mica, 700 lb.

Shareholders of the Rhodesian Selection Trust were informed last month that it had been decided to re-open the Mufulira mine. It is expected that copper production on a restricted scale will begin towards the end of the year.

The report of Loangwa Concessions (Northern Rhodesia) for 1932 reveals the arrangements that have been concluded with the British South Africa Company whereby the period of prospecting rights is extended to December 31, 1940. In return for the extension the Chartered company is to be allotted, not later than June 30, 1935, 1,000 fully-paid shares in Loangwa Concessions for every 1,000 square miles or part thereof retained by the company after April 30, 1935.

Gold Coast.—A circular to shareholders of Ariston Gold Mines (1929), issued last month, stated that holders of the remaining debentures and convertible notes had exercised their option and converted into shares, so that the company has no longer any preferential charges. A progress report by Mr. C. B. Brodigan, which accompanies the circular, states that extensions of the old 16th level south of Prestea have opened up a large compact body of ore, which, although not payable at this point, is considered encouraging. The reserves of ore at June 30 last were estimated to be 223,000 tons, averaging 10·55 dwt. in value.

Shareholders of Bibiani (1927) have been informed that the mill was started on April 8 last and has since operated as a pilot plant. Up to the end of June 4,679 tons of ore had been treated, yielding 1,330 oz. of gold. These operations revealed the need of finer grinding and this section of the plant is to have its capacity increased.

The report of Lyndhurst Deep Level (Gold and Silver) for 1932 shows that no mining operations were carried out, the property remaining in charge of a caretaker. Since the close of the year one half of the Boabedroo Concession, including the Akyenase mine and plant, has been sold to Konongo Gold Mines, Ltd., in return for £250,000 in fully-paid 2s. shares in that company. The reefs being developed by the Konongo company continue through the Lyndhurst property and arrangements are in hand to prospect these occurrences.

Nigeria.—At an extraordinary meeting of the Junction Tin Mine (Nigeria), held last month, a resolution proposing the voluntary liquidation of the company was approved.

Australia.—Shareholders of the Wiluna Gold Corporation have been informed that it was expected to commence treating ore at the rate of 40,000 tons per month by the middle of July.

Two interesting developments have been reported by the Great Boulder Proprietary. A cross-cut in East Section 29, Main Shaft 1,933 ft., last month intersected a lode 12 ft. in width, having an average value of 15 dwt., while a cross-cut 390 ft. north of the Main Shaft on the 500-ft. level cut a lode 3 ft. wide averaging 8 dwt. in value.

The accounts of Barrier South, Ltd., for 1932 show a profit of £127, reducing the debit

balance brought in to £7,249. As work on the neighbouring property of the Zinc Corporation was confined during 1932 to improvement of the ventilation system there was nothing further to report with regard to the company's leases.

New Zealand.—The report of the New Zealand Crown Mines for 1932 shows a profit of £708. A dividend equal to 6¼% absorbed £596, leaving a balance for the year of £112.

Malaya.—The report of Selayang Tin Dredging for 1932 shows a loss of £134, increasing the debit balance brought in to £2,515. The dredge recovered 94 tons of tin concentrates at a cost of £7,072, equal to 4·9d. per cubic yard treated.

Dutch East Indies.—Arrangements were concluded last month for the taking over of the Sinkep Tin Company by the Billiton Joint Mining Company. The purchase consideration is stated to be Fl. 2,500,000, either in cash or 4½% debentures of the Billiton company. It is probable that the operations of the Singkep company will be stopped for the time being, Billiton costs being much lower.

Burma.—The final dividend announced by the Burma Corporation in respect of the financial year ended June 30 last was 4 annas per share, of which 3½ annas is out of the year's earnings and ½ anna from accumulated profits. The total paid for the year thus amounts to 5½ annas per share, tax free, as compared with 4 annas per share for the previous year.

At an extraordinary meeting of Kamounghla Tavoy Tin, Ltd., held last month, the sale of the company's mining properties in Lower Burma to the Tavoy Tin Dredging Corporation was approved. The purchase consideration was £10,000, satisfied by the allotment of 50,000 shares of 4s. in Tavoy Tin Dredging.

Korea.—Shareholders of the Chosen Corporation were informed last month of a projected hydro-electric installation on the Yalu River, in the financing of which French and Japanese capitalists are interested. The Great Nurupi mine is said to be only 20 to 25 miles distant from the proposed site.

Yugoslavia.—The report of Trepca Mines for the three months ended June 30 last shows an estimated working surplus of £93,430, equal to 14s. 11d. per ton milled. Capital expenditure during the quarter totalled £10,268. During the period under review 125,118 tons of ore was milled yielding 14,083 tons of lead concentrates and 18,272 tons of zinc concentrates.

Further details are now available of the extent to which the Central Mining and Investment Corporation has become interested in Novo Brdo Mines, Kopaonik Mines, and the Zletovo Mines. The corporation has undertaken to purchase at par 200,000 5s. shares (1s. paid) in the Novo Brdo company and to subscribe for 200,000 5s. shares at par in the Kopaonik and Zletovo companies. The two last-named companies held extraordinary meetings last month, at which proposals to increase the capital of each company to £225,000 were approved. In the case of Zletovo Mines this involved the creation of 160,000 new 5s. shares, while shareholders of Kopaonik Mines agreed to the creation of 200,000 new shares of the same value.

Consolidated Tin Smelters.—The report of Consolidated Tin Smelters, Ltd., for the year to June 30 last shows the revenue to have been £166,377, increasing the amount brought in to £261,764. Of this amount £66,122 has been absorbed in the payment of preference dividends, £74,942 paid as an ordinary dividend, equal to 5%, and £25,000 used to write down shares in subsidiary companies, the balance of £95,700 being carried forward.

Chemical and Metallurgical Corporation.—During 1932 the operations of the Chemical and Metallurgical Corporation were conducted at a profit of £2,280, after allowing £8,791 for depreciation. A circular accompanying the report contained full details of the offer for the sale of the whole of the issued capital of the corporation, to which reference was made in the June issue of the MAGAZINE. An agreement with Imperial Chemical Industries, providing for the exchange of shares in the corporation for Imperial Chemical Industries' shares, was approved at the annual meeting held last month.

Tin.—The statistics relating to tin stocks at the end of July show a further reduction in visible supplies amounting to approximately 1,900 tons. These stocks now stand at 44,622 tons, as compared with 57,630 tons at the end of the previous year. Although the reduction was not so large as had been expected the price of the metal continued steady around £215 per ton. The results of the effort being made to obtain world-wide restriction are awaited with interest.

SMELTING PRACTICE AT THE ROAN ANTELOPE

By A. RUSSELL MERZ

Following on the article on the Roan Concentrator which appeared in the July issue of the MAGAZINE, the author completes the account of metallurgical practice at this Northern Rhodesian copper producer.

The operating practice at the Roan Antelope smelter is notable for its simplicity. The character of the concentrate produced from Roan ore is responsible for the unique position of this plant among copper smelters. The major points of difference are three: First, no roasting of the concentrate is required, owing to a deficiency in iron and sulphur; secondly, no converter slag is produced, due to the negligible quantity of iron in the matte; and, thirdly, no electrolytic treatment is needed, owing to the rare purity of the copper produced. All these factors react towards reduction of smelting costs through decreasing the amount of equipment and labour required to smelt the full production of concentrate and produce therefrom a large tonnage of copper. The smelter commenced operations on October 15, 1931, when the first charge was fed to the reverberatory furnace. Actual production commenced five days later, when the first copper was converted and cast.

There has been no appreciable change in the type of ore mined since the plant was started, as mining has been confined chiefly to the eastern end of the ore-body. There will be an increase in the amounts of iron and sulphur present in the concentrate as mining operations progress westward. Generally speaking the concentrate is a simple mixture of chalcocite (Cu_2S) and gangue material (shale), a typical analysis showing—Cu, 58·67%; SiO_2, 13·40%; FeO, 3·90%; CaO, 0·10%; Al_2O_3, 4·12%; MgO, 0·70%; and S, 16·02%. A decrease in the copper content of the concentrate causes no corresponding decrease in the copper content of the matte produced, but since a lower-grade concentrate contains more gangue material more limestone is required to flux it. The course of material in its passage through the smelting plant is shown in the accompanying flow-sheet (Fig. 2).

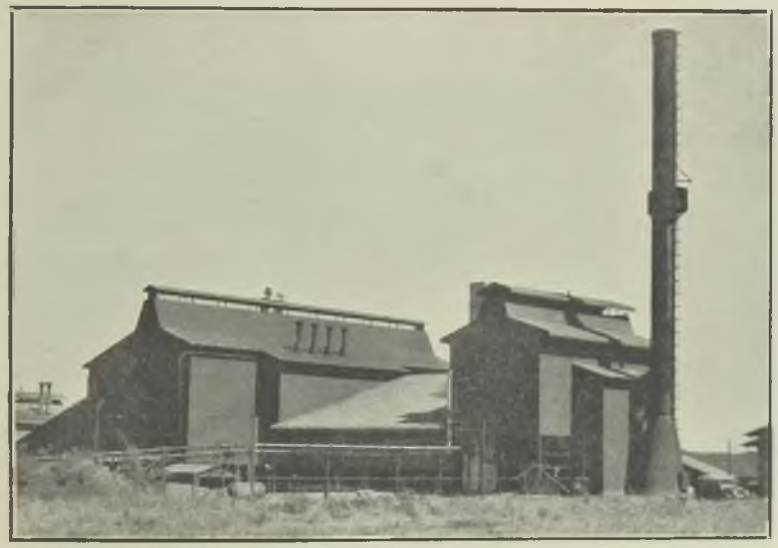


FIG. 1.—THE ROAN ANTELOPE SMELTER.

CONCENTRATE HANDLING.—The concentrate is transported from the concentrator by pumping through a 3-in. pipe to three Oliver filters situated at the smelting plant. The filters deliver their product, at 8 to 10% moisture, to a system of belt-conveyors, which discharge into three stock bins of 100 tons capacity each. The original equipment comprised three Lowden dryers, one connected to each filter, arranged to receive the product of the filters and discharge it into the three stock bins mentioned above. The dryer equipment was removed after it was found that the wet concentrate could be

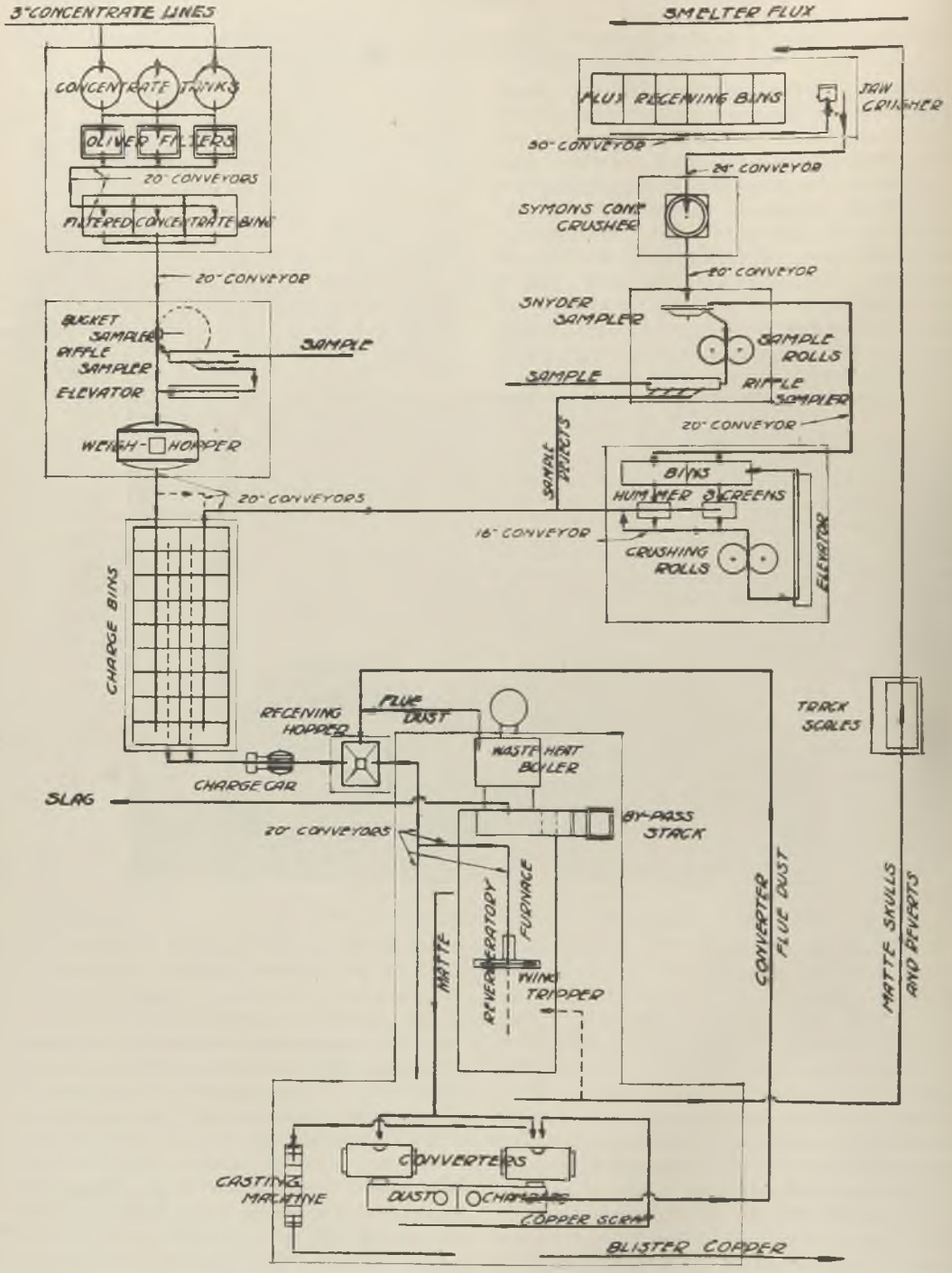


FIG. 2.—SMELTER FLOW-SHEET, APRIL, 1933.

handled through the system without difficulty. The stock bins will accommodate a full day's production of concentrate, which is weighed, sampled, and conveyed to the smelter storage bins during the day shift. Each bin is equipped with a belt-feeder, which delivers the concentrate on to an inclined belt-conveyor, on which it is carried to a hopper weighing machine.

The weighing apparatus consists of a circular steel drum, together with motor and reduction gears for revolving the drum, all mounted on a frame which is supported on weighing levers. The drum is provided with an opening in the shell, through which the concentrate is charged and discharged. The feeders, belt-conveyor, sampler, and operating mechanism of the hopper weighing machine are all synchronized through a system of electrical interlocks to operate from a main control at the weighing-beam. The weight cannot be printed unless the scale beam is in balance. After the drum is filled and the weight of the concentrate recorded by the ticket-printing mechanism it is revolved 180° and the contents discharged into a 30-ton capacity receiving hopper. The drum is then revolved to its loading position. The concentrate is weighed in 23-ton batches. It requires 20 minutes to complete the cycle of filling, weighing, and emptying.

The receiving-hopper is equipped with a belt feeder, which continuously discharges the concentrate on to an inclined belt-conveyor during the weighing operations. The concentrate is conveyed to the top of the smelter storage bins, where it is distributed by trippers to the various bin compartments.

All the ingredients of the reverberatory charge are stored in the main smelter storage bins. These consist of 18 steel compartments, arranged in two parallel rows of nine each. Three compartments are reserved for crushed limestone flux, one for crushed smelter reverts, and the balance for concentrate. The material in a compartment is taken as a unit lot and the weight and analysis of each " lot " of material is determined before any of it is removed for smelting.

Flux Preparation.—Flux and smelter reverts are delivered in standard railway cars to storage bins at the crushing plant. The material is fed from the bins by a travelling apron feeder on to a belt-conveyor, which delivers it to a jaw crusher situated under and at the end of the line of bins. The product of the jaw crusher is carried on an inclined belt-conveyor to a $5\frac{1}{2}$-ft. Symons is reduced cone crusher, where the limestone to $\frac{3}{8}$ in. size and the reverts to $\frac{7}{8}$in. size.

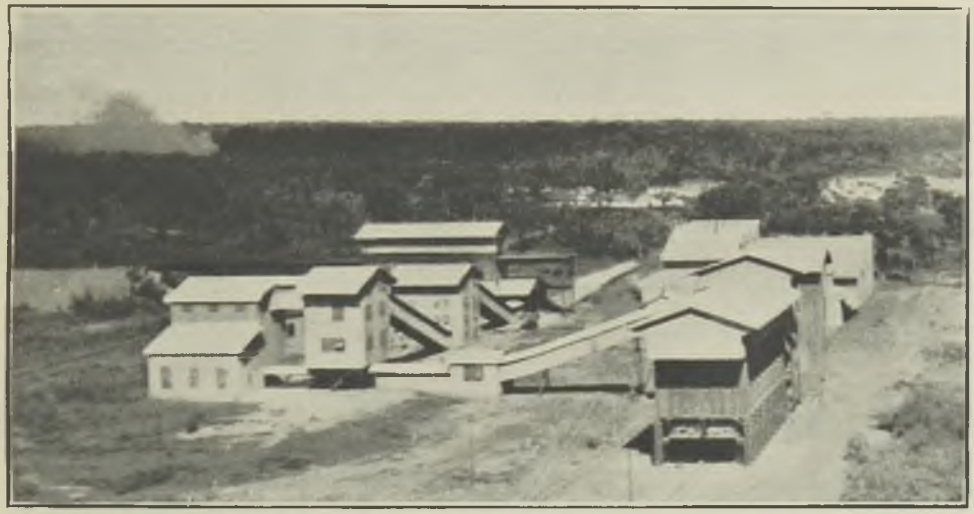


Fig. 3.—Flux Plant.

The smelter reverts are conveyed directly from the Symons crusher to the smelter storage bins. Limestone flux is further reduced to pass a four-mesh screen by a set of 42-in. by 16-in. rolls in closed circuit with two 4-ft. by 5-ft. Hum-mer vibrating screens. The crushed limestone is delivered to the smelter storage bins by a belt-conveyor.

This system includes a sampling plant to sample the Symons crusher product, consisting of a Snyder sampler, a set of 24-in. by 14-in. rolls, and a vertical riffle-sampler.

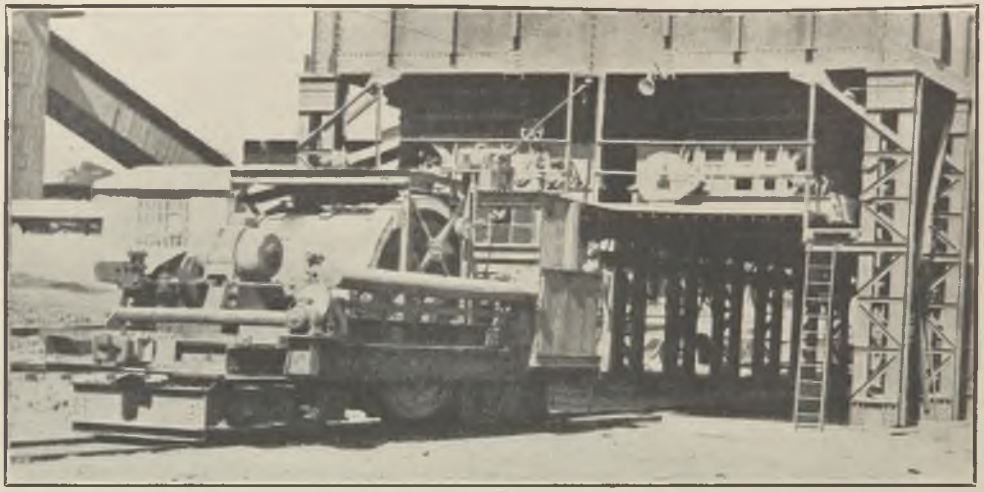


FIG. 4.—CHARGE CAR UNDER SMELTER STORAGE BINS.

CHARGE PREPARATION.—The ingredients of the reverberatory charge are removed from the smelter storage bins by means of apron feeders attached to the bottom of each bin compartment into a specially-designed charge car, in which they are transported to a receiving hopper at the reverberatory furnace. The charge car is powered by an overhead trolley circuit and is equipped to perform all the functions of weighing, mixing, and transporting the charge ingredients. It consists of a circular drum 7 ft. 6 in. internal diameter and 6 ft. long, together with a motor and reduction gears for revolving the drum, all mounted on a frame which is suspended from scale beams. The drum is provided with an opening in its periphery for the purpose of charging and discharging the material. This opening is fitted with a sliding gate operated by levers. A system of motor-operated cams lifts the load off the knife-edges when weighing is not being done. A pointer and calibrated dial situated in the cab indicate the weight in pounds of each ingredient as it is fed into the drum.

A typical charge consists of 18,800 lb. of concentrate and 1,130 lb. of limestone flux or when crushed matte is available 17,300 lb. of concentrate, 1,050 lb. of limestone flux, and 1,650 lb. of crushed matte skulls. This fills the drum a little more than half full, which allows sufficient empty space for proper mixing. The drum is revolved and its contents mixed while the car travels to the point of discharge.

REVERBERATORY SMELTING. — The reverberatory furnace is of the usual type and is 100 ft. long and 25 ft. wide, inside dimensions. The walls and roof are built of silica brick. The side walls are 2 ft. thick and the roof is 18 in. thick over the smelting zone and 15 in. thick over the settling zone.

The charge is carried on belt-conveyors from the receiving hopper to the charge floor of the reverberatory furnace, where it is distributed by a two-wing tripper to trough-shaped hoppers arranged on each side of the furnace over the side walls. The charge is dropped through 6-in. pipes into the furnace to form an embankment against the side walls. There are twelve charge pipes on each side. The embankment of charge is maintained to cover the face of the side walls for a distance of 60 ft. from the burner wall.

Fuel for heating the furnace is coal pulverized to pass 80% through a 200-mesh screen and blown into the furnace through four ports in the end wall spaced at 4-ft. centres and a few inches above the maximum height of the bath.

The coal is pulverized at a central plant, which supplies the needs of the smelter and also of the direct-fired boilers at the power plant. Two Fuller Kinyon pumps blow the powdered coal through pipes to the bunkers which they supply. Electrically-operated valves control the quantity of coal pumped to each bunker. There are four coal bunkers over the reverberatory furnace, each of 18 tons capacity. Each bunker is equipped with a Bailey feeder driven by a small motor

through Tex-ropes and variable reduction gears, so that the rate of feed to each burner can be varied from 6 to 25 tons of coal per day. Each feeder has an individual primary air fan, which furnishes the air required to carry the coal from the feeder to the burner. The coal drops through a 3-in. pipe into a 7-in. primary air pipe, which joins a 12-in. branch from the secondary air main before reaching the furnace. The volume of air is controlled in both primary and secondary air lines by means of butterfly valves, which are locked in position after adjustment. The mixture of fuel and air is proportioned to produce complete combustion, with an excess of 0·6% oxygen, as determined by daily analysis of gas samples aspirated from the furnace.

A Stirling boiler and the reverberatory stack are closely connected to the furnace, so that the maximum recovery of waste heat is made by the boiler. The recovery of heat energy in the form of superheated steam averages 52% of the total calorific value of the coal burned in the furnace. The hot gas is drawn through the boiler and discharged into the stack by an induced draught fan. An air preheater situated between the boiler and stack utilizes the heat of the waste gas from the boiler to heat the secondary air for combustion. The secondary air is supplied by a forced draught fan which blows the air through the preheater and an insulated duct to the burner end of the furnace. The air reaches the burners at a temperature of 400° F.

The draught in the furnace is maintained as near to zero as is practicable and ordinarily is not allowed to go above 0·02 in. water-gauge. Control of the draught is obtained by regulation of butterfly dampers at the intake of the induced draught fan. A native operator watches the recording draught gauge and alters the damper position to keep the draught within the specified range. Despite the moisture in the furnace charge, a very good fuel ratio is obtained because of the high percentage of matte-forming elements present. The average fuel consumption is 15·5% of the charge, the weight of matte is 70% of the weight of charge, and the weight of slag is only 26% of the charge.

The matte-forming elements in the charge consist of copper sulphide and iron sulphide, which melt to form a mixture of the following analysis : Copper, 78·7% ; iron, 0·58% ; and sulphur, 19·58%. This material has a specific gravity of 5·5 and the slag has a specific gravity of 3·0, a difference which causes a clean separation of the two in the furnace bath.

In order to operate the furnace at its greatest efficiency a depth of at least 12 in. of matte is kept in the furnace at all times. The greatest possible safe depth of matte is 24 in., which is the level of the doors through which the slag is skimmed.

The matte is tapped through two 3-in.

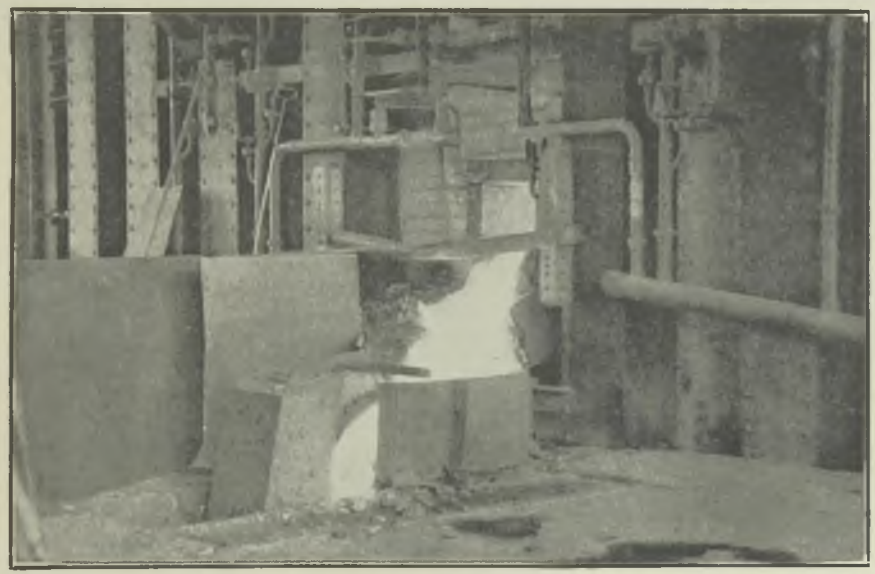


Fig. 5.—Skimming Slag.

FIG. 6.—TAPPING MATTE.

holes, 9 in. apart vertically, in a replaceable copper block fastened to the side wall of the furnace just beyond the charging zone. The holes are opened by burning them out with oxygen. The matte flows through them and down a clay-lined launder into large semi-steel ladles, which are supported on low trucks on a track below. The track extends under the operating floor, parallel to the side of the furnace, into the converter aisle. The matte ladle trucks are hauled by means of a cable operated from an electric hoist. A ladle will hold 22 tons of molten matte. When both tap-holes are opened it requires from 20 to 35 minutes to fill three ladles, which is the usual amount charged to a converter. It is customary to tap from two holes at the same time, since a speedy transfer of the matte from the reverberatory to the converter greatly decreases the amount of matte that freezes to the ladles, all of which must be rehandled, crushed, and resmelted in the reverberatory furnace. When the last ladle has been filled, the flow of matte is stopped by ramming stiff clay plugs into the tap-holes.

The ingredients of the charge are proportioned to produce slag having a silicate degree of 1·75. This entails a flux burden of only 6% limestone and produces the minimum

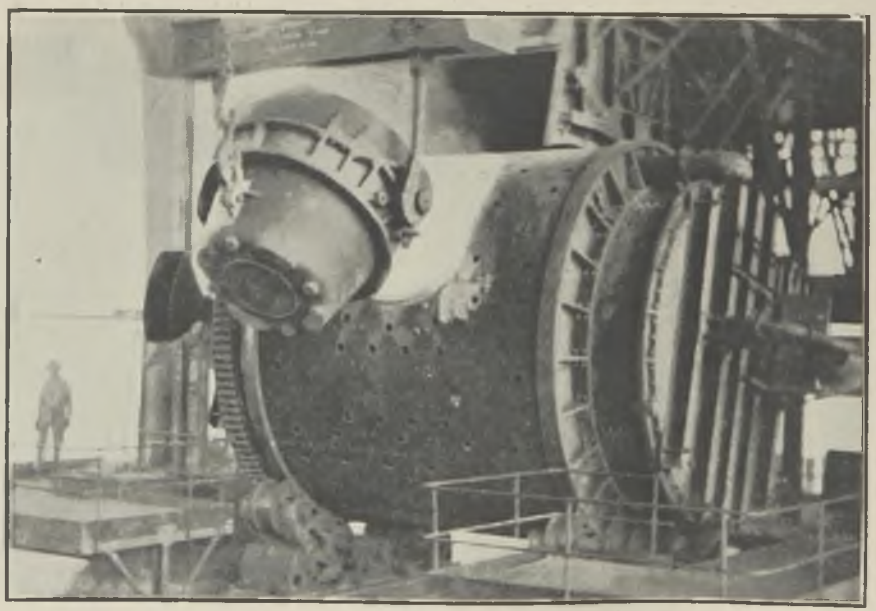


FIG. 7.—THE CONVERTER.

quantity of slag compatible with a fluidity which allows ready settlement of matte particles through it and ease in handling. An average slag analysis shows: SiO_2, 47·3% ; FeO, 13·7% ; CaO, 11·4% ; Al_2O_3, 14·7% ; MgO, 2·9%. The copper content of the slag varies from 1·0 to 2·5%, depending on the amount of cuprous oxide in the charge.

There are two skimming doors in the furnace, one in the end wall and one in the side wall. These are closed with clay dams, which are chipped out when the slag is to be skimmed. Reverberatory slag is used to provide a protective lining in the steel ladles in which molten copper is handled.

The slag is carried to the dump in ladles of 14 tons capacity. The ladles are mounted on trucks and each truck is equipped with electrically-driven gears for tilting its ladle. An electric trolley-locomotive hauls the slag to the dump, which is half a mile from the furnace. The locomotive weighs 16 tons and handles three loaded trucks, a total weight of 140 tons.

Even though the furnace charge is wet, there is a considerable amount of dust carried out of the furnace by the stream of gas. This dust, combined with ash from the coal, settles in the boiler and connecting flues. The accumulation of dust is removed and smelted. An average analysis of this dust shows: Cu, 31·22% ; SiO_2, 19·82% ; FeO, 4·59% ; CaO, 3·13% ; Al_2O_3, 11·37% ; MgO, 0·35% ; S, 5·7%.

A considerable amount of clay mud is used around the reverberatory furnace and converters for sealing openings and lining launders. This clay is abundant near the smelter and is mixed to the proper consistency in a wet pan mill, of the Chilean mill type. Two natives operate the mill on day shift and produce enough clay to supply all three shifts.

Converting.—The converters are of the Peirce-Smith type, 12 ft. in diameter and 20 ft. long inside the shell, and are lined with 12 in. of magnesite brick throughout, except along the tuyère line, where the lining is 15 in. thick. There are 30 tuyères in each converter, each $1\frac{1}{2}$ in. in diameter. One converter has ample capacity to handle the entire production of matte from the reverberatory furnace. The other converter is kept available as a spare.

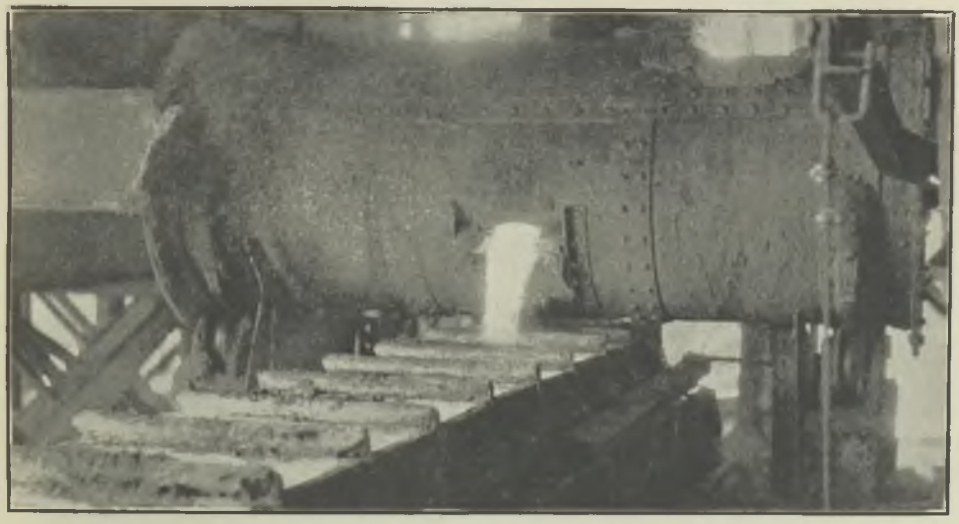


Fig. 8.—Casting.

A blowing engine, driven by a 950-h.p. electric motor, situated in the power station, supplies the air blast, at a pressure of 15 lb. per square inch, for oxidation of the iron and sulphur in the matte. The heat produced by the oxidation of the sulphur and the small amount of iron in the high-grade matte is just sufficient to finish the charge at a proper temperature for casting. The converter is kept hot during its idle periods with pulverized coal, which is blown through a burner port in one end. Before starting a blow the coal is shut off and the burner port filled with clay. At the end of the blow the clay is removed and the coal fire started.

The converters are served by an electric

overhead travelling crane, which has two cross traverse carriages, one of 50 tons capacity and the other of 20 tons capacity, which operate independently of each other. As the ladles are filled with molten matte they are pulled into the converter aisle one at a time, picked up by the crane, and emptied into the mouth of the converter.

After the converter has received its charge of matte the air is turned into the tuyères and the converter is rolled back into the blowing position. A 35-h.p. air-driven motor revolves the converter. A receiver supplies the motor with air and has ample capacity to roll the converter into a safe position in the event of a failure of the air blast.

Punching of the tuyères is done almost continuously during a converter blow by use of steel rods 4 to 5 ft. long and $\frac{3}{4}$ in. in diameter, with the punching end upset to $1\frac{1}{8}$ in. diameter.

The finish of a converter charge is determined chiefly by the appearance of the copper on the rod. This is different from the usual converter-practice, in which the finish is determined almost entirely by the appearance of the flame.

The temperatures attained during a converter blow are about the same as those of the finishing or white metal stage of the conversion of lower-grade matte. The temperature at the end of a normal blow is 2,370° F.

The converter blows are interrupted at the clear copper stage for the purpose of making moulds for the casting machine. Clear copper is used for making moulds because it gives a more solid and level bottom than blister copper. After the moulds have been cast the copper remaining in the ladle is poured back into the converter and the blow continued for five to ten minutes to produce the desired "set" for casting.

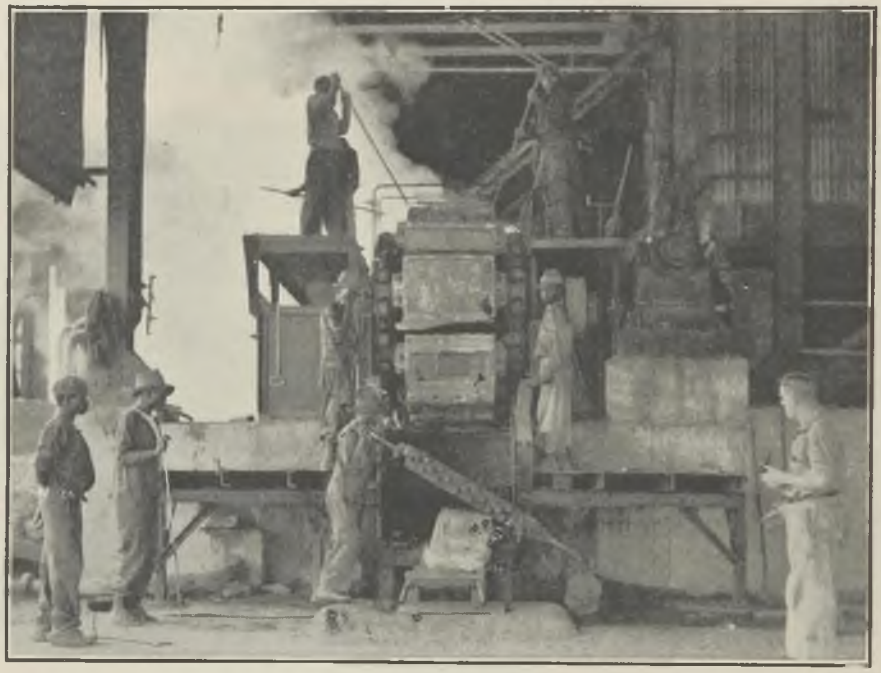


FIG. 9.—THE CASTING FLOOR.

Each converter has its own dust chamber and stack, in which dust from the blowing operations and from the pulverized coal ash settles. Converter flue dust amounts to 40 tons per month and is allowed to accumulate until a converter has finished a campaign and goes down for repairs to the lining. At this time the dust is recovered from the flue and resmelted in the reverberatory furnace. A typical analysis of converter flue dust shows: Cu, 73·29%; SiO_2, 0·88%; FeO, 0·69%; CaO, 0·22%; Al_2O_3, 1·32%; and S, 11·41%.

Handling of reverts is an important part of the operations in the converter aisle. Reverts consist of the material that freezes and adheres to the sides of the ladles and

any spillage of the molten materials. These are all dumped together on a platform, where, after breaking up the large pieces, the metallic copper is separated from the matte and slag. The copper is returned to the converters for remelting and the remainder is loaded into a hopper-shaped railway truck for delivery to the crushing plant.

CASTING.—The casting machine is of the straight-line type and is equipped with 50 moulds. The moulds are of the standard shape and size for blister copper cakes, 28 in. by 18 in. by 3½ in. The average weight per cake is 350 lb. Each mould has a lip which overlaps the back edge of the preceding mould and prevents spillage between them. cake requires 25 seconds, which gives a casting rate of 25 tons per hour.

The chain of moulds advances as each one is brought under the pouring spout of the drum for filling. In their progress to the discharge end of the machine the cakes are cooled by water sprays, which are regulated to suit the rate of casting. As the moulds turn over the head pulley the cakes are loosened with bars and fall on a chute, which discharges them on to two-wheeled hand-trucks. The cakes are taken on the hand-trucks to an open space on the floor, where they are spread out with the " set " side up for trimming and inspection. They are then loaded into standard steel railway trucks

FIG. 10.—NATIVE FURNACE CREW.

When the copper from the converter has been brought to the casting machine the crane operator tilts the ladle a very little at a time and pours the copper into a coal-fired drum. The casting drum is a brick-lined cylinder, 4 ft. in diameter and 10 ft. long, which rests on rollers on each side of the casting machine tail-pulley, so that the drum extends across the moulds above them. The copper is poured from the ladle into the drum through an opening in the top of the drum near one end. It is poured from the drum into the moulds through an opening at the bottom centre. An electric hoist, in conjunction with a counterweight, revolves the drum and controls the stream of molten copper. The machine is started and stopped for each mould to be filled. The cycle per

for shipment. All rejected cakes, fins, and cleanings from the casting machine are returned to the converters for remelting.

The moulds are made with a cast-iron pouring-plate imbedded in the bottom. This plate has the Roan Antelope brand marked in raised letters, so that each cake is marked with the brand " R.A." When a mould becomes cracked or burnt it is replaced by a new mould. The plates are recovered from the old moulds by pressing them out in a hydraulic press and are used several times.

PERSONNEL.—The operating personnel of the smelting plant is composed of 30 Europeans and 160 natives. When the smelter started operations in October, 1931, there were only a few Europeans who had had any experience

in copper smelting, but in a very short period they learned the technique required and now perform their duties like veterans. The natives were abysmally ignorant of such work, as many had never seen a white man, not to mention a copper smelter. From this condition they have improved immeasurably, until now the large majority are good workmen as long as they are supervised by Europeans. Their judgment is far from impeccable, but they are useful and satisfactory on any job which requires repetition of a definite routine. The natives, who were quite happy a few years ago with little food, less clothing, and no money, have quickly adopted the white man's clothes and boots, some details of his more varied diet, and other blessings derived from the contents of the pay envelope. Though it must go undisputed that the average native is by nature less eager to work than the average white man, the temptation of a regular income of white man's money is more than they can resist, as is evidenced by the great number of applicants always available for work.

ALLUVIAL GOLD

By H. L. HOLLOWAY

The author discusses the deposition of alluvial gold and shows how an examination of practical considerations may be of help in assessing the potential value of a placer deposit.

Often the nature of the deposit in which alluvial gold is found is a puzzle to the prospector, so much so that in early days in Western America the phrase became coined "Gold is where you find it," which meant that it had a habit of showing up under what might be regarded as most unfavourable conditions. Yet everything in nature has its *raison d'être* and the natural laws which govern the laying down of the various types of alluvial deposits offer a study of interest. Generally alluvial gold is thought of as a concentration over bedrock (to which, by reason of its specific gravity, it is natural that it should fall) in gravels subject to movement by running water. Its presence is often considered to indicate clearly the existence of auriferous rock formations in the higher courses of the streams in which it occurs. In a large number of cases both these suppositions are correct, but, on the other hand, the gold is very frequently not concentrated over bedrock and the rivers in which it occurs often drain no primary auriferous areas.

In streams which themselves erode the original formations from which the gold is derived and which may be termed primary carriers, there is every tendency for the gold to work deeper and deeper into the wash, when the particles of the metal are of anything more than extreme fineness, until their downward progress is arrested by the bedrock. Such downward progress must presuppose a certain movement in the wash also, for where the particles of gold are carried over tightly-packed or cemented gravels they cannot penetrate them. To transport gold a stream must be rapid, either permanently or intermittently, and in that part of its course where it is capable of transporting nuggets its channel will be swept clear of all but coarse stones with some intermixed sand. The gold particles in their journey downstream are subjected to a pounding and grinding process between the boulders and hard sands, which tends to reduce them to ever finer and more flattened flakes, until finally they are reduced to microscopic fineness and become susceptible to water movements that would not stir them in coarser condition. The specific gravity and consequent penetrative power of the metal is then more that offset by this susceptibility and it tends to become one of the surface constituents, ready to be carried onwards again by any increase in the velocity of the stream current. Finally the flakes become so fine that they are scattered and deposited anywhere the sand which accompanies them may be deposited.

The stage at which gold loses its habit of gravitating towards the bottom is dependent on other factors than its physical fineness. A minute flake offers more resistance to water movement than does a rounded speck of the same weight and the tendency of the latter to penetrate deeper into the wash is much greater. In normally tranquil rivers with only infrequent flood conditions the gold is more likely to be found concentrated on the bottom than in those streams swept by frequent spates. In the former it may be said that even with particles which require about 150 or more to make a grain the

gravitational tendencies still are strongest and the gold concentration will increase with the permeability of the wash. With streams subject to constant floods, where often the carrying capacity of the current is increased by the muddy condition of the water, the tendency of the same size of particle to gravitate downwards is overcome and as the flakes become still more minute the tendency to remain on the surface of the wash increases. In the lower reaches of auriferous rivers subject to periodical floods gravel bars which receive a new deposit of light float gold with each spate are a common feature and while the surface values on such bars are often good, it is rarely that sinking to lower levels does not produce disappointment.

Following the course of an auriferous river from the point where it receives its gold contents to the point where such contents have become so thinned out as to no longer offer economic interest, it may be said that if the river to which the gold is delivered is sluggish the gold will simply stay where it is delivered and there will be a rich, but local, concentration. In the more interesting case of a rapid stream, a fall in its upper portions of 50 ft. or more per mile will mean that bedrock is swept clean in a river of volume, except in particular places. Gold delivered to the river will be swept along over the bedrock until it encounters a lodging point, usually at some eddy or twist in the stream course. Gold held temporarily in irregularities of the bedrock may be disregarded, as the progress of erosion will result in it being swept on again. In powerful rivers of rapid fall—*i.e.*, geologically young rivers—the process of deepening the channel is carried on too rapidly for the formation of extensive flats and only small elbows in the course will receive deposits of boulders and gravel, with a due content of gold. Little fine gold will be encountered in these upstream bars—boulder rather than gravel bars—as only when fine particles are efficiently trapped will the swift current allow them to settle. The water infiltration through the rock constituents of these bars will carry sand between the interstices of the stones and with the sand any lodged gold particles. These particles will find their way to the bottom and there the heavier ones are likely to remain, often jambed beneath the boulders. Prospecting such bars is far from simple. Apart from the difficulty of working amidst boulders, a score of pans may be washed without result if the nuggets are coarse and the bar may be given up in the belief that it is above the delivery point where the gold enters the river. Pockets of nuggets found in such bars are due to some natural riffle being so placed as to receive gold guided to it by a favourable swirl or eddy in the stream, the concentration being later covered and preserved by boulder deposits before a change in the configuration of the river bottom results in the metal being swept on again. Only a percentage of the gold fragments will be permanently trapped in their passage. The remainder will continue a spasmodic movement downstream, ever subject to the forces which tend to reduce them to finer particles.

If a gold-bearing river is to become of economic importance for large-scale working it must sooner or later reach a point where the more level nature of the terrain and the decreased velocity of the stream permit the formation of extensive deposits of the auriferous wash in the form of "flats." It is unnecessary to enlarge on the mode of formation of these flats, but a study of the deposition of the gold in them shows the reasons why the values are so unevenly distributed. The deposition must be governed by the physical fineness to which the gold has been reduced and by the carrying force of the stream, but certain general characteristics hold good in all cases. The fact that gold has been brought down at all presupposes either a permanent or intermittent velocity of current sufficient to furnish the carrying force. The more suddenly this current slackens and the heavier the individual particles of gold the more closely will the concentration be confined to a limited area in advance of the point at which the decreased velocity occurs. In such conditions the tendency of any but exceedingly fine gold will be to work its way downwards into the wash and the deeper the wash is penetrated the richer should be the gold contents.

With the more normal conditions of a gradually slackening current, however, the gold, apart from nuggets, will be deposited in the most favourable catchpoints on the gravel bars formed at the bends of the river course. Nuggets tend to remain in the main river channel until reduced by attrition to a more easily transportable size. One action of a rapidly moving stream is to throw objects in the centre of its course to the sides. If the sides are steep this action is restricted to the balance arrived at between

this side-throw action and the gravitational force which tends to hold the objects to the deepest portion of the stream bed. Gravel bars formed in such a manner that they meet the full force of a rapid current do not make favourable catchpoints for light gold, while bars formed on the inside and lower portion of bends do. Gold particles forced to the side of the main current are swept over such bars each time the river rises and, carried by a slackened current and encountering the resistance offered by the rough surface of the wash, are deposited, the heavier flakes on the upstream portion, or head of the bar, and the smaller specks on the lower portion. Once deposited the gold will do one of three things, depending on the resistance it can offer to further transportation. If fairly heavy it will tend to bore deeper into the wash on which it lies, if moderately fine it will more or less remain where placed to share the fate of the layer of wash of which it forms part, or if very fine it will be picked up and carried on again by the next spate. It is not only bars of this nature which offer favourable catchpoints, but they are the chief collectors of the carried gold.

Gravel bars in an active river are ever in a state of transition, either being built up or destroyed. As a bar is built up its point advances outwards and upwards in the stream, the most favourable catchpoint changing as the bar changes. If the deposited gold has been of a nature to hold its position when favourable conditions ruled the rich streak it has formed will remain buried beneath poorer or barren wash. In course of time, through changes in the river course, the bar will be converted into a portion of a flat and if it is bored by the drill of the prospector the various streaks of wash enriched with fine or coarse gold will be encountered. All alluvial flats—and with flats may be included high terraces, which are nothing more than ancient flats—have been formed by changes in stream courses and during those changes, the details of which it is usually impossible to trace, first one point and then another has been a favourable catchpoint for gold brought down by the river.

Gold may be delivered to a river either from a primary or a secondary source, but the question of its source does not affect its deposition, except that as its physical condition may vary. In few large auriferous rivers will the gold content be derived from one single source and where a gold-bearing tributary joins the main stream a zone of enrichment will often occur containing two distinct types of gold. The following up of alluvial deposits usually results in disappointment as far as the discovery of lodes of economic importance is concerned. The coarse gold which is more favourable for forming concentrations in alluvial ground is usually derived from pockety occurrences, which may, and often do, accompany occasional auriferous stringers traversing large areas of barren country rock. Where such country rock is soft the breaking down process proceeds much more rapidly than would be the case with a quartz reef and far more gold is released over a large territory with many small stringers than from a few rich lodes in a more durable formation. Often, too, whatever may have been the source of alluvial deposits, such sources have completely disappeared. Much alluvial gold is derived from secondary concentrations, river systems which have ceased to exist having laid down auriferous gravels across great stretches of country, and present-day streams traversing these old gravels gather them into their own wash and reconcentrate the gold content. Unless the present-day streams follow the ancient courses for a considerable distance they can only subject an inconsiderable portion of the auriferous wash to a reconcentration process and it will be in rare cases that these reconcentrations will form payable deposits of any size.

Another source of secondary deposits is supplied by auriferous alluvials transported bodily by glacial action. Streams flowing through and reconcentrating from such deposits are sometimes locally very rich, but they rarely present areas of any magnitude. British Columbia offers innumerable cases of such deposits.

It is not unusal for the prospector to encounter a very decided difference between the gold contents of the older and newer portions of the wash in the same river bed. This may be caused by changes in that part of the river course which is the receiver of the gold content, either by landslides, volcanic flows, or by earth movements, or it may be that erosion has exhausted old or tapped new sources of supply.

A last type of deposit may be briefly touched on and that occurs when an auriferous stream empties into a deep lake, where all matter carried, other than in suspension or in solution, is deposited, until in the course of time the lake becomes filled

up. Such deposits exist in some South American countries. In a normally rapid river sand and finer materials derived from the breaking up of the constituents of the wash and the erosion of the country are carried by the stream beyond the point where gold is deposited to form sand bars and mud banks in the lower waters. In a lake of the kind mentioned practically all such matter would be deposited at the same time as the gravels containing the gold and the auriferous contents would need to be that much greater.

No study of the laws affecting alluvial deposits can be expected to furnish the answer as to the economic value of individual occurrences without the aid of pick, shovel, pan, and boring tools, but such study does enable a practical prospector to determine, by concentrating on what might be termed key points, the potential value of an area in the minimum of time.

PRIMITIVE MINING IN THE PHILIPPINES

By LAURENCE L. WILSON

The author describes the gold and copper mining methods adopted by the Igorot in Luzon, Philippine Islands, and gives an account of some of the religious beliefs by which their work is influenced.

INTRODUCTION.—During the past year the author has been enjoying the experience of prospecting for gold in the Central Cordillera Mountains, the backbone of Luzon, Philippine Islands, the home of the Igorot, who from time immemorial have been mining in these rugged, pine-clad mountains. For months at a time these virile, enduring, mountain-minded people have been his only companions. He has visited most of their workings, some not previously seen by a white man, and, with increasing respect, has become acquainted with their mode of mining, which he thought worthy of record.

Tradition indicates that the knowledge of gold may have been brought with them by the Igorot when, as the advance guard of the Malay race, they came out of the west, invaded the Philippines, and finally settled in these mountains—possibly about the time that Solomon was getting gold from Ophir. Traces of his early Hindu culture are seen in such practices as animal sacrifice, augury, and trial by ordeal. The Igorot still treasure an old volume written in the ancient script, which they have long since forgotten how to read. This knowledge of gold was no doubt stimulated and increased by the Chinese, who, as pirates and merchants, were visiting the Philippines as far back as the seventh century. The Chinese did a considerable amount of mining here at times—both lode and placer—and traces of their influence are sometimes seen in methods of timbering the shafts, use of tools, and other practices. The Spanish influence was apparently little felt, as the fierce highlanders ably defended their mountain fastnesses and were unconquered by the Spanish until 1846. Even then the conquerors got most of their gold from the Igorot and taught them little. The Igorot, who love a practical joke, sometimes led the Spanish speculators to drive quite extensive tunnels where there was no chance of getting rich. Thus, while learning from others, these industrious people have through the centuries developed their own methods, due to their peculiar manner of life and the type of ore in which they find the precious metal. The Americans have brought modern mining methods into these mountains and

THE AUTHOR AND ONE OF HIS STAFF.

Cross Staking Claim to a Tunnel.

employed many Igorot in their rich mines, where they have become efficient with jack-hammers and dynamite. The author, however, will try to describe the Igorot processes as uninfluenced by modern invention and as still practised in some localities.

The Kankanai and Nabaloi tribes of Igorot have developed into the best miners, most of the gold being found in their territory. While the metal is found more or less all through the tangled and tumbled mountains, the main Igorot mining districts are those around the barrios of Suyoc, Tabio, Akupan, and Antamok. Suyoc is usually considered to have been the first large mining centre and Suyoc miners are still said to be the most expert.

In this brief general description of Igorot mining methods, of course, it must be remembered that different customs and modes may exist side by side, that there are all grades of ability, and that not all the Igorot are miners. Many a time the author has been guided by an enthusiastic Igorot over steep mountain trails, through runo and bamboo thickets, and up rough rocky gorges, only to arrive at a barren lode.

The mountain men are indefatigable prospectors. Also their other life interests—hunting, fishing, going to distant camote patches and rice paddies, gathering wood, attending live stock, and other activities—all lead them to visit every neck of the woods where outcrops, slides, and cuts are investigated for gold-bearing veins. Thus, while modern American methods have developed old veins and opened adjacent new ones into among the richest mines in the world, gold has not yet been discovered in localities unknown to the Igorot.

He is a gallant gambler, not only in looking for surface indications, but will often tunnel a likely looking prospect until past the hope of developing a paying proposition. Moreover, by his industry and simple living, he is enabled to work many stringers on which a white man would soon starve.

Gold Mining.—*Custom of Working.*—Gold mining is more or less a community affair. The allied family in one small barrio may own a combination of the lode and placer mine in a portion of a mountain together with the gold-bearing gravel of the stream following therefrom. They usually work it individually, each person taking for his own that which he produces. Occasionally, when they feel that they can trust each other, they mine in common, each receiving an equal share of the gold produced, but the head man receives a larger share for supervision. Often, of course, one man will own the mine and employ help on a share basis or for a daily wage. Much of the mining is seasonal, so that farming and other minor industries go on alternately and often coincidently with the mining industry.

Igorot at Work in Tunnel.

Utensils.—The primitive tools of these patient miners are: A short, pointed gad made of fire-tempered wood or steel sometimes lengthened with a wooden handle, a stone or hardwood hammer, wooden wedges, and a short wooden shovel, together with various sized baskets woven of split bamboo.

While most of the iron is imported, the people early learned to work the metal and are good smiths. The bar is heated in a charcoal fire, shaped with a stone hammer, and tempered by plunging into water. The bellows, used to produce an air draught on the charcoal, may be a clever arrangement of wooden pistons working alternately in two or four bamboo cylinders. Sometimes hollowed logs or boxes, constructed of slabs of wood, have been used in place of the bamboo. One box type has a single double-acting piston. An opening is provided in each end for the admission of air during the back stroke and a flap of hide is placed over this to act as a check valve during the down stroke. The simplest bellows consists of two fans, woven of split bamboo, which are waved alternately back and forth quite efficiently.

For lighting the tunnels a torch may be formed of a bundle of long, thin splinters of pitchy pine wood. It has been the custom to start a fire either by striking flint with steel or through friction heat produced by rapidly twisting one bamboo stick in the hollow of another.

Working Methods.—Using their simple tools the Igorot have made many excavations along the line of the gold-bearing veins. They would break down the rock by building a fire against its face and dashing cold water on the heated surface. They carry out the ore in baskets—the gangue likewise—or drag it out in larger baskets or stoneboats made of hollowed logs drawn by carabao hide thongs. Many tunnels are necessarily small and tortuous—following the ore in the hard rock—but some creditable shafts, rises, winzes, stopes, and fills are seen. The best Igorot methods of timbering, stoping, and back filling are admired even by American miners.

The Igorot worked in and down as far as feasible, driving tunnels many metres long and putting in rises or shafts until stopped by very hard rock or waterflow. All the great mines in this district are developments of old abandoned Igorot workings.

Milling.—The Igorot are expert in the recovery of gold from the ore. This is the work of the women. At a glance they pick out the pieces containing gold, which are broken, if necessary, to about the size of a pea and then crushed by being placed on a large hard flat rock and rolled with a heavy stone—say, 50 cm. in diameter.

This ore is carried to a spring or stream, where it is ground to a slime by rubbing. A hard, flat stone, placed perhaps on a wooden frame for convenience, is used for the nether stone, the ore being placed thereon, soaked with water, and rubbed back and forth with a fitted hand-stone. There may be as many as a dozen of these stones in one

Native Crushing Stones.

group or mill, the women working sociably together and the small children playing about.

In free-milling ores the clever women recover a very high percentage of the gold, but in complex ores, such as the tellurides and pyrites, they are not so successful. Sometimes they roast the ore before grinding or they may afterwards set it away in a tunnel where natural disintegration takes place. They then pan it out each year for a number of years, saying that the gold is growing in the ore. But they have back-filled tunnels with waste which assayed as high as $100·00 per ton and certain of their discarded concentrates have assayed $2,500·00 per ton.

The slime is panned out in a shallow bark or thin wooden shell, bound with bamboo. It is about 70 cm. long and 30 cm. wide turned up some 6 cm. on the

sides, being open at the ends—one slightly more flaring. Water is slowly admitted at the opposite end and, accompanied by a certain gentle shaking movement all its own, together with handling, the waste is separated and washed off, leaving the glittering gold in the tail. This is removed to a half coco-nut shell and later stored in a small section of bamboo. Sometimes the juice of the leaf of the aglayan plant or of dampened tobacco is squeezed in the water while panning. This is to cause the fine floating gold to go to the bottom—the reverse of the modern flotation process.

When enough gold has been accumulated it is melted in an iron dish, with a charcoal

Fine Grinding on a Rub-Rock.

fire, into bullion. It is often purified by means of several heatings, using salt or sometimes soda as a flux and skimming off the slag each time. Some of the Igorot are very adept at adulterating the gold and improving its colour by the addition of copper and silver and a final roasting in salt.

Placer Mining.—Much of the Igorot mining is placer. All the streams flowing from the auriferous regions are regularly worked after each rainy season. The best sections are usually owned and worked by certain individuals, some of whom have built quite intricate, permanent, rock-walled sluice-boxes which catch the descending gold throughout the rainy season.

At the beginning of the dry season the owner cleans out and repairs or rebuilds his sluice-box, which may be 25 m. long. The rough surface of the bedrock of the river channel serves as the bottom of the sluice-box, while the sides are more or less symetrically placed convenient boulders. A part of the stream is directed into this "box" and the gravel deposited during the high water sluiced through, the heavy gold sinking to the bottom and being caught by the natural riffles formed by crevices in the rock bottom. These riffles are then carefully cleaned out and the contents panned by the women in the same manner as related previously.

Lode-Placer Mining.—The most characteristic manner of Igorot mining is to start working the gold-bearing vein where it outcrops—maybe near the top of the mountain. During the dry season the men dig pot-holes and dog-holes one above the other. A long ditch is dug along the mountain to catch water during the rainy season or perchance to conduct it from a convenient stream or spring. This ditch may lead directly to the workings or to a storage reservoir, according to conditions. When a sufficient head of water is acquired it is directed into the workings and they are boomed out, exposing the vein for the next season's work.

In this way big cuts and slides are made. At Suyoc the huge Pelidan slide is ½ km. wide and the rich vein, from which half a million pesos' worth of gold is reported to have been taken, is covered several hundred feet underneath. In some places, where the whole mountain is permeated with free gold and small stringers, the entire mass is being washed down—a part each year, as the water is directed into different gullies. In many cases the stream below is worked during the dry season and the gold-bearing gravel panned by the women.

Gold Manufacture.—While much of the gold is disposed of in the form of bullion, the Igorot love the metal for itself and have made ornaments and utensils for their own use. They mould and hammer out ear-rings, necklaces, finger-rings, carabao, and pig figures and at Tabio they mined the gold which they beat out into gold dishes and even a hat. Fernando Fienza, a former rich owner of an Antamok mine, had manufactured from gold a whole set of dishes and numerous other articles.

Copper Mining.—While gold is by far the chief mining interest of the Igorot, they have mined salt, flint, opal, magnetite, and

possibly coal and iron, but their other main mining interest has been copper. The copper ore-body in Mankayan, which carries about 20% copper, was successfully worked for centuries before the advent of the Spaniard. In mining this ore the Igorot divided the district between the small barrios. It was again subdivided, a section to each family, each working its own claim. The ore was broken down by means of iron instruments and by fire, which was also used to break up the rock due to the action of the steam produced from the water content of the rock. The native copper was picked out of the ore and the balance roasted in a furnace.

Smelting.—The furnace was constructed with a round hollow base in clayey ground, some 30 cm. in diameter and 15 cm. deep, surrounded by a loose stone wall about 50 cm. high. An inclined conical funnel of stone admitted the forced draught from a compound bamboo bellows. About 20 kg. of the sulphuretted ore was placed in the centre of the furnace, with charcoal along the sides. It was roasted about an hour and much of the arsenic and antimony, with some sulphur, was eliminated. The roasted ore was then placed in a fire-clay crucible in the form of a still and smelted for about 15 hours to a matte.

The matte was super-roasted in the furnace for an hour in contact with charcoal and limestone in order to slag off the iron. Some black copper would melt out and collect in the rounded bottom of the furnace. Cold water from handy vessels was poured upon the remaining semi-molten matte, resulting in thin plates of copper being formed. This " Rosette " copper was striped off and stored. The cuprous oxide in the remaining matte was reduced by again roasting it in the furnace between rows of wood.

Cleaning up a Creek Bed.

Recovering the Gold.

The product, together with the black copper, was again placed in the crucible, smelted, and poured out into clay moulds. To prevent the surface of the cooling metal from oxidation the Igorot beat it with green twigs.

These commercial copper ingots, which had thus been extracted with so much skill and patience by the Igorot, were over 90% pure and represented about a 50% recovery from the ore.

If the copper was to be employed in the manufacture of kettles, pipes, and other domestic articles it was further refined in the furnace and the carbonaceous compounds were oxidized out by reducing the quantity of charcoal and increasing the air-draught.

The Miner.—Something has been told about the physical and social aspects of Igorot mining, but the religious aspect should not be neglected, for the Igorot are very superstitious people and their daily life is much influenced by their religious ideas. The Igorot believe in one supreme being—Kabunian—and in many supernatural beings of various ranks and characteristics. These, known as Anitos, have the intelligence and sensibilities of human beings, but have superior abilities and lack a corporal body. They may be good or bad, friend or foe, and one must keep on friendly terms with them by means of obedience and sacrifice if he is to succeed in his undertakings. Favoured men or women, who might be called wise men, have the ability of communicating with these Anitos and expect to become Anitos themselves upon their death. Some of their lore should prove of interest.

Gold has been grown by and belongs to the Anitos. When it is found in a tunnel the miner must make an offering payment

either of blood, by cutting the finger or toe of one of the men, or else a cañao is made. A cañao is a ceremonial feast and sacrifice—typified by slaughter of animals, feasting, dancing, and usually drinking tapoi (rice wine). Only pigs are killed at cañaos made in relation to mining gold. After they kill the pig the wise men pray, saying: "We would not take this gold if we were not hungry. Please forgive us and accept this pig as payment for the gold." Then the pig is butchered, cooked, and eaten.

When the ore is taken out the gold must be extracted as soon as possible or some

Native Flume for Hydraulic Operations.

will go away. A cañao should also be made before melting and refining the gold, so that none of it will leave.

There are certain things which a successful Igorot miner does not do. When working in a tunnel one can eat the flesh of the pig and carabao, but not of the cow, for the cow does not lie in the mud. One must not whistle or sing in his tunnel and a woman must not step over the tools.

Sometimes the Anitos communicate with men in omens and augury. If one is going on a journey and a certain animal or small bird crosses the trail one must return home and propitiate the Anitos before starting again. If the bird flies in the direction the man is going, he sees a good omen in that event and expects a successful prospecting trip, or if going to sell his gold he will expect a good price for it. If he wishes to discover the condition of a vein, the Igorot may kill a chicken and observe the bile sac. If full of a liquid of dark colour it is favourable, but if pale and empty there is not much hope.

Sometimes a miner may be so fortunate that an Anito displays to him a bright fire some night. If he goes there the next day he may expect to find gold. If the fire was high the gold is deep, but if the fire is low the gold is not far down in the ground. Numerous instances are given of this method of finding gold. The Dugong (meaning, very rich mine) at Suyoc was thus found and Chugchugan followed the sign of the fire at Acop and found the Pitkil from which much gold has been taken. Sometimes the Anitos reverse the action. At Anginteg in Ampusungan there was a prosperous mining community with a number of rice paddies. One night an Anito appeared to one of the wise men and said: "We do not wish to live here any more." So the people moved away and you just see a number of rubbing stones scattered about in the grass.

If the people desire better fortune in finding gold in a tunnel they may cañao a pig there, but no tapoi is drunk. A level place is made near the tunnel and there at eventide the pig is slaughtered. The blood is sprinkled in the tunnel and the meat boiled in a pot in which is placed a pinch of gold. When cooked, the wise men place some of the meat in the tunnel and pray: "Please accept this pig and bring gold from —— (some known rich mine) and place it in our tunnel." Then they eat the pig. After which the wise man places runo sticks as a fence around the tunnel. No one is allowed to enter the tunnel during the next day while the gold is coming to it. On the following morning the wise man removes the runo sticks, the men enter and start digging out the gold.

Mismisan was prospecting for gold in Tabio. He found a small vein and was digging a tunnel, but found little gold. One night as he lay asleep there appeared to him an Anito in the form of an old man with white hair and flowing beard. The Anito said: "Dig in higher up above your tunnel." Then Mismisan woke up, but no one was there, so he knew it had been an Anito. In the morning Mismisan killed a chicken and looked at the bile sac. It was favourable, for there was sour, dark fluid in it.

Accordingly he went to his prospect, dug in higher up, and found considerable gold.

An Anito appeared one night to Magastino, a Suyoc miner, and said : " Do as I tell you and go to your mine where you will find gold, but if you do not first follow my instructions, it will profit you nothing. First, get a spotted pig and kill it. Before killing it pray to us in order that we may know that you honour us in your tunnel."

Notwithstanding these instructions in the morning Magastino did not obey the Anito, but went directly to his tunnel, where he did strike gold, taking out three and a half peso weight. However, on returning home that evening he became sick and in a few days died. Before dying he related his vision to his neighbours, who said : " Why did you not tell us before and we would have done as the Anito said, but now it is too late."

The gold in Suyoc, as in other districts, first stood in the shape of a great high tree which reached to the heavens. When it fell it was buried and some of the branches (veins) have been found and much gold taken from them. The main trunk has not been found and remains buried very deep.

Gold was first discovered many generations ago at Suyoc by a band of boys from near Cervantes, who were out on a fishing trip. They took a short cut over the hill and saw the gold in the shape of a pig rolling along the ground and had difficulty in catching it. Then they tried to carry it, but it was too heavy. So, leaving one boy on guard, they went to get some men to help. The boy on guard became impatient and started cutting up the gold pig. He cut off the ears and tail ; then stood up to rest and look for the other boys. When he turned to the pig again it was no more. So the boys went home with only the gold ears and tail. Shortly afterward the boy became crazy. Then the people knew that an Anito had been injured, so they made two enormous ear-rings out of the ears and tail and forced the boy to wear them. They cañaoed a great number of carabao, pigs, and chickens, thus trying to appease the Anito. However, the boy sickened and died, so they put the ear-rings in the coffin with him. This might have been the end, but a rapacious man stole the ear-rings out of the coffin. He became sick and thereupon broke down and confessed his crime. His people made cañao and tried to put the ear-rings back, but, as there were many coffins in that place, they could not find the right one. Since the people could not rid themselves of the ear-rings they have passed them down, a sort of plague, from generation to generation until now. Langbay at Sagada is the caretaker of the male ear-ring, whose name is Gumiland, and his brother-in-law at Taccon is the caretaker of the female ring, whose name is Barrong. Each year they must cañao three pigs of different sizes, for if they do not do this they become sick. The ear-rings are very much worn and have become small. They are of very fine gold and the male ring glows in the dark.

As a fitting conclusion to this description of the Igorot, their mining methods and customs, the following quotation from the account of Hernando Riquel, an early Spanish explorer, might be given. " There are many gold mines in these mountains. The ore is so rich that I will not write any more about it, as I might possibly come under suspicion of exaggerating, but I swear by Christ that there is more gold on this island than there is now in all Biscay."

EARTH MOVEMENTS

By C. P. STROMEYER

(*Concluded from the July issue, p. 30.*)

This process, though not always in its completeness, is likely to occur with relatively great rapidity where the area of deposition is far removed from the denuded area, as for instance near the Nile Delta, to the influence of which the folding of the Judean highlands may be attributed as well as the terrible earthquake referred to by the Prophet Amos. When the two areas are in juxtaposition—as, for instance, in the Persian Gulf and the Tigris and Euphrates basins—then, as already explained, the expansions and contractions balance each other and earthquakes are not likely to occur between them.

This remark, however, does not apply to the side areas, which are illustrated in Figs. 11 and 12. Radial compression stresses around a compression centre decrease inversely as the square of the radial distance and the circumferential tension stresses decrease in the same ratio. The crossing of equal tension and compression stresses

constitutes a shearing stress which is logarithmically curved as in Fig. 11. Such lines are often visible around punched holes in steel plates, due to the mill scale falling off along these shear lines. They also show up on polished plates of mild steel if properly etched.

The compression and tension stresses of which the shear stresses in Fig. 11 are composed are illustrated in Fig. 12. At the centre of the connecting line the compression and tension stresses neutralize each other, but at angles of 45° from each centre the radial compression stresses of one centre combine with the circumferential compression stresses of the other centre and as these lines are crossed by equally intense tension stresses the combination constitutes a shear stress which is 40% more intense than a shearing stress situated at the same distance from a single centre.

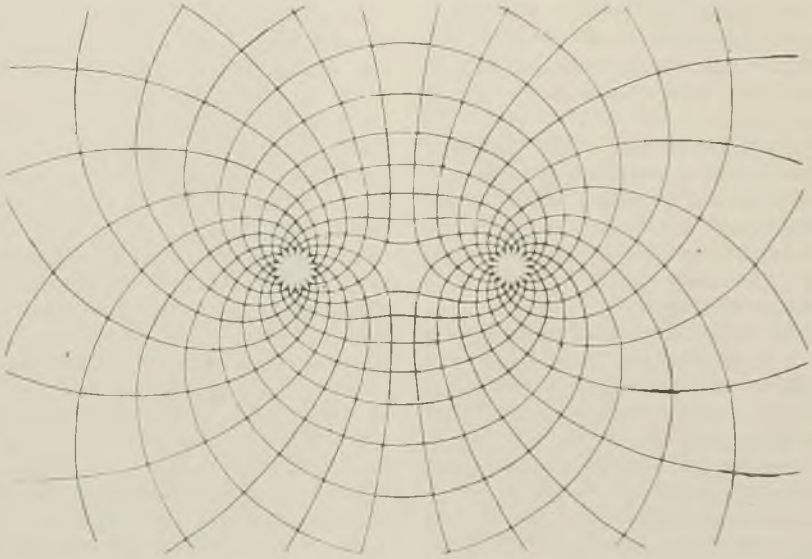


FIG. 11.

Illustrative cases are rare, but the California earthquake of 1906, though complicated, fits reasonably well. In the great fault, 189 miles long, the shear movement was about 20 ft. Shear fractures are very often a combination of two right-angled fractures and in this case there was another shear fracture at right angles to and starting from the centre of the great fault. The main shear stress, which was in the direction of S.E. to N.W., would be due to a tension produced over the large Mississippi area to the north and to the compression area of the Gulf of Mexico where the Mississippi sediment is being deposited.

The Nile basin is apparently the only case in which the tension and compression areas are situated so far apart that their stresses do not interfere with each other and therefore the local single effects are fairly intense, as illustrated by the large outpourings of lava in Abyssinia from, as yet, unexposed cracks or dykes.

The following brief survey will show that local denudation, and the deposition of the dislodged material, will fully account for the innumerable dykes and folds of the earth's crust and for plutonic intrusions.

In North America half a dozen half-covered plutonic ridges have been discovered. South America seems to have an even larger number, Africa has at least the same number, and there are many in Europe and Asia. The total number of plutonic ridges cannot be far short of 40 or 50, not counting those which are under the sea. Assuming each ridge to be, say, 5,000 miles long and 200 miles wide and the thickness of the crust 30 miles, then before the once-fluid granite could become exposed at the surface an average of one-third of the thickness will have been removed or, say, 10 million cubic miles, say 500 millions for the 50 ranges. Assuming that in 99 cases out of 100 the resulting contraction and expansion balanced each other, the remaining five million cubic miles could account for 17,000 dykes

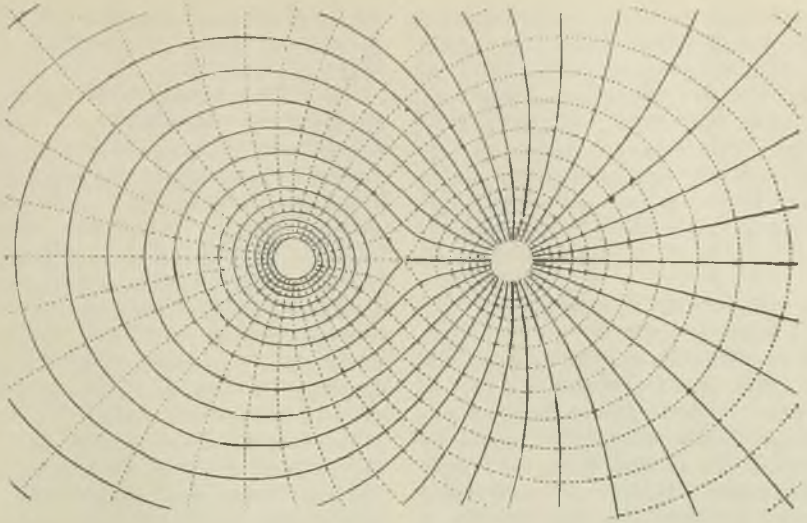


FIG. 12.

10 ft. wide, 1,000 miles long, and 30 miles deep, as well as for folds and overthrusts innumerable. It is not intended to discuss the age of the earth, except to show that the above suggestions lead to approximately the same results as are obtained by other means.

Assuming, first, that the denudation proceeded at the rate of 1 ft. in 100 years, it would take sixteen million years for the once-fluid granite to be exposed, or 800 million years to raise the 50 granitic ridges. Assuming, secondly, a temperature gradient and the same rate of denudation, the temperature of the local crust would decrease about 1° F. in 5,000 years and the once-fluid granite would arrive at the surface in ten million years (500 million years for the 50 ridges).

The Alps, being a fairly modern structure, may serve to illustrate both the general principle of earth foldings and also the complications which accompany them. The Alps have a span of about 130 miles from the plane of the Po to the Bavarian table-land. Assuming an average underground European temperature gradient of 1° F. per 50 ft. and a freezing temperature of 2,000° F. for molten granite under high pressure, also that the thickness of the hard crust is or was about 100,000 ft., then the uncovered granite intrusions in the Alps indicate that the originally molten upper surface of the granite has slowly risen 100,000 ft., while the superimposed material was being worn away, but only near the centre of the span. At both ends of the span there will have

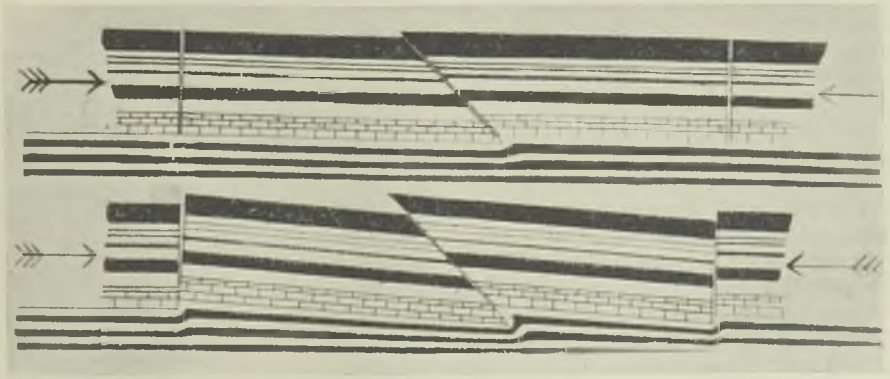


FIG. 13.

been no erosion, so that the average thickness of removed material will have been about 33,000 ft. Also the average cooling of all the material of the 130 miles span will have been, not 2,000, but 667° F. Little is as yet known about the thermal expansion coefficient of rock at high temperatures, but 0·000015 per 1° F. does not err on the high side. Adopting this coefficient, the contraction of the N.–S. span of the Alps will have been—

$$130 \text{ miles} \times 667° \text{ F.} \times 0{\cdot}000015 = 1{\cdot}3 \text{ miles or } 6{,}700 \text{ ft.}$$

If all the eroded material had been carried north and south into the North Sea and to the Po and the Adriatic, the warming due to its blanketing effect would have balanced the contraction of the eroded parts, the only earth movement being a southward wandering of a point like Munich over a distance of 1·3 miles. About one-fifth of the material, however, is likely to have been carried eastward by the Danube, if it flowed in that direction during the whole time, so that some external influence will have had to be active in producing a thrust movement of 1,360 ft. plus the necessary thrust movement for puckering or lifting the Alps 100,000 ft.

This outside influence is the material that had been pushed from east to west while northern Russia, Finland, and Sweden were being eroded and enormous areas of once-molten granite exposed. The N.–S. width of this bared area amounts to 500 miles or more and the volume of material removed must have been quite five to six times as great as that removed from the Alps. The greater portion will have moved south, but a large fraction has unquestionably moved west and, covering North Germany, has caused a N.–S. expansion which produced the necessary thrust for the arching of the Alps.

A simple geometrical estimate will show that the N.–S. thrust for effecting the gradual increase of the central height of a long span of 130 miles is 0·71 ft. for a central increase of height of the first 100 ft. rise. Removing this added height and repeating the double operation 1,000 times, the total uplift of the under-side of the crust, which had originally rested on the fluid granite, is 100,000 ft., as required. The continuous expansion of North Germany will have been—

$$0{\cdot}71 \times 1{,}000 = 710 \text{ ft.}$$

This thrust is accompanied by stresses which, as the mountains are not disintegrated, cannot have exceeded a compression of more than 1/1,000 of the length of the 130 miles (680,000 ft.), say 680 ft., making a total of—

$$710 + 680 \text{ ft.} = 1{,}390 \text{ ft.}$$

Adding this movement to the above-estimated N.–S. contraction of 1,300 ft. makes a total of 2,690 ft. to be accounted for by the deposition of material from Russia and the Baltic. This is about 0·4 of the material removed from the Alps and about 6% of the material which has apparently been eroded in Russia, Finland, and Sweden. This rough estimate demonstrates for a single ridge that local earth movements can explain what is impossible of explanation by general contractions of the earth's surface.

Important additions have to be made to the estimated thrust movement on account of local folds and overthrusts. If cross sections are obtainable, the thickening of the central portions of the bottom layers of folds should permit of a fair estimate to be made of the shortening due to folds. Other movements would have to be judged on their merits and the following considerations might be of some help. Crushing stresses produce slanting fractures. Fig. 13 represents such a sloping fracture, due to a horizontal thrust, the uplift of the sloping fracture producing vertical bending fractures. Seeing that the upper strata are colder and much stronger than the plastic lower ones the left-hand fracture is not likely to occur unless there is a very heavy overthrust, but the right-hand fracture will occur even under slight bending. The amount of uplift can be estimated from the thickness and taper of the dyke material which fills the vertical fracture and the distance between the two fractures.

A mathematical consideration leads to the result that $Y = Y_o \epsilon^{-a.x} (\cos a.x - \sin a.x)$, where Y is the uplift above the original level at the distance x from the slanting fracture. The value of $a^4 = 3D/ET^4$, where D is the density, say 0·1 lb. per cubic inch, E is the modulus of elasticity, say 10^7, and T is the thickness of the strata measured in inches (63,300 in. per mile). The maximum bending moment, and, therefore, the vertical fracture, occurs where ax is 1·57, so that x, the distance between the two fractures, would be about 170 miles if the strata were perfectly elastic, but on account of the plasticity of its lower layers and the relatively high position of the neutral plane the distance may be much less, especially if the thickness T is less than the assumed 30 miles.

Reversing the estimate we find that if the distance, x, is known, it should be possible to obtain approximate information about the thickness and plasticity of the earth's crust.

Seeing that the denudation of mountain tops and changes of temperature are the cause of folding the reversed process may be expected—*i.e.*, of folding producing meteorological changes. When a layer of moisture-laden air is forced to move over a mountain range (Figs. 9–10) it expands, its temperature is reduced, it parts with some of its moisture as rain or snow, and it gains all the heat liberated by the condensation. When it descends to its original level on the other side of the mountain range it experiences a compression and an increase of temperature, which is approximately 10° C. per 1 kilometre of height, or about 11° F. per 1,000 ft. height. This warmed and dried air passes over the ocean waters and recharges itself with an amount of moisture which depends on its acquired temperature. Evidently the average height of the mountain ranges of the earth determines the surface temperature not only of the sea and the amount of moisture absorbed, the downpour of rain and the erosion of the highlands, but also the surface temperature of land surfaces. These, in turn, affect the rate of deposition on the ocean bottom and the greatness of the resulting earth movements and upheavals.

In other words, the higher the mountains the hotter the earth's surface and the faster the mountains rise, but only to a limit which is fixed by the thickness or thinness of the crust and its inability to support itself when arched. Thus it would be impossible for the Alps to sustain themselves if their thickness were only a mile. Then also the isothermal layer of the atmosphere, said to be about 9 miles, would be pushed higher and higher by rising mountain ranges. But it is still a debatable point whether the height to which air-currents in their attenuated condition can rise is fixed by the isothermal layer or whether that height is fixed by the height to which layers of air are projected when passing over mountain ranges.

Seeing that according to this brief meteorological sketch the height of mountain ranges affects the surface temperature of the earth, it is probable that past glacial periods have been associated with a marked lowering of the effective heights of the then existing mountain ranges and also that during glacial periods earth movements and operations of raising mountains will have been at a minimum. This correlation is, it seems, being confirmed by discoveries of glacial periods during past geological ages.

BOOK REVIEWS

Hydraulic Machinery. By DANIEL W. MEAD. Cloth, octavo, 396 pages, illustrated. Price 24s. London: McGraw-Hill Publishing Co.

This is a scholarly work by a professor on machinery for raising liquids. It does not cover machinery using water to produce power. The first portion of the book deals at length with the theory of energy and its transformation, of impulse and reaction, of plant efficiency, electric power, and the cost of energy. This is followed by a detailed consideration of various kinds of pump in common use, including direct-acting steam pumps, three-throw pumps, and centrifugal or turbine pumps. In addition there are sections on deep-well pumps, air-lift pumps, including compressor details, hydraulic rams, and siphons.

The plant described is American and the book is American, but, if it may be said without offence, the book is very readable to a Briton, if a little long winded in parts. There is a full mathematical treatment of centrifugal pumps. The illustrations are good and few mistakes have been noticed in this well-produced book.

HUMPHREY M. MORGANS.

Geology. By W. H. EMMONS, G. A THIEL, C. R. STAUFFER, and I. S. ALLISON. Cloth, octavo, 514 pages, illustrated. Price 24s. London: McGraw-Hill Publishing Co.

Three of the authors of this book are professors of geology in the University of Minnesota and the fourth in the State Agricultural College, Corvallis, Oregon, and the appearance of another well-produced and copiously illustrated textbook from America is likely to arouse feelings of envious astonishment in British geologists! This work, however, can hardly be of more than limited utility to the British student, owing to its almost exclusively American point of view. Its scope, indeed, is comprehensive, although

the treatment is elementary, and the bearing of geology upon human affairs is kept well in mind. An attempt has been made to present the subject in such a way as to demand no preliminary training in any other science, but it would, perhaps, have been wiser to recognize that, as far as certain aspects are concerned, this cannot be done satisfactorily. Some want of proportion in the allocation of space to the various parts of the subject is apparent. Thus twenty pages seems an excessive allowance for earthquakes, which, though doubtless of "news-value," are after all (in the words of this book) "minor geologic phenomena." On the other hand the treatment of the erosion cycle and its expression in landscape forms seems hardly as full or as clear as its importance demands. By far the majority of the illustrations are drawn from North America, a fact that, in spite of the wealth of material available, tends somewhat to narrow the appeal of the book. By way of rendering the book self-contained a final chapter on earth history is included. This, again, deals mainly with the geological history of the North American continent and the necessity for brevity has reduced it to little more than a summary of conclusions, without much indication of the evidence upon which they are based. Still, this chapter might be read with profit by a non-American student sufficiently advanced to bring some critical judgment to bear upon it. There is, indeed, plenty of matter in the book of interest to the British student, but he could hardly be expected to adopt it as his principal textbook and few students have the means or inclination to provide themselves with more than one!

T. H. WHITEHEAD.

The Volcanic Area of Bufumbira, South-West Uganda. Geological Survey of Uganda Memoir No. III. Part I, Geology, with Notes on the Petrology and Economic Geology. By A. D. COMBE and W. C. SIMMONS. Paper boards, 150 pages, illustrated, with maps. Price 15s. Entebbe: Geological Survey Office.

The general geology and physiography of the volcanic area of the extreme south-west corner of Uganda are described in detail by A. D. Combe, who geologically surveyed this section of the Western Rift of Central Africa. A coloured geological map on a scale of 1 : 125,000 delimits no fewer than 49 principal lava flows from those of the great volcanoes lying within British territory. The region has probably the most extensive exposures of leucitic rocks in the world and may perhaps be reckoned as one of the largest potential reserves of potash. The petrographical notes by W. C. Simmons are of a preliminary nature, but serve to emphasize the importance to petrologists of the second volume of the memoir, promised in about a year's time, which will deal with the investigations of Professor A. Holmes and Dr. H. F. Harwood on the petrology and geochemistry.

The concluding chapter is devoted to economic geology and deals principally with the newly-discovered alluvial gold of the upper Kashasha and Kibisamwika Rivers. The auriferous country, which is unusual for Uganda in that it has swiftly-flowing rejuvenated rivers, is described in detail. The difficulties in the way of rapid prospecting are pointed out; indeed part of the region lies in the Lubugule forest, marked on all maps as "Impenetrable." Sluicing operations were commenced towards the end of 1931 and, although the area is still in the prospecting stage, over 600 oz. of gold have been exported. The alluvial gold, which on the whole is decidedly coarse and little worn, occurs together with detrital rutile, wolfram, and cassiterite. In spite of the fact that the metal has manifestly not travelled far its source has not yet been definitely located. The country rocks consist of Karagwe-Ankolean phyllites, with numerous quartz veins. Some of the latter carry fine gold or auriferous pyrite, but no visible gold has been found, to say nothing of the coarse variety found in the streams. The possible bearing of river capture, river reversal, and high-level terrace gravels on the source of the gold is discussed. An account is given of the operations up to the early part of 1932. On the whole the evidence appears to indicate that the gold is derived from concealed G 2 granite, the tin-bearer of south-west Uganda, though here denudation is only just reaching the zone of cassiterite.

The many excellent photographs and panoramas by Combe, taken under difficult conditions, give a good idea of the scenery of the volcanic country. The map is included in the price of the volume.

A. W. GROVES.

☞ 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

June 30.

Mount Isa.—According to official reports from the Mount Isa mine development and other work during last month was progressing satisfactorily and the output of ore was kept up to requirements. The smelters are running normally and an additional unit which is expected to improve extraction results materially has been added to the flotation plant in the mill. The Mount Isa company is now drawing its coke supplies regularly at the rate of about 20,000 tons a year from the new ovens erected by the Queensland Government at Bowen, instead of from Newcastle, New South Wales, as heretofore. The position generally should be appreciably improved by the recent rise in the price of lead, although that price has not by a considerable amount reached the figure on which the estimates of profits originally were based. A table published by the Mining Trust, Ltd., in 1930 gave the then expected net annual profit (subject only to taxation) of the Mount Isa company, working the first 2,000 tons a day unit, at various prices for lead. No credit was taken for zinc, none of which has yet been produced, and the value of silver was placed at 1s. 7d. per oz. —a little under the present London quotation. This table started with the price of lead at £12 and the estimated profit at that figure was given as £257,000 ; with lead at £13 the expected profit was £327,000, and at £17 £386,000. In the following table are given details of the production for May, with comparisons for April :—

	April.	*May.*
Ore mined, tons	67,285	66,613
Ore milled, tons	66,245	65,226
Assaying—Lead, per cent	9·8	9·7
Silver, oz.	5·4	5·2
Lead concentrate produced—		
Flotation, tons	10,224	10,276
Assaying—Lead, per cent	41·5	41·8
Silver, oz.	20·2	19·3
Jig, tons	1,621	1,260
Assaying—Lead, per cent	48·4	48·0
Silver, oz.	24·4	23·0
Silver-lead bullion produced, tons	4,636	4,096

Mount Morgan.—The once famous Mount Morgan mine is getting well into its stride in the extended operations entered upon a short time ago. Chief energies during May continued to be directed to what is now called "the quarry," embracing the extensive open-cut work now in hand. Additional faces are being opened from time to time as it becomes necessary to supply the mill with its increasing call for ore tonnage. There has been no difficulty in furnishing the concentrator with all the ore needed. The picking of the main shaft has been completed to a point some 20 ft. below the Linda level. The ore pocket that connects with the shaft from that level has been repaired and the work of enlarging the chamber at the top of the pocket for installing and operating the jaw crusher has been started. The two reconditioned air-compressors have been started up in the new station underground. The concentrator is now treating 320 tons a day, a tonnage which will increase to 3,000 weekly within the next few weeks. The new ball-mill was put into commission on May 21.

Industrial Court Decisions.—Important applications in connexion with the hours to be worked by the men employed both at Mount Isa and Mount Morgan, Queensland, have just been dealt with by the full bench of the Industrial Court. In the former case, Mount Isa Mines, Ltd., asked for exemption from the operation of the 44-hour week provisions of the Industrial Conciliation and Arbitration Act, which was passed last session and comes into operation on July 1 next. The President of the Court, in giving judgment, said the company had no objection to a 44-hour week if its costs were not increased—that is, if present hourly rates which are based on a week of that number of hours are maintained. The parties concerned think the reduced hours can be worked according to a roster to be agreed upon. The Court therefore decided that the present award should be amended to provide for a 44-hour week, with the present hourly rates, to be worked on the suggested roster. The general manager says the company will not be embarrassed by the Court's decision and that the result will be that, while the men will lose a few shillings a week, a greater number of men will be employed at no extra cost to the company. In the case of Mount Morgan an industrial agreement was made in February last for a 48-hour week and the men now asked that the hours should be reduced to 44 hours, apparently without reduction in pay. The Court decided that the present hours should continue until there

is some evidence that conditions at the mine have improved since the date mentioned and that when there is such evidence the union may renew its application.

Mount Coolon.—On the Mount Coolon goldfield, North Queensland, the Mount Coolon Gold Mines, N.L., continued its usual activity during May. The plant ran continually during the period except for some time lost owing to a mechanical breakdown, treating 3,661 tons of ore and 786 tons of old tailings and giving a product of 2,997 oz. of gold and 1,226 oz. of silver.

Mount Wandoo.—At the Mount Wandoo gold mine (North Queensland) the winze in the principal shaft (the Hardman) was during May extended 31 ft., to 65 ft., and timbered. The local mining warden reports that the reef maintains its size and value. The Reid shaft has been sunk a further 12 ft., on an 8-in. reef, giving 30 dwt. of gold to the ton. On the outcrop below the Bayly shaft work has been discontinued and the men previously working there are being employed putting a drive at the 109-ft. level in the Hardman shaft along the hanging-wall fissure.

Oil Shales.—The interest of the Commonwealth Government has been aroused by reports from the Resident Minister in London (Mr. S. M. Bruce) that a new and revolutionary process, invented by Dr. Duplan, for the treatment of crude oil has yielded remarkable quantities of gasoline and petrol. The Federal Minister in charge of Development (Senator A. J. McLachlan) considers these reports to be most encouraging. He says that if the inventor's claims can be established in connexion with large-scale operations Australia is about to enter upon a new era in the production of oil in vast quantities from shales and lignites.

Gold in Papua.—In the last annual report of the Territory of Papua the Lieutenant-Governor of the Territory (Sir John Murray) expresses optimism regarding the prospects of gold mining in Papua. It is mentioned that about £2,000,000 worth of gold has been produced in the Territory, most of it by the crudest and least scientific of methods. It would hardly be supposed, it is stated, that modern scientific methods could not extract at least as much again, especially now that the question of transport has practically been solved by the aeroplane.

VANCOUVER

July 10.

Coast.—The development of the Alexandria gold-quartz mine at Phillips Arm, which has been resumed as a result of financial arrangements which are understood to have been made in New York, is reported to be giving good results and plans are said to be again entertained for the erection of a treatment plant. This mine has been held by Vancouver interests for many years and operations have been carried on intermittently. The property consists of seven Crown-granted claims, most favourably situated on the coast, the main development tunnel being close to tide-water. The vein, which is of mineable width, has been traced on surface over a considerable vertical range and in extensive underground workings from adit tunnels and from a shaft which has been sunk to a depth of nearly 300 ft. below sea-level. Work is in progress at the Doratha Morton, Thurlow, Sonora, and Enid Julie groups in the same area of gold-silver mineralization. Princess Royal Gold Mines, Ltd., has been incorporated with a capitalization of 7,000,000 shares of no par value to acquire and operate an amalgamation of properties comprising the old Surf Inlet and Pugsley mines and an adjoining group of six claims known as the Wells group. These latter claims are believed to cover the extension of the Surf Inlet ore-bodies and it is believed in some quarters that failure to arrange terms for their acquisition was responsible largely for the abandonment of the fully-equipped Surf Inlet property by Belmont Surf Inlet Mines, Ltd., in 1925. The latter company carried on operations for a period of nine years with a total production in gold, silver, and copper valued at around $7,500,000. It is hoped that a stage of production may be reached in two or three months. There is a complete hydro-electric 1,200 h.p. power-plant, a mill with a normal capacity of 350 tons per day, full mining equipment, a town site with about 30 houses, and a wharf in good condition.

Bridge River.—Further encouraging reports are received of the second new ore-body that was discovered recently in the low-level workings of the Bralorne mine. This company's mill is now treating at the rate of 130 tons per day. The Pioneer mill has been stepped up to over 350 tons per day. Taylor (Bridge River) Mines, Ltd., has been incorporated, with a capital represented by 3,000,000 shares of no par value, to acquire

and develop a group of claims further down the valley. Several other speculative enterprises are being undertaken in the area, which is attracting general attention at this time.

Lillooet.—Golden Cache Gold Mines, Ltd., has been formed on the initiative of A. F. Noel, with a capital of 500,000 shares, for the purpose of further exploration of the Golden Cache and Bonanza properties on Cayoosh Creek. The Golden Cache mine was located by Mr. Noel towards the end of the last century and was operated by Golden Cache Mines, Ltd., representing Vancouver capital, for a short time. Some spectacularly rich ore was taken out of a pocket, but early anticipations were not realized and it is said that there was a lack of confidence in the management. The property was abandoned and was bought in at tax sale by Mr. Noel and associates in 1928.

Cariboo.—A third shipment of gold bullion has been made by the Cariboo Gold Quartz Mining Company, bringing the total production since milling was commenced at the beginning of the year to over $100,000. The plans for intensive development of the mine that were made possible by the recent financial arrangements are being put into effect, but it is understood that no greatly-increased rate of production is to be expected for some little time. Cariboo Mountain Gold Mines, Ltd., representing Victoria and Vancouver interests, has been formed to acquire and develop a group of 43 claims on Cariboo Mountain, in the Barkerville area. W. A. MacKenzie, who recently resigned his position in the Cabinet as Minister of Mines, is president of the company. Developments at the Island Mountain property of Cariboo Consolidated Mines, Ltd., are said to be highly encouraging. Newmont Mining Corporation has exercised its option in this undertaking to the extent of acquiring the controlling interest in the company. It is anticipated that an initial treatment plant will be justified later in the year.

Clinton.—A very decided check has been put upon promotion activities in connexion with the Big Slide property, at the junction of Kelly Creek with the Fraser River, by the action of the Department of Mines in causing an investigation of the mine to be made and in publishing a report thereon. It appears from this report by A. M. Richmond that the possibilities of the property are decidedly limited and that it is unattractive as a commercial enterprise. As a result of an exhaustive examination it is concluded that the only tonnage calculation possible relates to a block of ground in which some 3,000 tons of $3·30 rock might be estimated. This is an old property that has lain idle for many years following the failure of ambitious plans of development and treatment. It has been claimed that a vein, in which there are occasional streaks of ore carrying good values in gold, had been traced continuously over a considerable distance, but former reports by the Resident Engineer had indicated that the occurrence was more in the nature of discontinuous lenses in a zone of shearing.

Nelson.—Encouraging progress is being made in the deep-level development of the Reno mine, in the Sheep Creek camp. The sulphide ore-shoot that was encountered beyond a faulted area on the No. 5 level was reported originally to have a value of around $40 per ton. With further advance of the drift and in a winze that is being sunk from this level the ore-body is reported to show rapid improvement. The plans for the season's operations include a vigorous campaign of surface exploration, but this has been delayed by snow at the high elevations. The company's mill is maintaining steady production, which has totalled in the neighbourhood of $150,000 since the recommencement of operations in December last. A considerable amount of interest attaches to the work that is in progress on the Gold Belt property. The cross-cut tunnel, which was advanced at the rate of about 8 ft. per day, encountered the first of the four parallel veins that were explored at surface last year at a vertical depth of 182 ft. below the outcrop and in its calculated position. At 1,125 ft. a second vein has been struck which is believed to represent the main objective of the development work. Work is also being commenced on the Golden Belle group, adjoining the Gold Belt, where the No. 1 vein, in a series of similar occurrences, is believed to represent the extension of the main Gold Belt vein. A deep level cross-cut tunnel is to be driven to cut this vein, on which, owing to favourable topography, a depth of from 700 to 800 feet can be obtained in a reasonable distance. Machinery and equipment for this work is being installed, following completion of a road that has been built to the site. The work is under the same technical supervision as that on the Gold Belt property. An extended scale of operations has been initiated at the Kootenay Belle property, following the successful financing of the holding company, Kootenay Belle Gold Mines, Ltd. Shipments

of ore are being continued, pending completion of plans for the installation of a treatment plant on the property. In the Ymir camp two claims adjoining the Yankee Girl have been acquired by the Two Star Mining Company. A lease on the Perrier property, near Nelson, has been acquired by David Berry and associates of Nelson, with a view to shipping selected ore.

Boundary.—The Jewel mine, near Greenwood, has been re-opened by Dentonia Mines, Ltd., and it is planned to drive a tunnel from the Anchor claim to connect with the old workings of the mine on the 500-ft. level. Major Angus Davis has been appointed consulting engineer. New equipment is being installed and it is understood that the mill is to be reconditioned for early operation. Morning Star (Fairview) Gold Mines, Ltd., has been incorporated to acquire the properties controlled by R. L. Clothier in the Fairview camp. These include the Morning Star group and the Silver Crown. Immediate work is to be concentrated on the Morning Star mine, where the old shaft workings were recently unwatered. In the same camp the Dominion group of 26 claims has been acquired by Major T. Fraser and A. S. Williamson. There is believed to be a good opportunity for profitable operations, on a sufficiently large scale, of the extensive low-grade gold-quartz ore-bodies in this camp. The Brooklyn-Stemwinder group, in the Phoenix camp, which figured prominently in the copper production of the province 30 years ago, has been acquired by Vancouver interests, with the object of opening up showings of gold ore that have been prospected recently. The Northern Syndicate, representing business interests in Calgary with which Senator P. Burns is associated, is reported to have acquired the Dividend-Lakeview property, near Osoyoos. It is stated that some promising developments have occurred in the mine recently. The Parvenu property, on Oro Fino Mountain, has been reopened by the Twin Lakes Mining Company. The mine was operated last year by a Vancouver company on a small scale and produced about $23,000 from a gold ore in which spectacular specimens of free gold and galena are found. Recent exploration is said to have had encouraging results. Waterloo Gold Mines, Ltd., has resumed work on its property in the Lightning Creek areas of the Grand Forks division. The property was worked as a silver-lead-zinc mine at one time, but later developments have been devoted to a series of gold-quartz veins. A. G. Langley is consulting engineer and holds out high hopes for profitable operation.

East Kootenay.—The Monarch mine at Field, where operations were suspended in 1930 by the Base Metals Corporation, is to be reopened, following acquisition of control by a group represented by F. Eichelberger and the Mining Corporation of Canada. It is understood that plans are entertained for enlarging the treatment capacity to a scale at which it is estimated that costs can be materially reduced. Ore reserves are estimated to amount to over half a million tons, with a 15% lead and 12% zinc content, with low silver values. Considerable satisfaction is expressed with the decision of the Crows Nest Pass Coal Company to reopen its Coal Creek mines at Fernie, as a result of arrangements that were made at a recent conference that was brought about by the Hon. H. H. Stevens, Dominion Minister of Commerce. The mines, upon which the community of Fernie is entirely dependent, will be operated on a reduced scale. This action has been made possible by co-operation of the Canadian Pacific Railway Co. in providing a market for the output.

TORONTO

July 18.

Gold Production.—Gold production for Ontario for the month of June had a total value of $3,648,692, according to the monthly report of the Ontario Department of Mines, as compared with the May figure of $3,654,442 and the June, 1932, total of $4,179,045. Ore milled totalled 457,886 tons. The Porcupine belt was the most productive, its output of 277,930 tons of ore having a value of $1,829,775. Canada's gold production for May amounted to 237,661 oz., according to the report of the Dominion Bureau of Statistics. This figure compares with 237,017 oz. for April and 268,453 oz. for May, 1932. Production for the first five months of the present year was 1,196,512 oz., a decline of 2·7% from that of the corresponding period of last year.

Sudbury.—A rapid recovery from its prolonged period of slackness is being made by the International Nickel Company of Canada which, by the recent reopening of the Creighton Mine and the Coniston smelter

and by increasing tonnage at the Frood, brought its operations from 20 to 40% of its total rated productive capacity. Production from the Creighton mine, which has been reopened on a basis of 30,000 tons of ore per month, is being handled at the Coniston smelter, where two blast furnaces are operating on full time for production of monel metal matte. Frood mine's production, which has been increased from about 30,000 tons to 100,000 tons of ore per month, is being handled at the new Copper Cliff smelter in two of the five reverberatory furnaces. At the Port Colborne refinery operations have been increased to five of the nine electrolytic circuits. The best six-month period of its history has been concluded by the Falconbridge Nickel Company and operations have been started on the construction of a new combined office, warehouse, and machine shop. The monthly output of nickel exceeds 900,000 lb., which is more than double last year's average. Kenty Gold Mines, operating in the Swayze area, has recently met with encouraging results in shaft sinking. The No. 1 shaft, which is nearing its objective at 500 ft., cut the No. 1 vein at a depth of about 300 ft., the vein at the intersection revealing a width of some 15 ft. carrying heavy mineralization and free gold. The No. 2 shaft passed through the vein from 270 to 315 ft. depth, showing a true width of 30 ft., carrying considerable high-grade gold values. At the Lee Gold Mines' property, in the western section of the Swayze area, a high-grade mineral zone is extending rapidly.

Porcupine.—During the six months ended June 30 Hollinger Consolidated Mines produced gold and silver to the value of $6,133,572, as compared with $5,558,507 for the first six months of last year. The total profit was $2,296,491, as against $1,963,433 for the 1932 period, while the dividends paid amounted to $1,968,000. Considerable new ore, running over $8 per ton, has been opened up below the 2,750-ft. level in the eastern section of the property and favourable results are being obtained below the porphyry mass in the central section. While bullion production of Dome Mines for the month of June was $400,312, against $415,932 for May, the decline of $15,620 was due almost entirely to the fact that June has one day less than May. Production for the three months ending with June was $1,219,512, the highest on record for the mine. Work around the 23rd level of the company's new mine shows the width of the ore zone to be more than 156 ft., its length as yet undetermined. The new ore-body is said to be the largest straight gold body yet discovered in Canada. The winze being sunk below the 3,800-ft. level on the property of McIntyre-Porcupine Mines is down about 4,400 ft. below surface and is expected to reach the objective of 7,000 ft. towards the end of next year. The first three levels will be at intervals of 150 ft. and the following levels at 125-ft. intervals, while main haulage-ways will be located every 375 ft. At the company's annual meeting it was pointed out that the average yield for the past year was down 29 cents a ton if figured at standard value for gold, but up a cent if the premium were included.

Kirkland Lake.—A new high-grade ore-section on the property of Sylvanite Gold Mines is being steadily extended and values in excess of $25 in gold per ton have been revealed on the drive on the new vein on the 875-ft. level east of No. 4 shaft. The drive shows a width of five feet and has proceeded some 45 feet towards the Toburn boundary. Higher values have been encountered on a drive westward from the cross-cut, about 35 ft. in length, with the vein widening out. In view of these discoveries and the high-grade ore found on the Toburn property a short distance to the east a cross-cut is being run eastward from the 1,000-ft. horizon to pick up the downward extension of the two veins. Hoisting capacity has been more than doubled by the installation of a new head-frame and it is expected that the No. 2 shaft will reach a depth of 3,600 ft. by the first of November. Lake Shore Mines is obtaining favourable results from depth development, the No. 1 vein at the 4,000-ft. level carrying values of $15 to $30 per ton over a width of 15 ft. Barry Hollinger Gold Mines is planning to sink a three-compartment winze 500 ft. to a depth of 2,375 ft. from surface and to open up four new levels on the No. 7 ore zone. Results of diamond drilling from the 1,875-ft. horizon indicated an ore supply between the 1,875-ft. and 2,375-ft. levels large enough to last three years, with the mill handling 100 tons per day. Toburn Gold Mines produced $65,000 in bullion during June, the most successful month in its history. A high-grade ore-section is being developed towards the Sylvanite line. Favourable extension of the ore zone on the 500-ft. horizon has been revealed by recent development on the property of Ashley Gold Mines. Commercial-grade ore has been

intersected by the drive on the west vein on the 500-ft. horizon. Ore is being milled at the rate of 110 tons per day and the production of bullion is estimated at slightly more than $60,000 a month. Kirkland Gold Belt Mines has encountered ore on the 250- and 375-ft. horizons, while good ore is being taken out on the 125-ft. horizon. The recent installation of new power equipment will permit increased operations. Macassa, Canadian Kirkland, Federal Kirkland, and Lakeland are among the other companies carrying on development work in this district.

North-Western Ontario. During the period from February 23 to June 18 Parkhill Gold Mines, in the Michipicoten area, handled an average of 43·49 tons of ore per day in its mill, the rated capacity of which is between 50 and 60 tons a day. It is impossible to run the mill at capacity without a high tailing loss, due to the rich ore on the fifth level, but this condition is being remedied by the installation of a tube-mill and additional cyanide agitations. Bullion recovery for the total tonnage milled for the period equals $21·56 per ton exclusive of premium, mint charges, tailing losses, and gold tied up in circuit. The downward extension of the high-grade ore found on upper levels has been located on the dip of the vein on the sixth or bottom level at 730 ft. and the ore is well mineralized, with free gold showing. While no mine development is being undertaken at present by Central Patricia Gold Mines, mill buildings are being erected and preparations being made to get into production early next year. Favourable results are being obtained from explorations on the Springer group of claims. A large shear-zone showing commercial values in gold over a good length and width has been opened on the Michael-Webb property at Lochalsh, Algoma, by the Cor-Mac Mining Syndicate. Howey Gold Mines, Ltd., has a total bullion production of $279,000 from 81,130 tons of ore for the three months ended June 30. Recovery per ton averaged $3·44, compared with $3·24 for the previous three-month period. An extensive development campaign, including considerable underground work, has been started by the Nortricia Mining Company on its property in the East Bay section of the Red Lake district.

North-Western Quebec.—Siscoe Gold Mines had a total bullion production of $100,532 during June, as compared with $99,908 for May and $71,037 for June of last year. A total of 8,962 tons of ore was treated, which constituted a high record for the company. Northern Quebec Prospectors, Ltd., is undertaking a large development programme on its property in Bousquet township, in the Cadillac district of Quebec. It is planned to install mining plant in the immediate future. At the Dunlop Consolidated Mines property, adjoining the Vicour property, in Louvicourt township, 22 ft. of diorite similar to that on the Vicour has been uncovered by trenching. This trenching will be continued for a quarter of a mile before diamond drilling is commenced. The company has obtained $125,000 for development purposes. Ore reserves at the Pandora mine, in the Cadillac district, have been estimated at $350,000 by D. A. Mutch, consulting engineer, who made a recent survey of the property and recommended erection of a 100-ton mill. McWatters Gold Mines, operating in the Rouyn district, has completed its shaft to the objective of 400 ft. Check sampling at the 150-ft., 285-ft., down to the 450-ft. level at the Greene Stabell mine, in Dubuisson township, has recently been completed by H. A. Kee, engineering director of the company, and former sampling has been verified. A mill is now being installed on the property and production will begin next autumn. Financial arrangements have been completed by Malrobic Mines for a large development campaign on its property in the Malartic district. Preparations are being made to continue the shaft on the Granada property to 3,000 ft. The incline shaft is being equipped with a new head-frame and hoisting facilities which will aid development considerably. A new sorting plant is now in operation and surface exploration is continuing with encouraging results. Among the other companies engaged in exploration and development work in the district are McChesney-Mosso, Northern Quebec, Adanac, Normont, Stadacona, Seguin Rouyn, Herbin Lake, Gilbec, and Norgold.

Manitoba.—A vein of high grade has been traced on the property of Smelter Gold Mines, in the God's Lake district, for 1,000 ft. on surface. Development work is being pushed forward at the Little Long Lac Gold Mines property, in the Little Long Lac area. The first station has been cut at the 125-ft. level. It is planned to install a 50-ton mill in the near future. Mining operations have been started on the property of Oro Grande Mines, in south-eastern Manitoba, and a

75-ton mill has been installed. Active exploration work has been started by Lake Maron Gold Mines on its property in the Little Long Lac gold area. Owing to the continued drop in the price of copper, the Sherritt-Gordon mine was shut down in June and will remain inactive until the market for copper improves. During the year 1932 the company sustained a net loss of $8,453. Central Manitoba Mines, Ltd., had a total income of $488,295 for the year ended April 30, of which bullion production and premium returned $466.088. Mining and other costs totalled $512,740, leaving a net operating loss of $24,449. At the end of the year ore reserves were estimated at 23,727 tons, valued at $156,720.

Great Bear Lake.—Large deposits of high-grade silver and pitchblende are being opened up on the property of Eldorado Gold Mines, in the Great Bear Lake district. Installation of machinery will be proceeded with rapidly and production of silver is expected to begin early in September. Development work on the Rad group of claims of Great Bear Lake Mines is yielding encouraging results. Underground development will be started as soon as equipment can be installed.

JOHANNESBURG

July 5.

West Witwatersrand Areas. — In connexion with the official announcement that bore-hole No. 11 on the West Witwatersrand Areas' farm Venterspost has intersected a reef giving a low value at the point of intersection which has all the characteristics of the Randfontein Leader (Western Rand Leader), it has been recalled that bore-hole No. 7, which is situated on Venterspost and less than two miles to the north-east of No. 11 hole, reached a depth of 3,707 ft. The old Western Rand Estates' report shows that both No. 1 and 2 West Reef ore-bodies were passed through, the former at 2,707 ft. and the latter at 3,138 ft. depth. No. 2 West Reef assayed 23 dwt. over 9 in. Bore-hole No. 6, near the north-west corner of the farm Lebanon and just under two miles to the south-west of bore-hole No. 11, did not reach the Main Reef horizon. In bore-hole No. 8 the Randfontein Leader was intersected at 1,677 ft., "disclosing a compact, highly-mineralized banket body 20 in. in thickness, which showed visible gold in places: 4·5 in. of the core assayed 33·666 dwt. and the average assay value of the foot-wall portion of the reef for a corrected width of 12·21 in. was 18·333 dwt. of fine gold per ton at 2,000 lb." Bore-hole No. 9, situated some 5,000 ft. to the south-east of bore-hole No. 6, reached the Witwatersrand series at 2,250 ft. "The whole of the reef bodies disclosed by this hole appeared to be more sandy than in any other holes on the property" an old report states. "The Western Rand Leader is represented here by a highly-mineralized contact, showing only one large pebble; 8 in. of ore gave an assay value of 6·6 dwt. per ton. No. 2 West Reef was intersected at 3,227 ft., the upper 5 in. assaying 12·6 dwt. per ton and the lower 7·5 in. 11·23 dwt. per ton, the centre section of the reef being very sandy."

Western Reefs Exploration. — The Western Reefs Exploration and Development Co. is acquiring a further block of options over approximately 39,400 morgen, situate to the west of Klerksdorp. An agreement has been concluded whereby these options will be acquired for the sum of £10,000, with which amount the vendors have agreed to subscribe for 40,000 new shares of the company at par. Two diamond drills are now operating on the company's property.

Middle Witwatersrand (Western Areas) Company.—There is reason to believe that the preliminary reports of the Middle Witwatersrand (Western Areas) Company's geologists are of a very encouraging nature and as from present indications the Main Reef Series in this locality is likely to have a fairly flat dip the company has acquired options over an additional 20,000 morgen on the dip of its original holding. The company now holds a compact block of nearly 50,000 morgen of ground, which is situated between the property of the West Witwatersrand Areas and the ground held by the Western Reefs Company. It now commands a strike of over 20 miles and a dip of 15 miles. The aerial survey has now been completed and the maps should be available shortly. Dr. Heinberg, the geophysicist, has been engaged to carry out the electro-magnetic survey, after which boring operations will be commenced.

Klerksdorp. — The South African Townships, Mining, and Finance Corporation has secured options recently over the mineral rights of certain farms in the Klerksdorp district between that town and Potchefstroom along the presumed line of the extension of the Witwatersrand series and a substantial area of ground has been secured. For the

definition of interests these properties have been formed into a syndicate under the name of the Kromdraai Mining Syndicate (Proprietary), Ltd., with an initial capital of £10,000 in 10s. shares. The corporation has retained an 18¾% interest in the syndicate and the right to subscribe 25% of the first and any future issue of working capital at par.

Proposed New Company.—A company is being formed to acquire options over approximately 12,000 morgen of ground on the South-West Rand, adjoining and surrounded by the areas owned by the West Witwatersrand, Middle Witwatersrand, and Western Reefs companies. The new company will also have the option over the mineral rights of 4,000 morgen on the farm Gerhardminnebron, situated in the centre of the areas now being actively prospected by the three companies already mentioned and with the inclusion by other interested groups of some 8,000 morgen of ground and 1,500 claims on the farm Eleazer No. 18 the company will have a total area of approximately 25,000 morgen to exploit. This area commences at the farms Gerhardminnebron (8,000 morgen in extent, half of which is the property of the African and European Investment Co.) and Boschoek and extends in a westerly direction to the farm Eleazer, on which the Machavie mine is situated and on which the new company will have 1,500 claims. Gerhardminnebron adjoins the West Witwatersrand Areas' farms Turffontein No. 90, Kiel No. 85, and Kleinfontein No. 36. The ground to be acquired by the new company has been examined and reported upon by several engineers on behalf of participating groups. The new company will have an initial capital of £200,000 and will be floated under the aegis of the African and European Investment Co. and a first issue of £50,000 working capital—leaving a further £100,000 working capital in reserve—will be jointly subscribed by five groups—namely, the African and European Investment Co. (Lewis and Marks Group), New Consolidated Gold Fields, Bailey Group, South African Townships, Mining, and Finance Corporation, and Olthaver's Investment and Trust Co. The administrative and technical control of the new company will be retained by the African and European Investment Co.

Witpoort No. 14.—Since the Anglo-American Corporation took over the administration of the South African Land and Exploration Co. on April 25 application has been made to the Mining Commissioner for discoverer's rights on the company's farm Witpoortje No. 14 and later on a request for proclamation of the farm will be made. The mynpacht will be selected and the Government will be approached for a lease of the balance of the ground. Arrangements will be concluded with Brakpan Mines, Ltd., and West Springs, Ltd., for the extension of haulages in those mines into Witpoort No. 14 so that exploratory development work may commence. The future policy to be adopted will naturally depend on the results obtained.

Welgedacht.—The directors of the Welgedacht Exploration Co. have decided to obtain further information regarding the reef conditions on the company's farm Welgedacht, which is situated on the Far East Rand to the east of Modder East and to the north of Grootvlei. A complete aerial survey is to be made and bore-holes will be sunk in selected parts of the farm. The existing bore-holes on the property were sunk about 30 years ago. The estimated depth of the Main Reef Series is 1,000 to 3,000 ft. The company owns the freehold of the farm, a mynpacht, and other owners' rights thereon, equal to 1,241 claims, and in addition the mineral rights of the adjoining farm Goygerle, in extent 728 morgen.

Northern Transvaal Copper.—The Northern Transvaal (Messina) Copper Exploration Co. has decided to put down bore-holes on its property to prove the large ore-bodies indicated by the geophysical survey made by the Elbof Company some time ago. The property adjoins that of the Messina (Transvaal) Development Company and consists of 1,305 claims.

Gold Law Amendment Bill.—The Bill to amend the Transvaal Gold Law of 1908, to be known as the Mineral Law Amendment Act, has been published and will be submitted at the next session of Parliament. It virtually abolishes the old mynpacht, which constituted the exclusive mining rights of one-fifth of the area of a farm to the owner of the mineral rights, but in place of the mynpacht the owner of the mineral rights of the farm has the right to a lease from the Government of one-half of the area supposed to contain minerals. The terms of such leases will be on a sliding scale, depending on the risk involved and other circumstances. There will be a capital allowance of 7½% per annum of the capital expenditure necessary to bring

the mine to the producing stage, which is deducted from the mine's profits before the Government participates under the provisions of the lease.

Government Geologists. — During a debate in Parliament Mr. Patrick Duncan, the Minister of Mines, said a request had been made that Government geologists should be permitted to report on private property, but that this was undesirable for two reasons. In the first place they would be competing with geologists in private practice and in the second it was not altogether sound that Government servants should be concerned in reporting on prospects of mining propositions. There was, of course, much more than a geological opinion concerned in such matters. As an old mining authority had once remarked, many a good mine had been spoilt by being opened up.

PERSONAL

J. W. Cairns has returned to Northern Rhodesia.

Denison Denny has returned to Canada from Chile.

L. L. Ellis is here from South Africa.

Donald Gill has returned from the Gold Coast.

R. D. Hole has left for Angola.

A. W. Hooke is returning from Dutch Guiana.

W. R. Jones has left for South Africa.

Albert E. Knight has returned from the Gold Coast.

J. G. Lawn, who left for South Africa last month, has received the degree of Doctor of Science of the University of Witwatersrand, with the foundation of which he was closely connected.

A. M. Mackilligin is here from Brazil.

H. S. Munroe is here from Northern Rhodesia.

A. E. Page has left for the Gold Coast.

A. J. Peterson is now in Sydney.

R. M. Philip is returning from Newfoundland.

Frank Powell has returned from West Africa.

Thomas Pryor has returned from South Africa.

F. L. Purvis has left for the Gold Coast.

A. M. Robinson has left for the Gold Coast.

H. P. T. Rohleder has left for Tanganyika.

D. A. Sutherland is in Palestine.

J. Ellis Thomson has been appointed professor of mineralogy at the University of Toronto.

J. F. Thorn is on his way to London.

Vernon Turner has returned from Kenya.

F. H. Upcott is now in the Transvaal.

E. A. Walker is now in the Gold Coast.

John Warrick has returned to Western Australia.

J. H. Grieve Wilson has left for the Gold Coast.

John Rolland died on July 27 at the age of 46. He was the principal of the firm of John Rolland and Co., consulting engineers, who for some years have represented in this country Fried Krupp Grusonwerk, A.G., of Magdeburg, and the Lurgigesellschaft fuer Waermetechnik, Frankfurt (a branch of the Metallgesellschaft).

TRADE PARAGRAPHS

Lake and Currie have removed their office to Bevis Marks House, Bevis Marks, London, E.C. 3.

Head, Wrightson, and Co., Ltd., of Stockton-on-Tees, issue a new edition of their booklet describing the Akins classifier.

Commer Cars, Ltd., of Luton, in a leaflet describe the strenuous tests recently made on their new 2½-ton lorry "Centurion."

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, in the July issue of their *Gazette* publish an article fully descriptive of their electrical and magnetic research and testing equipment.

Elbof Geophysical Co., of Cassel, Germany (London representative: H. B. Bateman, 790, Salisbury House), announce that they have in hand a contract for geophysical surveying on behalf of the Indian Copper Corporation.

Hadfields, Ltd., of East Hecla and Hecla Works, Sheffield, draw attention to their improved three-stage, single roll, two roll, and four roll rotary coal breakers, the claws and cutters of which are made from "Era" manganese steel.

W. Sisson and Co., Ltd., of Elmbridge Road, Gloucester, are sending out a catalogue illustrating and describing the Sisson high-speed steam engine, together with leading features relating to its design and manufacture. This engine is particularly suitable for tin and other dredges.

Electric Furnace Co., Ltd., of 17, Victoria Street, London, S.W. 1, have published a pamphlet illustrating installations of "Efco," Heroult, Ajax-Northrup, and Ajax-Wyatt electric furnaces undertaken by them during their 21 years' experience in the design of this type of plant.

Riley, Harbord, and Law announce that they have removed to Parliament Mansions, Orchard Street, London, S.W. 1, and that their offices, chemical laboratories, and cement and concrete testing laboratories are now in one building. Their telephone numbers remain unchanged.

Ruston and Hornsby, Ltd., of Lincoln, report having recently received an order for two crude-oil locomotives for the School of Military Engineers, Portugal. Other recently-completed orders include locomotives for New Zealand, Finland, Belgium, France, Singapore, Macedonia, and Greenland.

A. L. Curtis, of Westmoor Laboratory, Chatteris, has published No. 4 of his *Sands, Clays, and Minerals*. This issue contains articles on fluorspar in industry, Canada's mineral wealth, the treatment of platinum-iridium scrap, the genesis of gangue, gypsum and its origin and uses, English china clay, and notes on sand analysis.

Hopkinsons, Ltd., of Huddersfield, have issued a catalogue covering their patent safety boiler mountings and valves. This is profusely illustrated with photographs and tabular matter distributed over some 500 pages and divided into 17 sections, ranging from specifications of boiler mountings to miscellaneous fittings.

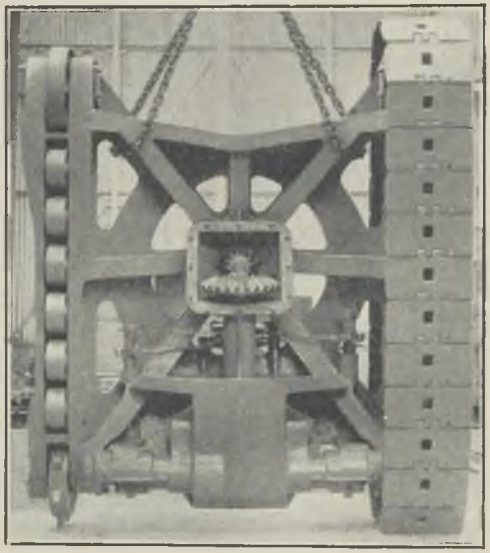
General Engineering Co., Inc., of Adelaide House, London, E.C. 4, publish a 20-page booklet entitled "Weights of Materials," etc. This contains a great deal of information, including the specific gravity and weight in pounds per cu. ft. of the principal metals, minerals, gases, and miscellaneous solids and liquids.

Orenstein and Koppel, A.-G., of Berlin, S.W. 61, are sending out through their London representative,

A. Gloster, of Vintry House, Queen Street Place, E.C. 4, an 8-page leaflet which contains extracts from various catalogues illustrating some of their designs relating to railway equipment, excavating machinery, including that of the chain-bucket type, and locomotives.

Denver Equipment Co., of 1419, 17th Street, Denver, Colorado, U.S.A. (London office: 840, Salisbury House, E.C. 2), have published a leaflet describing their exhibit at the Chicago exhibition. This is a working model of a flotation unit, which is actually in operation treating a gold-lead-zinc ore. Another leaflet they issue gives particulars of their service in testing their clients' ores to ascertain the most suitable concentrating process.

Ransomes and Rapier, Ltd., of Ipswich, write with reference to the article by Mr. Sinclair in the May issue of the MAGAZINE. They associate themselves with his remarks on the displacement of the chain drive on smaller machines by the direct gear



drive. They state that three out of four British and the two principal German manufacturers follow this practice with machines of all sizes. Given proper design they contend that this type of drive affords adequate ground clearance and that it is essentially simple, consisting as it does of spur and bevel gears cut from the solid steel. Adjustments with this system, these makers claim, are reduced to a minimum and involve only the tensioning of the crawler belts from time to time, the mechanism for which is easily accessible. They add that the gear drive being totally enclosed is readily and amply lubricated and all moving parts are entirely protected, as shown in the illustration.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E. 7, publish information concerning machinery guards such as they manufacture from wire mesh and in some exceptional cases from perforated metal. These guards are intended for the protection of moving parts, such as belting and flywheels, and are made in a variety of shapes and sizes. These products should be of interest to mill managers and those in charge of workshops.

Sir Isaac Pitman and Sons, Ltd., of Parker Street, Kingsway, London, W.C. 2, publish parts 20, 21, and 22 of their *Engineering Educator.* Part 20 contains the conclusion of the section on the theory of heat engines and this is followed by chapters on fuel, fuel calorimeters, and the commencement of a section devoted to steam boilers and their accessories, which is completed in Part 21. The subjects of reciprocating steam-engines and outlines of locomotive engineering are covered in Part 22.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report having received the following orders:—For England: One No. 0000 Raymond pulverizer for grinding magnesium oxide, one 3-ft. diam. Raymond air-separating plant for separating hydrated lime, one 6-ft. by 5-ft. 3-surface Hum-mer electric screen for screening ground cork, and one 40-ft. Spitzkasten. For Cyprus: 2-in. and 3-in. grit pumps for handling abrasive mud in either sulphuric acid or cyanide solution. For India: Ro-Tap testing sieve shakers.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, in their *Edgar Allen News* for July have an illustrated article dealing with dredge buckets and pins as manufactured from "Imperial" manganese steel. They have also issued the 8th edition of their catalogue relating to the K.B. rotary granulator. Special features of this machine are its all-steel construction, liners and hammers of "Imperial" manganese steel, flywheel which prevents fluctuations of speed and ensures smoothness of operation, and long self-aligning bearings which are dust proof.

George Cohen, Sons, and Co., Ltd., of 600, Commercial Road, London, E. 14, have issued a catalogue of chemical plant, which includes sections on grinders and pulverizers, mixers, filter presses, concentrating tables, and conveyers and elevators. The firm are not manufacturers, but agents for the sale of new and secondhand machinery, and guarantee the condition of all the machines they dispose of. Another catalogue is of rails, steel sections, tubes, and miscellaneous items. They also publish a bi-monthly house magazine, which is a well-prepared illustrated publication giving interesting news of the activities of the firm and its several associated companies.

Ruston-Bucyrus, Ltd., of Excavator Works, Lincoln, have prepared a new catalogue describing their No. 4 universal half-yard excavator, in which certain improvements have been embodied. The engine and machinery are now enclosed in an all-steel house instead of in wood, as formerly. This eliminates the risk of fire, which is always present on a petrol machine in a wood housing. Attention may also be directed to combinations of long booms and buckets for dragline work, three standard sizes being mentioned—$\frac{1}{2}$-yd. bucket and 30-ft. boom, $\frac{3}{8}$-yd. bucket and 35-ft. boom, and 6-ft. bucket and 40-ft. boom. Reference is also made to a tunnel shovel. The No. 4 may be operated with a Diesel engine, a petrol-paraffin engine (Dorman type), or an electric motor and the catalogue contains a great many illustrations and drawings and tabular matter indicating its wide field of operation.

Climax Rock Drill and Engineering Works, Ltd., of Carn Brea, Cornwall, have issued two new catalogues. These deal with a new drifter

hammer drill and with the P.A.P. alluvial prospecting drill. The makers claim for the hammer drill that for the usual run of rock encountered in metalliferous mining it is the fastest drifter of its size yet produced. The valve of the machine is of the disc type and is different in construction from any of the firm's other models. The cylinder is of 3½ in. diameter, the length of the stroke 2⅝ in., and the net weight, including the cradle, 154 lb. The air consumption per minute at 80 lb. pressure is given as 165 cu. ft. and the drilling speed in inches per minute with a 2-in. bit as 15. Machines of this type have been successfully tested in South Africa, Canada, and Australia and are now in extensive use in those countries. The drill is illustrated in the accompanying photograph. The second catalogue referred to is a reprint of an earlier edition and gives full information on this already well-known drill or alluvial prospecting. The catalogue is fully illustrated and gives details of all the working parts. The firm also issue a leaflet describing their drill carriage, on which as many as six drills may be mounted. This follows conventional design and is of interest to those engaged in long tunnel driving. Another publication is entitled "Drill Steel" and this gives a wealth of information on the selection of steel, its treatment, and the advantages of and methods of making the different kinds of bits. A particularly useful section is that containing a table which shows the length of bar steel required for making drill steels complete with shanks and bits, which is designed to obviate wastage of steel bar.

METAL MARKETS

Copper.—July witnessed an upward tendency on the standard copper market, but by the close of the month a reaction had set in and the advance was lost. The American export quotation fluctuated, partly in sympathy with dollar exchange movements, rising from 7·95 cents per lb. c.i.f. Europe at the beginning of the month to 9·15 cents by the middle, only to relapse to 8·55 cents. Increased industrial demand is reported in America, where the success or failure of the Roosevelt recovery programme is awaited with eager interest. The domestic price there has advanced from 8 to 9 cents delivered Connecticut Valley. The world statistical position is believed to be improving markedly.

Average price of Cash Standard Copper: July, 1933, £37 19s.; June, 1933, £36 16s. 1d.; July, 1932, £26 2s. 5d.; June, 1932, £26 18s. 4d.

Tin.—The trend of tin values was downwards last month, partly owing to a persistent lack of American buying till towards the close, nervousness owing to setbacks in other commodity markets, and, possibly, on the lack of information vouchsafed by the Tin Pool as regards its rate of liquidation. The statistical position, however, continues to improve steadily, although surplus stocks still remain quite substantial. A proposal was put forward at the World Economic Conference that countries which are non-members of the restriction scheme should be induced to join; these nations, however, will probably be shy of committing themselves.

Average price of Cash Standard Tin: July, 1933, £216 15s. 7d.; June, 1933, £220 1s. 8d.; July, 1932, £125 19s. 5d.; June, 1932, £114 12s. 11d.

Lead.—After being fairly firm throughout most of July, prices lost some ground at the close. Consuming demand in our country keeps up pretty well, but the Continent is a dull spot. In America some good buying has been witnessed recently, but doubtless there, as well as in London, some of this has been of an investment character. In view of the rather drab aspect of the lead market (world stocks are still estimated at around 500,000 tons), prices are likely to be sensitive to general economic influences.

Average mean price of soft foreign lead: July, 1933, £13 10s. 2d.; June, 1933, £13 8s. 6d.; July, 1932, £9 19s. 8d.; June, 1932, £9 15s.

Spelter.—Prices displayed firmness at times during July, but finally closed the month with a loss. The Cartel, which continued to record a steady and fairly substantial diminution in stocks month by month, has been renewed for a further term. The authorized rate of output of the Cartel members has been raised from 45 to 50% of the "Ostend basis." The scale of fines for over-production has been relaxed somewhat. Germany is preparing to build a new big electrolytic plant.

Average mean price of spelter: July, 1933, £17 15s. 10d.; June, 1933, £16 17s. 7d.; July, 1932, £11 15s. 6d.; June, 1932, £11 14s. 1d.

Iron and Steel.—The British pig-iron market has entered the quiet holiday period, but sales are being fairly satisfactorily maintained. Prices are steady, with No. 3 Cleveland foundry g.m.b. quoted at 62s. 6d. delivered Middlesbrough zone. Hematite is talked up, but East Coast mixed numbers are still about 59s. The British mills rolling heavy specifications are by no means over-busy, but they are taking a hopeful view of the future. Continental steel has been in the doldrums following the recent raising of prices by the Cartel.

Iron Ore.—The approach of the summer holiday season resulted in a lessening of buying interest in this market and business fell last month to negligible proportions. Prices, however, were maintained fairly well at about 15s. 6d. per ton c.i.f. for best Bilbao rubio and 14s. to 14s. 6d. for good North African ores.

Antimony.—Consumers were not induced by the firm attitude of Chinese holders to buy on any appreciable scale during July and in the absence of business prices tended to sag a little. Chinese regulus for forward shipment is now quoted at

LONDON DAILY METAL PRICES.

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

	COPPER.			TIN.		ZINC (Spelter).	LEAD		SILVER		GOLD.
	Standard.		Electrolytic	Best Selected.			Soft Foreign.	English.	Cash.	Forward.	
	Cash.	3 Months.									
July.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
11	37 17 6	38 1 3	42 5 0	40 10 0	211 12 6	211 7 6	17 17 6	13 6 3	14 15 0	17 11/16	18 1/16	124 10
12	38 11 10½	38 15 7½	42 7 6	—	217 17 6	217 13 9	18 3 9	13 11 3	15 0 0	18 1/16	18 1/16	124 9
13	38 4 4½	38 8 1½	42 5 0	—	214 12 6	214 12 6	17 18 9	13 6 3	15 0 0	18 1/8	18 1/8	124 1
14	38 5 7½	38 9 4½	42 0 0	40 10 0	214 12 6	214 7 6	17 15 0	13 5 0	14 15 0	18 1/16	18 3/16	124 2
17	38 1 10½	38 5 7½	42 0 0	—	212 15 0	212 8 9	17 15 0	13 7 6	14 15 0	18 1/16	18 1/16	124 3
18	38 8 1½	38 11 10½	42 0 0	40 10 0	215 8 9	215 7 6	18 0 0	13 10 0	14 15 0	18 1/8	18 1/8	124 5½
19	38 11 10½	38 15 7½	42 0 0	—	216 12 6	216 7 6	18 2 6	13 12 6	15 0 0	18 1/8	18 1/16	124 4
20	38 5 7½	38 10 7½	42 0 0	—	212 17 6	212 12 6	17 16 3	13 10 0	15 0 0	18 1/8	18 1/4	124 6
21	37 9 4½	37 11 10½	41 10 0	39 15 0	212 17 6	212 16 3	17 12 6	13 7 6	14 15 0	18 1/8	18 1/4	124 1
24	36 15 7½	36 18 1½	41 0 0	—	213 3 9	213 3 9	17 7 6	13 1 3	14 10 0	18 1/8	18 7/16	123 6½
25	37 4 4½	37 6 10½	41 7 6	39 15 0	215 16 3	215 16 3	17 15 0	13 7 6	14 15 0	18 1/8	18 1/4	123 6
26	37 1 10½	37 4 4½	41 7 6	—	214 17 6	214 17 6	17 7 6	13 5 0	14 15 0	17 7/8	18	123 9½
27	36 14 4½	36 18 1½	41 7 6	—	214 16 3	214 18 9	17 6 3	13 2 6	14 10 0	18 1/8	18 1/4	124 6
28	37 1 10½	37 4 4½	42 0 0	40 0 0	216 2 6	216 7 6	17 7 6	13 6 3	14 15 0	18 1/8	18 7/16	124 3
31	36 11 10½	36 15 7½	41 10 0	—	214 15 0	215 8 9	17 2 6	12 18 9	14 10 0	17 15/16	18 1/16	124 0
Aug.												
1	35 19 4½	36 1 10½	41 10 0	39 5 0	212 10 0	213 2 6	16 11 3	12 5 0	14 0 0	17 7/8	18	124 0
2	36 9 4½	36 13 1½	41 10 0	—	214 6 3	214 13 9	16 13 9	12 8 9	14 0 0	17 3/4	17 7/8	124 3
3	36 14 4½	36 19 4½	41 10 0	—	214 12 6	214 18 9	16 16 3	12 12 6	14 0 0	17 7/8	17 15/16	124 7
4	36 16 10½	37 0 7½	41 10 0	39 10 0	214 16 3	214 18 9	16 15 0	12 7 6	13 15 0	17 7/8	18	124 6½
8	36 12 6	36 16 10½	41 10 0	39 10 0	214 11 3	214 13 9	16 10 0	12 2 6	13 10 0	17 15/16	18 1/16	124 7½
9	36 13 1½	36 16 10½	41 5 0	—	215 8 9	215 8 9	16 15 0	12 5 0	13 15 0	17 15/16	18	124 8
10	36 16 3	37 0 7½	41 5 0	—	216 6 3	216 6 3	16 17 6	12 6 3	13 15 0	18 1/16	18 1/8	124 8

about £23 to £23 10s. per ton c.i.f., with spot English regulus £37 10s. to £40 ex warehouse.

Arsenic.—The easiness of the dollar resulted in the price of Mexican material advancing to £16 5s. to £16 10s. c.i.f. Cornish white remains at £16 10s. f.o.r. mines.

Bismuth.—The official price was raised during July to 4s. 9d. per lb. for merchant quantities.

Cadmium.—Inquiry has not been particularly active, but a moderate turnover continues at around 1s. 2d. to 1s. 3d. per lb.

Cobalt Metal.—Following the placing of this metal on the Tariff Free List the official price was reduced to 5s. per lb. Business was not stimulated very appreciably.

Cobalt Oxides.—Demand remains sluggish, with prices nominally unchanged at 4s. 7d. to 5s. per lb. for black and 5s. 2d. to 5s. 5d. per lb. for grey.

Chromium.—Metal is still quoted at 2s. 8d. per lb. delivered.

Tantalum.—Somewhere about £15 per lb. is quoted for the usual run of orders, which are small.

Platinum.—Quiet conditions have prevailed in this market, but the official price is without change at £17 15s. per oz.

Palladium.—There is but little inquiry, but holders have been a little firmer in their ideas, current quotations being £3 12s. 6d. to £4 7s. 6d. per oz.

Osmium.—Prices are upheld at £12 to £13 per oz.

Iridium.—About £9 to £10 per oz. is asked for sponge and powder, but business is light.

Tellurium.—Quotations vary rather widely according to quantity, etc., the present range being about 17s. 6d. to 20s. per lb. for the usual small orders that are forthcoming. Less is accepted for larger parcels.

Selenium.—The market is quietly steady at the unaltered prices of 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse.

Manganese Ore.—During the past month a few odd cargoes have been sold, including some West African. South Africa has also been more active again. Business generally, however, is still poor. Prices remain at about 9½d. per unit c.i.f. for best Indian and 8½d. to 9d. c.i.f. for 50 to 52% washed Caucasian ore.

Aluminium.—Conditions in this market have changed hardly at all. Prices remain at £100 for ingots and bars and £102 for rolling billets, both less 2% delivered.

Sulphate of Copper.—English makers are still quoting £16 15s. to £17 5s. per ton, less 5%.

Nickel. — Demand continues to make an encouraging showing, with prices steady at £225 to £230 per ton, according to quantity.

Chrome Ore.—Business is still restricted, but prices are upheld at about 80s. to 85s. per ton c.i.f. for first quality 48% Rhodesian and 100s. to 105s. c.i.f. for 55 to 57% New Caledonian.

Quicksilver.—Interest on the part of users has been limited and quotations have eased slightly to about £9 to £9 5s. per bottle, net.

Tungsten Ore.—In the early part of July there was a remarkable rise in prices to over 20s. per unit c.i.f. The volume of business done at the higher levels, however, was small and values have reacted to around 17s. 6d. per unit c.i.f. for forward shipment from China. The rise seems to have had little solid foundation in the shape of an expansion in consumption.

Molybdenum Ore.—In the absence of any appreciable new business prices now stand at about 40s. to 42s. 6d. per unit c.i.f. for 80 to 85% concentrates.

Graphite.—The market is quietly steady, with 85 to 90% Madagascar flake around £19 to £21 duty paid and 90% Ceylon lumps £15 to £17 c.i.f.

Silver.—On July 1 spot bars stood at 18½d. but, although America and the Continent sold in the early part of the month, India and China bought and with some speculative support prices rose to 18¾d. on July 18. A temporary spurt followed the agreement reached by the silver-producing and consuming countries at the World Economic Conference, but this proved transitory and with sentiment less favourable quotations eased towards the end of the month, spot bars closing at 17 15/16d. on July 31.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
July, 1932	933,947	47,213	981,160
August	943,174	48,148	991,322
September	912,870	48,631	961,501
October	926,686	48,279	974,965
November	930,085	48,631	978,716
December	931,749	48,869	980,618
January, 1933	919,125	48,332	967,457
February	835,931	47,214	883,145
March	896,728	50,135	946,863
April	845,099	49,998	895,097
May	893,464	51,140	944,604
June	868,834	49,799	918,633
July	872,695	50,976	923,671

TRANSVAAL GOLD OUTPUTS.

	June.*		July.†	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	114,000	£213,290	117,000	£220,295
City Deep	100,000	21,249	108,000	21,725
Cons. Main Reef	80,500	23,744	83,000	23,696
Crown Mines	290,000	86,329	300,000	88,514
Daggafontein	56,000	£120,968	57,700	£125,821
D'rb'n Roodepoort Deep	51,100	14,091	53,500	14,661
East Geduld	73,000	24,837	73,500	24,999
East Rand P.M.	162,500	40,506	169,500	41,001
Geduld	88,000	27,068	91,500	27,507
Geldenhuis Deep	78,000	15,267	82,000	15,372
Glynn's Lydenburg	7,500	2,675	7,500	2,755
Government G.M. Areas	208,000	£510,966	208,000	£521,863
Kleinfontein	52,000	9,507	53,100	9,922
Langlaagte Estate	77,000	£130,895	79,000	£136,953
Luipaard's Vlei	36,400	8,293	36,900	8,310
Modderfontein New	173,000	52,031	177,000	50,467
Modderfontein B	75,000	16,970	77,500	17,540
Modderfontein Deep	45,100	19,107	45,200	19,024
Modderfontein East	76,500	19,518	78,000	20,537
New State Areas	91,000	£255,775	90,000	£258,146
Nourse	71,000	18,270	72,000	17,815
Randfontein	262,000	£419,418	275,000	£443,286
Robinson Deep	100,000	26,774	101,000	26,969
Rose Deep	63,000	11,887	65,000	11,959
Simmer and Jack	89,200	20,951	92,200	20,880
Springs	84,500	£218,496	84,500	£223,409
Sub Nigel	39,700	35,956	42,300	36,764
Transvaal G.M. Estates	20,000	5,053	20,700	5,078
Van Ryn	52,000	£58,633	53,000	£59,522
Van Ryn Deep	77,000	£126,559	79,000	£125,412
West Rand Consolidated	95,000	£144,758	98,000	£150,567
West Springs	86,000	£106,807	86,000	£104,547
Witw'tersr'nd (Knights)	72,000	£71,460	75,000	£76,292
Witwatersrand Deep	47,500	14,437	51,000	14,259

* Gold at 120s. per oz. † Gold at 123s. per oz.

COST AND PROFIT ON THE RAND, Etc.

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

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

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
July 31, 1932	217,525	12,056	—	229,581
August 31	217,658	11,727	—	229,385
September 30	216,398	11,642	—	228,040
October 31	216,298	11,353	—	227,651
November 30	219,024	11,207	—	230,231
December 31	221,008	11,310	—	232,318
January 31, 1933	222,005	11,292	—	233,297
February 28	222,589	11,472	—	234,061
March 31	223,490	11,626	—	235,116
April 30	225,279	11,611	—	236,890
May 31	227,178	11,562	—	238,740
June 30	229,751	12,059	—	241,810
July 31	230,306	12,269	—	242,575

PRODUCTION OF GOLD IN RHODESIA.

	1930	1931	1932	1933
	oz.	oz.	oz.	oz.
January	46,121	45,677	42,706	48,656
February	43,385	42,818	45,032	47,661
March	45,511	42,278	47,239	49,929
April	45,806	43,776	46,487	53,559
May	47,645	43,731	46,854	53,358
June	45,208	44,118	48,441	51,442
July	45,810	44,765	47,331	—
August	46,152	43,292	49,254	—
September	46,151	42,846	50,198	—
October	45,006	44,260	50,416	—
November	44,351	44,516	48,082	—
December	46,485	50,034	52,096	—

RHODESIAN GOLD OUTPUTS.

	June.		July.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,600	10,466	25,800	9,272
Globe and Phœnix	6,078	5,419	6,078	5,436
Lonely Reef	11,000	1,917	12,500	1,908
Lufri Gold	—	—	—	—
Rezende	6,500	2,279	6,500	2,166
Sherwood Star	6,900	1,904	7,000	1,880
Wanderer Consolidated	15,600	3,517	16,000	3,613

WEST AFRICAN GOLD OUTPUTS.

	June.		July.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	8,056	£26,319	8,577	£24,990
Ashanti Goldfields	13,625	14,808	13,613	14,829
Taquah and Abosso	10,181	3,338	10,935	3,577

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
July, 1932	53,585	—	1,391
August	51,536	—	1,026
September	54,427	—	1,160
October	51,236	—	2,169
November	53,956	—	4,386
December	52,282	38,612†	4,602
January, 1933	45,755	9,133	4,005
February	47,281	—	4,365
March	47,105	5,747	4,758
April	52,909	—	12,460
May	53,300	—	* 7,135
June	53,451	—	—
July	54,455	—	—

† Period Jan.–Nov. 1932.

AUSTRALASIAN GOLD OUTPUTS.

	June.		July.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,249	6,126	5,132	4,337
Blackwater (N.Z.)	3,817	1,613*	4,182	1,878*
Boulder Persev'ce (W.A.)	7,083	13,668	7,248	8,947*p*
Grt. Boulder Pro. (W.A.)	6,436	5,329*	7,008	5,110
Lake View & Star (W.A.)	42,008	82,680	43,559	82,871
Sons of Gwalia (W.A.)	12,026	14,417	12,302	15,549
South Kalgurli (W.A.)	9,650	14,262	9,584	13,996
Waihi (N.Z.)	18,030‡	5,442* / 33,180†	—	— / —
Wiluna	36,052	9,369*	—	—

* Oz. gold. † Oz. silver. ‡ To July 8. *p* Profit.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	June.		July.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Champion Reef	9,150	5,256	9,470	5,555
Mysore	14,545	7,640	14,870	7,676
Nundydroog	18,115	9,183†	18,654	10,642*
Ooregum	13,508	4,196	13,000	4,613

* 1,895 oz. from 1,535 tons Balaghat ore.
† 425 oz. from 749 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	June.		July.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	168,987*d*	—	8,280*
Chosen Corp. (Korea)	12,670	17,687	—	—
Frontino Gold (C'lbia)	4,400	24,294	4,950	20,915
Fresnillo	73,996	58,104*d*	—	—
New Goldfields of Venezuela	10,722	3,419*	13,364	3,755*
Oriental Cons. (Korea)	—	86,644*d*	—	81,290*d*
St. John del Rey (Brazil)	—	30,000	—	41,500
Santa Gertrudis (Mexico)	12,291	8,494*d*‡	—	—
Viborita	—	—	—	—
West Mexican Mines	2,030	19,000*d*	—	—

* Oz. *d* Dollars. ‡ Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

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

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	May.	June.	July.
Ayer Hitam	29½	—	—
Batu Caves	9	—	—
Changkat	55	58	28
Gopeng	—	68*	—
Hongkong Tin	—	85½*	—
Idris Hydraulic	12¾	—	21½
Ipoh	40¾	51	23½
Kampar Malaya	—	—	—
Kampong Lanjut	—	—	—
Kamunting	146	118	137
Kent (F.M.S.)	—	—	—
Killinghall	—	64¾*	—
Kinta	—	32*	—
Kinta Kellas	—	32½	—
Kramat Tin	80	67	50
Kuala Kampar	—	—	13
Kundang	—	—	—
Lahat	11¾	6	9⅝
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	80	—	71½
Malim Nawar	—	—	5
Pahang	72	72	78
Penawat	40⅜	50	32
Pengkalen	—	62½*	—
Petaling	100	—	—
Rahman	—	—	—
Rambutan	—	—	—
Rantau	—	—	—
Rawang	20	32	35
Rawang Concessions	40	28	27
Renong	28½	—	40¾
Selayang	—	—	—
Southern Kampar	—	—	130
Southern Malayan	47½	50	50½
Southern Perak	—	—	57½
Southern Tronoh	17	17	15
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	47½	—	59½
Taiping	17	15½	—
Tanjong	—	—	—
Tekka	—	36*	—
Tekka Taiping	—	61*	—
Temoh	—	—	26
Tronoh	37	37	33
Ulu Klang	—	—	—

* 3 months to June 30.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	May.	June.	July.
Anglo-Nigerian	21⅞	14½	16
Associated Tin Mines	110	109½	101½
Baba River	3	3	2
Batura Monguna	—	—	—
Bisichi	30	5	—
Daffo	—	—	—
Ex-Lands	—	15½	24
Filani	—	—	—
Jantar	10	10	10
Jos	8½	8½	—
Juga Valley	5½	5½	5½
Kaduna Syndicate	14	12⅝	10
Kaduna Prospectors	6	7	6
Kassa	4½	4⅝	5
London Tin	80	74	70
Lower Bisichi	3½	3½	—
Naraguta Extended	—	—	—
Nigerian Consolidated	—	5	—
Offin River	—	—	—
Ribon Valley	12	9	10
Tin Fields	—	—	—
United Tin Areas	11	8⅝	9
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	May.	June.	July.
Anglo-Burma (Burma)	24⅜	32	37¾
Aramayo Mines (Bolivia)	98	96	90
Bangrin (Siam)	44	43½	56¼
Beralt	26½*	26½*	—
Consolidated Tin Mines (Burma)	61	67	98
East Pool (Cornwall)	46½	44	—
Fabulosa (Bolivia)	31	26	27
Geevor	66	67	66
Kagera (Uganda)	25	25	—
Kamra	—	32½	25¾
Malaysiam Tin	13½	13½	11½
Mawchi	234*	224½*	226½*
Patino	—	—	—
Pattani	—	55	67
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	94	109½	130
South Crofty	58½	54½	—
Tavoy Tin (Burma)	67½	43½	51
Tongkah Harbour (Siam)	30	26	35
Toyo (Japan)	80½	70¾	65½
Zaaiplaats	12¼	12½	—

* Tin and Wolfram.

COPPER LEAD, AND ZINC OUTPUTS.

		June.	July.
Britannia Lead	Tons refined lead	4,990	—
	Oz. refined silver	235,630	—
Broken Hill South	Tons lead conc.	6,104	—
	Tons zinc conc.	6,574	—
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	520,332	514,000
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	400	400
	Tons yellow metal	530	460
Messina	Tons copper	786	757
Mount Isa	Tons lead bullion	4,850	—
Mount Lyell	Tons concentrates	3,028*	3,393‡
North Broken Hill	Tons lead conc.	8,570	—
	Tons zinc conc.	7,736	—
Rhodesia Broken Hill	Tons Zinc	1,600	1,600
	Tons V_2O_5 conc.	—	—
Roan Antelope	Tons blister copper	—	—
Sulphide Corporation	Tons lead conc.	1,869	—
	Tons zinc conc.	2,596	—
Trepca	Tons lead conc.	4,897	4,778
	Tons zinc conc.	6,405	7,381
Zinc Corporation	Tons lead conc.	7,352†	—
	Tons zinc conc.	5,101†	—

* To June 14. † To July 8. ‡ To July 12.

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

		May.	June.
Iron Ore	Tons	242,177	214,037
Manganese Ore	Tons	11,156	12,690
Iron and Steel	Tons	84,927	69,019
Copper and Iron Pyrites	Tons	25,296	16,373
Copper Ore, Matte, and Prec.	Tons	4,391	1,936
Copper Metal	Tons	13,703	10,986
Tin Concentrate	Tons	4,058	2,356
Tin Metal	Tons	85	100
Lead Pig and Sheet	Tons	30,405	26,666
Zinc (Spelter)	Tons	6,809	6,843
Zinc Sheets, etc.	Tons	1,473	1,656
Zinc Oxide	Tons	24	550
Zinc Ore and Conc.	Tons	10,502	21,625
Aluminium	Cwt.	9,358	75,838
Mercury	Lb.	92,434	79,469
White Lead	Cwt.	7,728	6,986
Barytes, ground	Cwt.	26,853	27,799
Asbestos	Tons	2,508	2,184
Boron Minerals	Tons	992	952
Borax	Cwt.	8,642	10,410
Basic Slag	Tons	—	—
Superphosphates	Tons	3,164	—
Phosphate of Lime	Tons	14,091	25,820
Mica	Tons	130	187
Tungsten Ores	Tons	374	249
Sulphur	Tons	3,651	7,191
Nitrate of Soda	Cwt.	1,702	100
Potash Salts	Cwt.	84,017	48,535
Petroleum: Crude	Gallons	32,968,868	38,202,765
Lamp Oil	Gallons	12,690,692	5,582,129
Motor Spirit	Gallons	109,354,596	99,211,048
Lubricating Oil	Gallons	9,496,787	10,220,580
Gas Oil	Gallons	11,882,010	5,993,910
Fuel Oil	Gallons	47,271,485	45,851,139
Asphalt and Bitumen	Tons	4,357	8,423
Paraffin Wax	Cwt.	81,909	106,868

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	May.	June.	July.
Anglo-Ecuadorian	15,852	17,386	18,168
Anglo-Persian	624,000	—	—
Apex Trinidad	47,700	44,130	42,870
Attock	1,233	1,135	1,106
British Burmah	4,854	4,810	4,819
British Controlled	36,488	31,155	27,773
Kern Mex.	873	808	835
Kern River (Cal.)	3,485	2,881	2,926
Kern Romana	156	172	126
Kern Trinidad	4,571	3,985	3,447
Lobitos	22,221	21,315	22,170
Phœnix	65,400	64,023	62,275
St. Helen's Petroleum	3,850	4,006	4,090
Steaua Romana	90,457	87,703	—
Tampico	2,442	2,220	2,292
Tocuyo	1,095	1,052	1,023
Trinidad Leaseholds	30,450	32,150	33,050

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	July 10, 1933.	Aug. 10, 1933.
	£ s. d.	£ s. d.
Anglo-Ecuadorian	14 0	14 0
Anglo-Egyptian B	1 10 0	1 8 9
Anglo-Persian 1st Pref.	1 10 0	1 10 0
,, ,, Ord.	2 2 6	2 1 3
Apex Trinidad (5s.)	1 6 0	1 4 6
Attock	10 9	12 6
British Burmah (8s.)	5 0	4 3
British Controlled ($5)	5 3	5 0
Burmah Oil	3 17 6	4 0 0
Kern River Cal. (10s.)	4 9	5 0
Lobitos, Peru	2 3 9	2 5 0
Mexican Eagle, Ord. (4 pesos)	8 0	9 3
,, ,, 8% Pref. (4 pesos)	9 0	9 6
Phœnix, Roumanian	12 9	12 3
Royal Dutch (100 fl.)	21 10 0	21 2 6
Shell Transport, Ord.	2 13 0	2 11 3
,, ,, 5% Pref. (£10)	11 12 6	11 10 0
Steaua Romana	12 0	12 0
Trinidad Leaseholds	2 16 9	2 13 9
United British of Trinidad (6s. 8d.)	5 0	5 0
V.O.C. Holding	1 17 6	1 15 0

PRICES OF CHEMICALS. Aug. 9.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.	1	0	9
,, ,, 80%	,,	1	18	5
,, ,, Glacial	per ton	59	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	1
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate (Mono- and Di-)	,,	58	0	0
,, Sulphate, 20·6% N.	,,	6	15	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	18	0	0
Barium, Carbonate (native), 94%	,,	4	10	0
,, Chloride	,,	10	0	0
Barytes	,,	8	5	0
Benzol, standard motor	per gal.		1	5
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	,,	16	10	0
Boric Acid	,,	26	10	0
Calcium Chloride, solid, 70/75%	,,	5	5	0
Carbolic Acid, crude 60's	per gal.		3	0½
,, ,, crystallized, 40°	per lb.			10½
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.			9½
Copper Sulphate	per ton	17	0	0
Creosote Oil (f.o.b. in Bulk)	per gal.			3½
Cresylic Acid, 98–100%	,,		1	4½
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine Resub. B.P. (28 lb. lots)	,,		14	11
Iron, Nitrate 80° Tw.	per ton	6	0	0
,, Sulphate	,,	1	12	6
Lead, Acetate, white	,,	31	10	0
,, Nitrate (ton lots)	,,	27	10	0
,, Oxide, Litharge	,,	28	0	0
,, White	,,	37	10	0
Lime, Acetate, brown	,,	9	10	0
,, ,, grey, 80%	,,	15	10	0
Magnesite, Calcined	,,	9	10	0
Magnesium Chloride	,,	6	10	0
,, Sulphate, comml.	,,	5	0	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	0
Nitric Acid, 80° Tw.	per ton	21	10	0
Oxalic Acid	per ton	47	15	0
Phosphoric Acid. (Conc. 1·750)	per lb.			10
Pine Oil	per cwt.	2	7	6
Potassium Bichromate	per lb.			5
,, Carbonate, 96/98%	per ton	30	0	0
,, Chlorate	per lb.			4½
,, Chloride, 80%	per ton	9	10	0
,, Ethyl Xanthate	per 100 kilos	7	8	0
,, Hydrate (Caustic) 88/90%	per ton	40	0	0
,, Nitrate	,,	30	0	0
,, Permanganate	per lb.			8½
,, Prussiate, Yellow	per ton	75	0	0
,, ,, Red	per lb.		2	0
,, Sulphate, 90%	per ton	10	10	0
Sodium Acetate	,,	22	5	0
,, Arsenate, 45%	,,	23	0	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			4
,, Carbonate (Soda Ash), 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	2	6
,, Chlorate	,,	32	0	0
,, Cyanide, 100% NaCN basis	per lb.			8
,, Ethyl Xanthate	per 100 kilos	7	0	0
,, Hydrate, 76/77%	per ton	14	0	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (refined)	,,	8	10	0
,, Phosphate, comml.	,,	12	0	0
,, Prussiate	per lb.			4½
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	3	3	6
,, Sulphide, Conc., 60/65%	,,	10	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	9	10	0
,, Roll	,,	9	10	0
Sulphuric Acid 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw.	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	4	0
Tartaric Acid	per lb.			11½
Turpentine	per ton	52	5	0
Tin Crystals	per lb.		1	0
Titanous Sulphate (Stabilized)	,,			9
Zinc Chloride	per ton	9	10	0
,, Dust, 90/92%	,,	20	0	0
,, Oxide (White Seal)	,,	35	0	0
,, Sulphate	,,	9	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	July 10, 1933. £ s. d.	Aug. 10, 1933. £ s. d.
SOUTH AFRICA:		
Brakpan	5 12 6	5 17 6
City Deep	1 6 3	1 9 3
Consolidated Main Reef	2 2 6	2 3 9
Crown Mines (10s.)	8 16 3	9 9 3
Daggafontein	4 2 6	4 13 9
Durban Roodepoort Deep (10s.)	1 16 3	2 0 9
East Geduld	5 12 6	6 5 0
East Rand Proprietary (10s.)	1 6 6	1 10 3
Geduld	6 7 6	6 16 3
Geldhenhuis Deep	1 6 3	1 8 9
Glynn's Lydenburg	1 0 0	1 9 3
Government Gold Mining Areas (5s.)	2 11 3	2 14 3
Grootvlei	3 2 6	3 18 9
Langlaagte Estate	1 7 6	1 7 9
Luipaard's Vlei (2s.)	10 3	11 0
Modderfontein, New (10s.)	3 5 0	3 5 0
Modderfontein B (5s.)	18 6	18 3
Modderfontein Deep (5s.)	17 6	17 0
Modderfontein East	3 3 9	3 1 3
New Kleinfontein	1 9 0	1 11 3
New State Areas	3 1 3	3 3 9
Nourse	2 0 9	2 4 3
Randfontein	2 10 9	2 15 3
Robinson Deep A (1s.)	12 6	13 9
" B (7s. 6d.)	1 12 6	1 13 0
Rose Deep	1 0 0	19 9
Simmer and Jack (2s. 6d.)	8 9	9 0
Springs	5 2 6	5 13 9
Sub Nigel (10s.)	8 11 3	9 4 3
Van Ryn	1 5 6	1 6 3
Van Ryn Deep	1 11 3	1 15 0
Village Deep (9s. 6d.)	1 3	1 3
West Rand Consolidated (10s.)	1 1 6	1 3 6
West Springs	1 9 3	1 10 6
Witwatersrand (Knights)	1 2 6	1 4 3
Witwatersrand Deep	1 5 6	1 7 6
RHODESIA:		
Cam and Motor	2 10 9	2 11 6
Globe and Phœnix (5s.)	1 0 0	19 0
Lonely Reef	9 6	9 6
Luiri Gold (5s.)	6	6
Rezende (17s. 6d.)	1 7 6	1 6 3
Sherwood Starr (5s.)	13 6	14 0
Wanderer	18 9	18 9
GOLD COAST:		
Ariston (2s. 6d.)	8 3	8 3
Ashanti (4s.)	2 9 9	2 8 3
Taquah and Abosso (4s.)	12 6	12 6
AUSTRALASIA:		
Associated Gold (4s.), W.A.	3 0	4 0
Boulder Perseverance	2 3	2 9
Golden Horseshoe (3s.), W.A.	3 6	4 6
Great Boulder Propriet'y (2s.), W.A.	8 9	9 9
Lake View and Star (4s.), W.A.	1 1 0	1 5 0
Sons of Gwalia (10s.), W.A.	1 6 0	1 18 9
South Kalgurli (10s.), W.A.	1 10 9	1 15 0
Waihi (5s.), N.Z.	18 6	19 3
Wiluna Gold, W.A.	2 8 6	2 16 0
INDIA:		
Champion Reef (10s.)	1 3 6	1 3 0
Mysore (10s.)	15 0	17 9
Nundydroog (10s.)	2 10 0	3 1 0
Ooregum (10s.)	6 9	9 0
AMERICA:		
Camp Bird (2s.), Colorado	8	8
Exploration (10s.)	3 6	3 6
Frontino and Bolivia, Colombia	1 8 0	1 13 0
Mexican Corporation (10s.), Mexico	8 0	8 6
New Goldfields of Venezuela (5s.)	7 6	8 0
St. John del Rey, Brazil	1 1 0	1 4 0
Santa Gertrudis, Mexico	6 3	13 6
Viborita (5s.), Colombia	4 0	4 6
MISCELLANEOUS:		
Chosen, Korea	15 6	16 3
New Guinea	5 0	6 3
COPPER:		
Bwana M'Kubwa (5s.), Rhodesia	6 0	5 6
Esperanza	6 3	6 3
Indian (2s.)	2 3	2 3
Loangwa (5s.), Rhodesia	1 7	2 0
Mason and Barry	15 6	18 0
Messina (5s.), Transvaal	12 0	10 6
Mount Lyell, Tasmania	17 6	17 9
Namaqua (£2), Cape Province	3 6	3 6
Rhodesia-Katanga	11 3	11 6
Rio Tinto (£5), Spain	20 15 0	21 2 6
Roan Antelope (5s.), Rhodesia	1 5 9	1 7 0
Tanganyika Concessions	16 6	15 0
Tharsis (£2), Spain	3 18 9	3 12 6

LEAD-ZINC:	July 10, 1933. £ s. d.	Aug. 10, 1933. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	8 3	8 3
Broken Hill Proprietary, N.S.W.	1 6 6	1 9 3
Broken Hill, North, N.S.W.	3 8 9	3 7 6
Broken Hill, South, N.S.W.	2 6 3	2 5 0
Burma Corporation (10 rupees)	13 9	13 6
Electrolytic Zinc Pref., Tasmania	1 4 3	1 4 3
Mount Isa, Queensland	8 6	8 9
Rhodesia Broken Hill (5s.)	2 0	1 9
San Francisco (10s.), Mexico	15 0	13 6
Sulphide Corporation (15s.), N.S.W.	8 0	7 9
ditto, Pref.	12 6	13 9
Trepca (5s.), Yugoslavia	14 0	13 6
Zinc Corporation (10s.), N.S.W.	1 3 9	1 7 6
ditto, Pref.	3 18 9	4 3 9
TIN:		
Aramayo Mines (25 fr.), Bolivia	18 9	18 9
Associated Tin (5s.), Nigeria	6 6	6 0
Ayer Hitam (5s.), Malay	14 3	14 0
Bangrin, Siam	19 0	18 0
Bisichi (10s.), Nigeria	7 9	7 6
Consolidated Tin Mines of Burma	4 9	5 0
East Pool (5s.), Cornwall	1 0	1 0
Ex-Lands Nigeria (2s.)	2 6	2 3
Geevor (10s.), Cornwall	7 3	7 6
Gopeng, Malay	1 13 9	1 11 3
Hongkong (5s.), Malay	14 3	13 6
Idris (5s.), Malay	6 0	5 6
Ipoh Dredging (10s.), Malay	1 3 9	1 2 6
Kaduna Prospectors (5s.), Nigeria	7 0	6 6
Kaduna Syndicate (5s.), Nigeria	15 6	15 0
Kamunting (5s.), Malay	9 3	8 9
Kepong, Malay	10 0	11 3
Kinta (5s.), Malay	6 9	7 0
Kinta Kellas (5s.), Malay	5 6	5 3
Kramat Pulai, Malay	1 0 6	1 0 0
Kramat Tin, Malay	1 10 0	1 10 0
Lahat, Malay	—	—
Malayan Tin Dredging (5s.)	1 3 3	1 1 3
Naraguta, Nigeria	10 0	10 0
Pahang Consolidated (5s.), Malay	7 0	7 0
Penawat ($1), Malay	2 0	2 0
Pengkalen (5s.), Malay	10 0	9 6
Petaling (2s. 4d.), Malay	12 9	12 0
Rambutan, Malay	5 0	5 0
Renong Dredging, Malay	1 3 9	1 0 6
Siamese Tin (5s.), Siam	18 0	16 6
South Crofty (5s.), Cornwall	3 6	3 6
Southern Malayan (5s.)	12 9	11 0
Southern Perak, Malay	1 8 9	1 6 9
Southern Tronoh (5s.), Malay	6 6	5 0
Sungei Besi (5s.), Malay	11 0	10 0
Sungei Kinta, Malay	11 9	10 6
Tanjong (5s.), Malay	7 0	7 3
Tavoy (4s.), Burma	6 0	5 3
Tekka, Malay	10 0	9 3
Tekka Taiping, Malay	10 9	8 9
Temoh, Malay	15 9	15 0
Toyo (2s. 6d.), Japan	3 0	4 0
Tronoh (5s.), Malay	17 0	16 0
DIAMONDS:		
Consol. African Selection Trust (5s.)	1 7 6	1 10 6
Consolidated of S.W.A. (10s.)	6 3	6 0
De Beers Deferred (£2 10s.)	6 10 0	6 10 0
Jagersfontein	1 9 6	1 10 0
Premier Preferred (5s.)	2 0 0	1 15 0
FINANCE, ETC.:		
Anglo American Corporation (10s.)	18 6	19 9
Anglo-Continental (10s.)	5 0	4 6
Anglo-French Exploration	1 3 0	1 6 9
Anglo-Oriental (5s.)	7 3	7 0
ditto, Pref.	15 3	15 0
British South Africa (15s.)	1 2 3	1 1 9
Central Mining (£8)	16 15 0	17 18 9
Consolidated Gold Fields	3 7 6	3 15 0
Consolidated Mines Selection (10s.)	11 6	15 3
Fanti Consols (8s.)	11 3	11 3
General Mining and Finance	2 3 6	2 9 3
Gold Fields Rhodesian (10s.)	7 3	8 9
Johannesburg Consolidated	2 9 6	2 15 9
London Tin Corporation (10s.)	13 6	12 6
Minerals Separation	4 7 6	4 10 0
Mining Trust	4 9	4 9
National Mining (8s.)	9	—
Rand Mines (5s.)	5 12 6	6 0 9
Rand Selection (5s.)	15 0	17 0
Rhodesian Anglo American (10s.)	17 6	17 0
Rhodesian Selection Trust (5s.)	10 9	12 9
Rhokana Corp.	6 15 0	6 15 0
Tigon (5s.)	3 9	3 3
Union Corporation (12s. 6d.)	4 13 9	5 0 0
Venture Trust (6s. 8d.)	8 0	9 9

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 WORLD PETROLEUM CONGRESS

The World Petroleum Congress, held under the auspices of the Institution of Petroleum Technologists in London last month, was the occasion for the presentation of a number of papers dealing with various aspects of petroleum technology. Some of these will be of interest to the general reader and summaries of several papers of this character are presented in what follows.

Oil-Field Distribution.—Professor V. C. Illing, concluding a paper on "The Fundamental Principles Governing the Distribution of Oil-Fields," says: The basic conceptions put forward in this discussion of an interesting but elusive problem are that, in the main, there are three broad groups of problems which decide the distribution of oil-pools. The first is the source rock which limits the general area in which oil can be found. The second is the reservoir rock conditions which determine where the oil can be accumulated in commercial quantities and the last is the preservation of the oil from the incidence of denudation which is readily able to disperse an oil accumulation. The relative importance of these three factors varies considerably, but it may be claimed with confidence that the importance of the third factor becomes greater with the age of the oil accumulation and that for this reason the older oil-pools are less widespread than those of the Upper Mesozoic and Tertiary rocks.

Unit Development of Oil-Fields.—Dr. J. B. Umpleby, summarizing his paper on the "Unit Development of Oil-Fields," says: Unit operation of oil-pools is a means to an end and not an end in itself. Its object is to produce more oil from each acre at less cost per barrel. Only through the operating of pools as single natural units can greatest use be made of the energy stored in the reservoir in producing oil. This energy once dissipated cannot be restored. Efficient development calls for a careful prospecting of reservoir conditions in order to determine the best distribution and density of wells. Development plans must be subject to modification as new information is acquired. This cannot be done under divided competitive ownership. Best operation calls for the least consumption of reservoir energy per barrel of oil produced, the least possible wastage of gas, the recycling of excess gas or even the introduction of gas from extraneous sources, and freedom of choice in selecting wells for production and pressure maintenance. Gas should not be marketed until oil production has ceased to be profitable. These things cannot be accomplished under divided competitive ownership.

Efforts toward unit development should be directed towards new areas rather than towards old fields. Legal recognition of acreage content as the basis of ownership and of reservoir energy as a common attribute of a pool to be used to a maximum in producing oil would remove the chief difficulties confronting unitization efforts. It is believed that with these two points covered and a law requiring that drilling permits for wild-cat wells be granted only on unitized blocks, it would be feasible to leave the details of unit formation to the leases and royalty owners. Agreements might take many forms and yet serve the major purpose.

Unitization may be accomplished theoretically, either by voluntary agreement or under compulsory regulation. It is concluded that, from a practical standpoint, elements of compulsion are necessary. The advantages of unitization to all interested parties, including the general public, and the intricacies, injustices, and wastefulness of current practices, are believed to justify and make feasible the necessary application of the police power to bring it about.

Well Location.—Dr. J. Versluys discussed the "Principles Governing the Location of Wells with Respect to the Structure," the following summarizing his conclusions: The writer gives in a condensed form his principles concerning the locations recommended for wells with respect to the structure. These principles are based on the author's conception of the effects of the various sources of energy available in an oil-field. The phenomena which cause production are mainly "depletion," "general motion," and drainage by "the direct action of gravity on the oil."

Invasion by oil of that portion of the structure which was originally occupied by gas has to be avoided as much as possible because only part of the oil which enters the gas cap can be recovered. For this reason care should be taken not to tap gas from the gas cap in the first stage of the producing life of a field. When, however, pressure has dropped in the field on account of production, conservation of the gas in the gas cap need not be made a hard-and-fast rule.

Parts of the field which have been drained by depletion and by the direct action of gravity have yielded only a small percentage of their oil and more oil can still be recovered if water is admitted afterwards, and preferably slowly.

The general motion causes the gas cap to expand and the edge-water to encroach. Their edges advance the more regularly the more evenly the wells are distributed around the crest, as they are farther away from these edges, and produced more gently, and as their number is greater. The old practice of stepping out in a zigzag line on one side of a structure should be abandoned. The most favourable method of developing an oil-field would be to drill one or two rows of wells on one or two contours in the oil, so that they should not be invaded too soon by edge-water or by gas from the gas cap. Considered from a merely theoretical

standpoint such wells should be drilled very closely and opened all at the same time, but for various reasons this is not commercially feasible. The structure should, therefore, be encircled with wells as soon as possible, so that it is better to space them widely in order to establish drainage within a short time on all sides with the available drilling strings. If necessary, intermediate wells on the same contours can be drilled later on.

As more oil can be set free from the sand when it is invaded by water than when it is depleted or invaded by gas, it may, in many cases, be tried whether it pays to recover the oil which remains in the sand up-dip of the original wells, after these wells have gone to water—*i.e.*, by drilling crestal stripping wells.

There are fields in which the edge-water encroaches so slowly as to be negligible and such fields could be drained by wells on the periphery. When the limit of economic production of these wells is reached, artificial flooding from the periphery and production through crestal wells may be profitable. All measures to ensure regular transgression of the edges of the edge-water and the gas cap become more urgent as the structure becomes flatter. In certain cases injection of gas at the crest may be useful, when the edge-water pushes the oil to the crest, in order to prevent the oil from penetrating the original gas cap and from being trapped in secondary domes and noses.

Surface Petroleum Showings.—The economic value of surface petroleum manifestations was discussed by A. Beeby Thompson, who in his paper endeavours to assess the value of petroleum manifestations as indicators of oil-fields of economic importance. The author claims that surface indications of oil are inevitable, if there is a rich concentration of oil or gas at depths within 1,000 to 3,000 ft., and that failure to discover "shows" of some kind is due to the present incomplete knowledge of all the phenomena associated with oil-field leakage. It is submitted that relief of pressure will alone account for the close relationship between observed pressures and those due to a hydrostatic level based upon present-day levels. Had fossil pressures been preserved gas pressures more nearly representing those of deep fields would be expected at shallow depths.

Various aspects of migration are discussed and the relative importance of direct evidences of oil is considered.

Geophysical Methods.—In the geophysical section a paper by Oscar Weiss was presented entitled "The Limitations of Geophysical Methods and the New Possibilities opened up by an Electro-Chemical Method for Determining Geological Formations at Great Depths." The paper dealt generally with the standard methods of geophysical survey, drawing attention to their several advantages and disadvantages. An outline was then given of a newly-developed electrical method, based on the simultaneous measurement of an input current and the resultant polarization current set up at the junction of two beds of different composition. These currents are separately recorded by galvonometers on a moving film against time marks accurate to 10th seconds. From an analysis of these records in terms of the time factor for different electrode spacings, determinations can be made as to the depth of the various formation junctions.

The important features of the new method are :

(*a*) An electrical method dependent not on conductivity, but on the chemical composition of the strata.

(*b*) Records can be obtained up to depths of 6,000 ft. with an imput current of only 1—2 watts.

(*c*) The screening effect which limited the older methods in many cases is almost entirely eliminated.

Aneroid Measurements.—Before the section dealing with modern developments in geological exploration Dr. T. Sutton Bowman discussed the use of the aneroid barometer in reconnaissance work, relating his experience while engaged on professional work in Nepal. The author concludes that :

1. The aneroid barometer can be used with some precision for the determination of local differences of height in tropical and sub-tropical countries if proper precautions are taken in the observations and computations.

2. In steep broken country, providing appreciable differences of height and vertical angles between points, differences of height determined by the aneroid can be combined with vertical angles obtained with an Abney level to measure horizontal distances for the control of sketch mapping.

3. The usefulness of this method is confined to steep broken country in the tropics or subtropics and is limited to the control of isolated sketch mapping or to the filling in of rough detail within a more rigid frame-work. The errors involved are too great to permit of extended work without further control.

4. The errors involved are of the order of those obtained with an infantry pattern range-finder. At all but short ranges the bulk of this error is due to errors in the measurement of the vertical angles, and not to errors in determination of the heights by the aneroid.

5. The advantages of the method are that it permits a single-handed explorer to construct fairly accurate sketch maps quickly, with no necessity for base measurement, bulky instruments, assistants as staff-holders, etc.

6. The advantages to the exploring geologist are that it permits him to make sufficiently accurate sketch maps with instruments likely to be carried as part of his normal field kit, single-handed, and without occupying too much of his time visiting points for survey purposes which are of little interest geologically.

7. The advantages to the military officer making a leisurely reconnaissance are that he can carry out fairly accurate sketch mapping single-handed and unobtrusively.

8. The method possesses advantages over the use of an infantry pattern range-finder in the matter of bulk of instruments, and the fact that errors do not increase rapidly with the range. The range-finder is superior in showing much lower linear errors at small ranges, and its applicability to country of low relief (to which the present method is quite unsuited), in its applicability to any latitude or climate, and in permitting ranges to be taken without the necessity of visiting any other points.

9. The method is therefore put forward as an emergency method of fair accuracy, or as an alternative to the use of the range-finder when the latter is not available or cannot be used conveniently.

10. Nothing in the discussion of the accuracy of aneroid heights in this paper has any reference to the determination of considerable heights by the comparatively rapid ascent of mountains.

MINE TIMBER PRESERVATION

In the July issue of the *Canadian Mining and Metallurgical Bulletin* the subject of the preservation of mine timber is revived by B. M. Winegar. The author, after some general remarks, goes on to say that there is a deplorable lack of accurate data on the real cause of failure of mine timbers. Decayed timber in mines means recurring replacement costs, interference with operation, and the creation of an unnecessary fire hazard. Generally speaking, the deeper the mine, the more susceptible is the timber to decay and, also, the more expensive it is to replace. At a temperature of 75 to 90° Fahrenheit and in a humid atmosphere decay is rapid, for this condition is ideal for the growth of wood-destroying fungi.

Decay in timber, however, is not peculiar to underground workings of mines. It occurs in mills, factories, round-houses, etc., where a humid condition exists, in spite of proper ventilation systems. However, in timber installations underground, even under the most up-to-date methods of ventilation, conditions for breeding of spores are much more favourable than in surface structures.

Preservation of timber has as its goal the protection of timber from decay, until worn out by mechanical action. Timber preservation is the art of protecting timber from fungi and insect attack and the principle on which this science is built is the poisoning of the food supply of wood-destroying fungi. The United States Bureau of Mines states that a great many tests have been made to determine how preservative treatment affects the strength of structural timber. These tests have shown that, when properly used, wood preservation does not affect the strength appreciably.

The practice of timber preservation, with a history of about 100 years in Great Britain and half that time in the United States, is comparatively new in Canada, as they have been treating timber for less than 25 years, but, as in Great Britain and the United States, a very large percentage of the timber treated in Canada is used by the railways and it is to their records that one must go for data. In the United States, in 1929, there was treated 113% more mine timber than in 1928. This compares with an increase of only 8% in timber treated for all purposes to which it is put.

In selecting treating agents, Geo. M. Hunt, timber treating authority of the United States Government, says: "As a general rule, it may be said that very few, if any, proprietary preservatives are better or more generally satisfactory in their respective classes than straight coal-tar creosote and zinc chloride." The present paper does not attempt to stress the advantages of using treated timber from the point of view of fire protection, but it has been definitely proved that treated timber creates far less of a fire hazard than does untreated timber. In Bulletin No. 235 of the United States Bureau of Mines the following statement is made: "Preservatives not only increase the life of the wood, but reduce the danger from fire by keeping the wood sound. Sound wood is harder to ignite than partly decayed wood and will withstand flames a longer time without failure. The saving in labour charges for replacing decayed timber greatly favours the use of treated timber, because decaying timber is liable to sudden brash failure, it constitutes a greater accident liability than sound timber."

Of the enormous quantities of timber consumed annually in mine maintenance, it may be safely estimated that 15% of that used underground is in more or less permanent openings and this timber is largely destroyed by decay. Experience has shown that about three years is the average life of such timbers, but even timber in locations such as these lasts less than two years in some instances. If it be assumed that the shaft gives a service of 15 years, then the timber in the passage-ways will have to be renewed from four to six times after original installation. Therefore, it may be said that the advantages incident to the use of treated timber are the assurance of uniformly low timber maintenance charges over a very considerable number of years, as well as freedom from frequent repairs and renewals attendant upon the use of untreated wood in construction of this sort.

Economics of Treated Timber.—For purposes of this discussion the life of treated timber will be assumed to be 15 years. It is interesting to note, however, that actual service records indicate a life of 25 years and over. Let us assume that the untreated timber will have a life of three years. Then five installations will be required during the 15-year period. Let us also assume that the first installation of untreated timber costs $57·00 per M.F.B.M. The second, third, fourth, and fifth installations will each require an additional $13 00 per M.F.B.M. for the removal of the decayed timber, making a total of $70. The mean of the five installations will thus be $67 40 per M.F.B.M. On the basis of a three-year life this is equivalent to an annual charge of $25·21 per M.F.B.M. This figure is computed by employing the "A.R.E.A." (American Railroad Engineering Association) formula:

$$A = \frac{P(1r)^n r}{(1r)^n 1}$$

in which A = Annual charge, P = Amount of initial investment, n = Number of years in the recurring period (the average life of the timber), and r = the rate of interest expressed as a decimal. Interest in this case is taken at 6% per annum.

If we take the installed treated timber at $77·00 per M.F.B.M., then, on the basis of the annual charge formula given above and assuming a life of 15 years, the annual cost of the treated timber is $7·93 per M.F.B.M. Therefore, treated timber will show an annual saving of $17·28 ($25 21 minus $7·93). If the annual consumption of untreated timbers, which are used in permanent workings of an average mine, is taken as 1,300,000 F.B.M. the aggregate saving per annum effected by resorting to wood preservation is $22,464; whilst, for the 15-year period, a grand total saving of $336,960 will be realized by using treated timber.

There are several other important advantages incident to the use of treated timber, which should not be overlooked. There is the assurance of uniformly reduced mine timbering costs over a very considerable period of years, as well as the avoidance of the costly and hazardous renewals necessary, at comparatively frequent intervals, where untreated timber is employed in permanent workings under conditions that are conducive to decay.

Then, again, these renewals, so costly and annoying in themselves, reduce the efficiency of the mine operations and net returns over any period. Moreover, it should not be overlooked that prices obtaining for untreated timber are the lowest in

years and are generally conceded to be at rock-bottom, more particularly as stocks on hand are practically negligible, so that in all likelihood such replacements as will become necessary will cost considerably more than we have assumed in our calculations, resulting in greatly increased economies being effected by using treated timber.

A point that is of great interest to the mining engineer is how long treated timber will have to last in his mine to justify its use. Knowing the cost of the untreated timber in place as well as the life to be obtained from untreated wood, then, if we have the cost of installed treated mine timbers, the number of years that these treated timbers must last, if wood preservation is to pay for itself, can very easily be determined by reference to the A.R.E.A. formula. For instance, we have calculated above that the annual cost of untreated timber is $25·21, on the basis of three years' life. Now if, for instance, timber treated with zinc chloride costs $77·00 per M.F.B.M. installed, a life of four years would obviously justify its use. As a matter of fact, we are conservative in assuming a life of 15 years. Hence the economy to be anticipated from using treated timber in permanent workings is very striking indeed.

For underground purposes, shaft and slope timbers, draft sets, mine ties, timber used in rises and winzes, ore-pockets and bins, and head-frames—in fact, all timber going into what might be called permanent locations—should be treated. It has been found economical to use treated timber in sills, ground-floor joists, and other lumber which comes in contact with the ground, which is used in surface houses, store-houses, etc. It has also been suggested that it is advisable to treat all exposed timbers.

Timber to be treated should be dapped, bored, and framed before going into the treating cylinders. This ensures complete protection from decay at points of contact. The value of treated timber is largely lost if untreated zones are exposed to the action of fungi. In case it is necessary to cut through treated timber, the exposed parts should be swabbed thoroughly with three applications of hot creosote oil.

The cost of maintaining timber underground varies in different mines, no two mines having exactly the same problems to meet. When timber replacements interfere with mine operation, the cost of mining is increased. Permanence in timber lowers operating expenses. Losses sustained and risks incurred because of decayed timber are well worth studying by the mining engineering profession.

DIAMOND DRILLING AT MOUNT ISA

Diamond-drilling practice as carried out at Mount Isa, Queensland, is described by R. Pitman Hooper in the *Proceedings* of the Australasian Institute of Mining and Metallurgy, N.S. No. 88, 1932. The author records that the Black Star lead, silver, and zinc ore-bodies, situated in the western zone of mineralization at Mount Isa, occupy an area 2,000 ft. long, with varying widths from 100 ft. to 300 ft. The strike is N. 5° W. and the average dip 60° west. To test the potentialities of this area at depth an extensive diamond-drilling campaign was commenced on October 16, 1927. It was continued, with from one to six machines working, until the end of 1931. During this period 26 inclined holes, with an average depth of 1,224 ft. and a total footage of 31,828 ft., were completed. A vertical hole, 2,452 ft. deep, for comparative purposes, has been omitted.

Plant and Operating Details.—*Drilling Machines.*—Standard Sullivan "C" type, with a capacity of 2,000 ft. of $1\frac{3}{16}$-in. hole and retaining a $1\frac{1}{8}$-in. core, and one "N" type, with a capacity of 2,500 ft. of $2\frac{3}{16}$-in. hole retaining a 2-in. core. "N"-size holes were used only for the first 50–100 ft. (and on one occasion for 500 ft.), in order to permit the bore-hole to be cased at the surface. Otherwise all bore-holes were "A" size, with a maximum depth of 2,000 ft. The "N" machine was used on two holes (1 D and vertical hole) only.

Boiler.—Marshall portable horizontal tubular type, developing 8 h.p., with a working pressure of 100 lb. For holes over 1,000 ft. deep and when using the "N" machine two of these were used. Insulation around the outside of the boiler consisted of ant bed—*i.e.*, red clay, packed on a wire framing.

Pump.—Gardner Denver, 6–3–6, steam-driven, Duplex type, delivering 2,000 gal. per hour at a working pressure of 100 lb.

Fuel.—Wood (local hardwoods as Mountain or Snapping Gum at 32s. per cord). Consumption averaged $\frac{1}{4}$-cord per 8-hour shift, or ·07 cords per ft. drilled.

Operating Details.—When possible drills were operated on a theee-shift dav for six days per week but, owing to a scarcity of drill-runners, the first holes were drilled on a one or two-shift basis until four drillers could be locally trained. Considerable drilling time was lost when on this basis on account of the time (1–$1\frac{1}{2}$ hours) taken in raising steam every morning. Each shift consisted of a drill-runner and one helper, who also attended the boiler. One drill-foreman overseered one to two drills and set his own bits. All mino. repairs such as replacing boiler fire-bars, repacking glands, necessary pipe work, erection and dismantling of derricks, etc., were performed by these men. Further lost time was occasioned in the early stages by bad boiler water. Scale formed rapidly on the boiler plates at the fire-box end, necessitating the removal, cleaning, and refitting of boiler tubes on an average once every eight weeks. This operation usually occupied four shifts. No satisfactory simple method was evolved to overcome this formation of scale until better water was obtained from the Rifle Creek storage dam. Fracture zones requiring two or three cementings also caused delay.

Drilling Practice.—Routine drilling was carried out—

(*a*) In medium to hard ground with a normal eight-stone (four inside and four outside) bit.

(*b*) In very hard ground with the normal bit backed by one to six reamer stones. In some cherty ground it was found difficult to maintain the correct gauge without these extra stones.

(*c*) In soft to hard pebbly ground with a double-tube core-barrel (rigid type) and a normal bit. The double-tube core-barrel of this type very effectively clears hard pebbles from the core shell and thus prevents wedging of tools. Considerable trouble was experienced with these hard irregular pebbles.

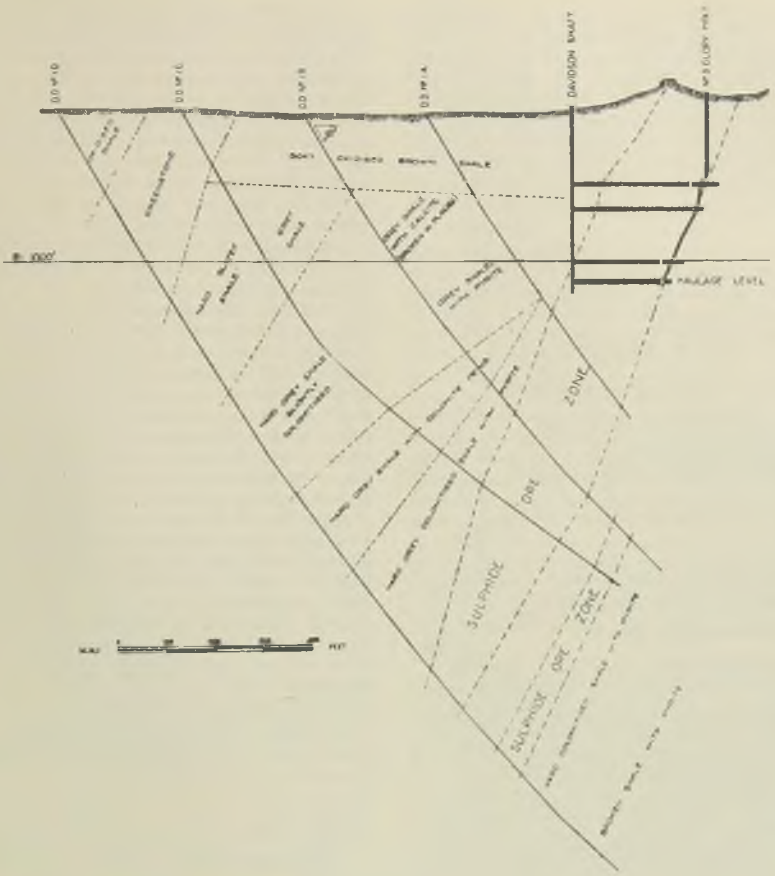


FIG. 1.—CROSS-SECTION THROUGH THE DAVIDSON SHAFT, SHOWING DRILL LAYOUT.

(*d*) In variable, but not caving ground, with two 8-ft. stiffener rods above the core-barrel. In variable ground the main problem was deflection of holes. The stiffener rods help to prevent it.

The life of a bit was very variable and an average difficult to determine, so that the following data must be considered to be only approximate. The greatest footage drilled by one bit without resetting was 200 ft. and the least 1 ft. This will demonstrate the wide variation in the drilling ground at Mount Isa—but 40 ft. per bit was considered to be an average life without undue reaming for the following bit. A bit set with 64 small "finehead" white diamonds was tested out but was found to rapidly lose its gauge, causing an undue amount of reaming before the next bit could start at the bottom of the hole. The bit in question had lost its gauge both inside and outside after 29 ft. of drilling through normal grey shales and was not used again.

Drilling Speeds.—As it was considered that contract drilling would not give the best results in core recovery and straight holes in ground as at Mount Isa, all drilling was done on a wages basis. The average per drill shift (3·6 ft.) and for every 100 ft., with a generalized classification of ground passed through, is shown in Table 1. These figures include time taken on account of any necessary running repairs, raising steam, fishing for tools, placing of casing, etc., but do not include time of erection or dismantling of plant. In making any comparisons this drilling speed may seem low, therefore the following factors are emphasized :—

(1) Maximum core recovery was required for every foot of drilling. Lack of knowledge of geological structures and relationships prevented rapid drilling (with low or no core recovery) to a certain horizon, followed by a maximum core recovery over the ore zones only.

(2) Persistent interlocking of hard wedge-shaped pieces of core in the core-barrel caused frequent pulls to prevent loss of core.

Carbons and Carbon Losses.—Data on these are incomplete, but are sufficient to quote as averages. The normal bit of eight stones averages 7·98 metric carats, with a value of £170. The smallest bit stone was 0·20 m.c., the largest 2·63 m.c., with an average of 0·80 m.c. A number of the smaller stones were used for reaming purposes. Carbon consumption averaged 0·0039 m.c.—*i.e.*, a cost of 1s. 6·75d. per ft. drilled. No full bits were lost during the whole campaign, but one jammed bit took 70 shifts to recover. On several occasions single small stones were lost or splintered, but losses from this source were not great.

Problem of Deflection.—All drilling was carried out at an inclination from 60° to 70° east, against

strata dipping 50°–60° west. All deflections (registered at 100 to 200 ft. intervals) with the exception of four cases were upwards. The downward deflections per 100 ft. in no case exceeded 1° and the maximum upward deflection was 13½°. The latter was serious, but only occurred on two occasions, one of which was corrected and in the other case the hole was redrilled at a higher inclination. The average deflection was 1¼° per 100 ft.

TABLE 1.

" A " line of Holes (13). *Rock Type.*	*Drilling Speeds Feet per Shift (2 men).*
Oxidized soft brown shales	6·3
Soft oxidized shales to unaltered grey shales	4·8
Hard grey shales with calcite and pyrite broken in places	5·3
Hard grey shales with pyrite bands to soft decomposing shales	4·2
Hard grey shales with pyrite to soft grey mudstone	4·4
Hard and soft grey shales with sulphide ore	3·4
" " " "	3·7
Soft grey shales slightly mineralized	3·6
Mineralized shales with fine-grained pyrite	2·9
" B " line of Holes (7).	
Oxidized soft brown shales	5·6
Soft oxidized shales with pyrite—broken in places	5·3
Soft grey shales—broken in places	4·5
" " " "	4·4
Soft grey shales—broken in places, slightly dolomitized	4·0
Harder shales with pyrite—slightly dolomitized	4·2
Dolomitized hard shales with pyrite	4·0
Grey shales (hard and soft) with sulphide ore	4·2
Grey shales to mineralized grey shales—sulphide ore bands	4·5
Mineralized grey shales	4·0
Hard grey shales with pyrite	3·7
Hard grey shales—slightly dolomitized and pyritic	3·3
" C " line of Holes (6).	
Decomposed greenstone schist	7·3
Hard grey shales with calcite stringers	3·6
Hard grey shales broken in places	4·0
Hard grey shales and mudstones to dolomitized shales.	4·2
Slightly dolomitized shales—broken in places	3·6
Hard dolomitized shales	3·8
Silicified and dolomitized shales	3·7
" " "	3·8
Hard silicified shales	3·7
Soft grey shales with sulphide ore and pyrite	3·4
Soft mudstones with sulphide ore	3·6
Mudstones to hard black slaty shales—sulphide ore bands	4·2
Dolomitized shales—broken in places	4·0
Hard grey shales with pyrite and sulphide ore seams	3·8
Hard grey silicified shales	3·4
Hard grey shales with sulphide ore bands	3·2

In routine drilling every endeavour was made to prevent excessive deflection by—

(*a*) Keeping carbons in bits true to gauge. This meant frequent changes of bits.

(*b*) Replacing worn core-barrels.

(*c*) Where possible using two 8-ft. stiffener rods at the back of the core-barrel. These rods were not used where any caving of hole might occur, as the rollers wedge easily.

(*d*) Working on wages so as to prevent any undue forcing of drills.

(*e*) Using a six-stone reamer set, in addition to normal bit, to ensure hole maintaining correct size in very hard ground.

METHOD OF STRAIGHTENING A DEFLECTED HOLE.—In drilling No. 8 C bore-hole a serious upward deflection, totalling 13½°, occurred between 300 and 500 ft. Similar trouble had been experienced in other holes—*e.g.*, No. 5 C was abandoned after drilling 476 ft.—and was probably due to fractured zones in the shales. In the case of No. 8 C bore-hole it was determined that some effort should be made to straighten the hole before abandoning it. The following scheme was advanced and carried out by Mr. H. Vale, the diamond drilling foreman and, as far as is known, has not been demonstrated on any previous occasion. Briefly, the idea was that if a 50-ft. " E " line of tools ($1\frac{9}{16}$ in. diam.) were suspended from an " A " line of rods ($1\frac{13}{16}$ in. diam.) in an inclined " A " hole, the " E " bit would bore on the bottom side of the " A " hole, and so give a certain amount of downward deflection (Fig. 2). This idea was successfully put into practice as follows :—

The hole was filled with concrete (three parts coarse sand to one part quick-setting cement)

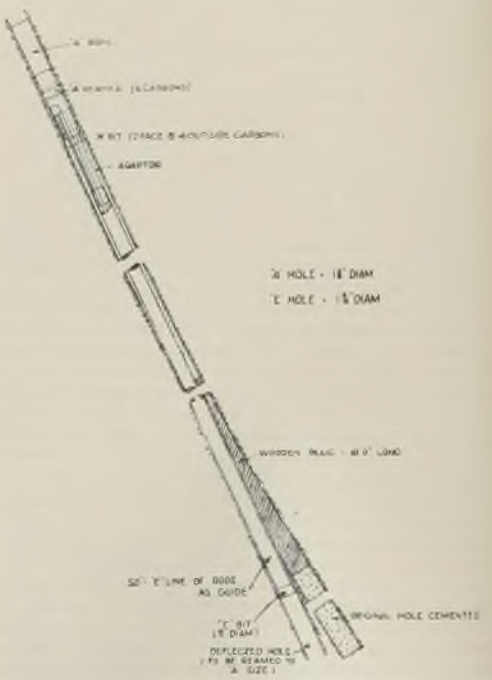


FIG. 2.—DIAGRAM SHOWING METHOD OF DEFLECTING INCLINED BORE-HOLES.

to 300 ft., where the dip of the hole had been determined by survey to be normal. The concrete was rammed down and a 4-ft. hardwood stick (1¾ in. diam.) pressed in place on top of it. A further small quantity of cement was then added to ensure that the stick would be firmly embedded in the hole. The concrete was allowed to set for 16 hours.

Drilling was commenced, using a very light feed and with 40 ft. of " E " rods, core-barrel, and bit on the end of the " A " line of rods. At 4 ft. the core showed that the bit had bored ⅞ in. into the shale. At 10 ft. the bit had passed out of the shale again and back into the concrete in the original hole. A 10-ft. stick was then substituted for the 4-ft. length and drilling recommenced. It was estimated that at the end of the 10 ft. the " E " bit would have passed entirely out of the original hole into the shales and so would not be deflected back by drilling into portions of the concrete. This proved to be correct. Drilling of the new " E " hole was continued to 70 ft. The hole was then reamed down from 50 ft. above to 70 ft. below the wood, using a six-carbon " A " reamer and an " A " bit (set with four outside and two face carbons); " E " rods, screwed to a special fitting, acted as guides in front of the reamers (Fig. 2). This reaming ensured a smooth curve into the new hole. Drilling was continued from this point with a normal line of " A " tools. No further hindrance or undue deflection was experienced and this hole was continued to a depth of 1,700 ft.

The surveys shown in Table 2 confirmed expectations as to dip and an examination of the core showed by the angle of the shale bands with line of the core that the general line of the hole had been maintained. This method is not advanced as infallible, as it has only been tried once. It might also be added that a similar attempt to straighten the hole, without the use of the wooden plug on top of the cement, was unsuccessful.

TABLE 2.

SURVEYS.

Original Hole.		*New Hole.*	
Depth.	Dip.	Depth.	Dip.
300	67 degrees	360	65 degrees
350	65 ,,	370	63½ ,,
380	61½ ,,	400	63½ ,,
400	61 ,,	450	63½ ,,
500	53½ ,,	500	61 ,,
560	51½ ,,	550	59½ ,,

Surveying of Bore-Hole (by the hydrofluoric acid-etched line on glass method).—Dip surveys were carried out at 100- to 200-ft. intervals or, in some cases of extreme deflection, at closer intervals. Direction surveys, using the Mass compass, were attempted, but met with indifferent success. They were therefore discontinued as everything indicated that the holes were running approximately true to direction.

The survey instrument, which presents no unusual features, was simply a strongly made brass container which screwed into the end of the core-barrel. Into the container was fitted a 6-in. glass tube, one-third filled with hydrofluoric acid (strength 1 commercial acid to 3 water) and stopped both ends with flush rubber corks. The outside diameter of the tube was 1 in. and the inside of the container 1⅛ in. The instrument was lowered on the end of the line of rods to the required depth and left for 1 to 1½ hours, according to the depth of the hole. In the deeper holes the longer period was necessary, so that the acid-etched line on the glass tube would be sufficiently deep to prevent obliteration by the splashing of the remaining acid as the rods were withdrawn, an operation which took up to one hour to perform. The actual carrying out of the dip survey was performed either by the foreman or the sampler, but the reading of the different dip-angles in the goniometer was done by the engineer.

Owing to the capillary attraction of the acid upon the glass tube being uneven in an inclined glass tube, a correction has to be applied to the reading of the dip as obtained in the goniometer. This correction will vary with the type of glass used and should be determined for each batch of glass containers. The correction graph used at Mount Isa is illustrated in Fig. 3. Data for the plotting of this graph was obtained by fastening the brass container on a suitable board mounting which could be inclined at known angles. The glass tube filled with acid was then inserted into the container and the normal routine of taking the survey followed. The difference in degrees between the angle as read on the goniometer and the angle of the brass container giving the correction. The angles were read in the goniometer twice—once with the glass inclined to the right, then reversed and inclined to the left. The mean was taken as correct.

Bore-Hole Sampling.—This did not present any great difficulties at Mount Isa. Mineralization consists of stringers and bands of sulphides of lead, silver, zinc, and iron in soft grey shales, with an occasional hard cherty band, 3 in. to 12 in. wide. In some cases leaching has removed much of the soft shale and destroyed its cohesion, but to all appearances has not materially affected the lead sulphides. Minor puckering and folding caused local enrichments and greater care was then required in selecting the direction in which the core is to be split.

Core recovery in ore-zones varied from 10 to 25% in certain leached and fractured areas to 98% in the harder footwall zones, but 70% is a general average. In areas of low core-recovery the tools were pulled frequently, in some cases for every foot of drilling. Core-splitting was done by a sampler, who acted at the direction of the examining engineer. Samples started 5 ft. outside of the commencement of the zone of sulphide ore and were taken at 5-ft. intervals. As the boundaries of ore-mineralization were not very marked it was not often that it was necessary to split a 5-ft. sample to define an exact wall of an ore-body. One-half of the split core was sent to the assay office for lead, silver, zinc, iron, specific gravity, or other determinations, and the other was packed into core-boxes for further geological study and reference. The actual length of core, representing 5 ft. of bore-hole, was recorded in the sample book, and from this the core recovery was calculated.

Core-splitting was done by hand. The apparatus consisted of an 8-in. length of 2-in. angle-iron hinged on one side to a 9-in. by 4-in. by ¾-in. steel block. The ends of the angle-iron were closed with ⅛-in. plate, so that a piece of core placed in a groove on the block was completely enclosed. A 3-in. broad chisel inserted into a slot in the back of the angle and hit with a hammer split the core into two pieces.

Sludge samples were taken over all mineralized zones in 5-ft. sections, corresponding as far as possible to the core samples. The sludges were collected in galvanized iron troughs, 6 ft. long, 1 ft. 3 in. wide, by 1 ft. 3 in. deep, with three baffle-plates to assist settling. After settling and decantation of surplus water the sample was washed into a sample tin and taken to the assay office. The drilling crew was found to be able to perform this duty satisfactorily. The assays from these samples, when compared to core assays, were not very reliable and were generally on the low side. Their inaccuracy was probably due to the presence of small fractured zones, through which the bore-hole passed before entering the ore-bodies. These would, when not smoothly cemented, act as collectors of the heavy sulphide ores. However, as it would be necessary to completely case the bore-hole to avoid this loss, the expense was not considered to be warranted. An attempt was made to graph the difference between sludge and core assays and the core recovery, but no definite information could be obtained.

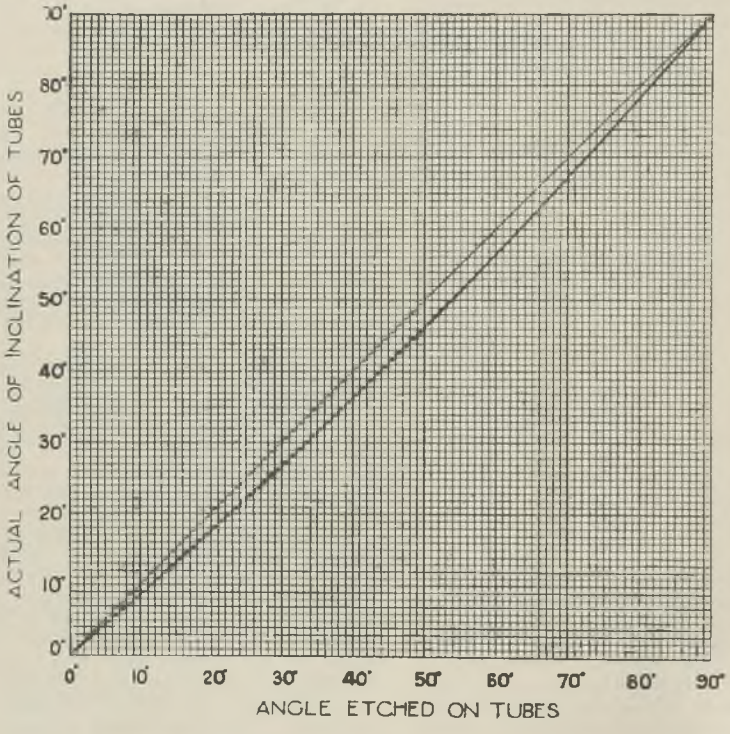
Recording of Bore-Hole Data.—A 30-in. to 1-in. section was drawn, showing drill and surface contour, and on it were recorded in their correct positions—

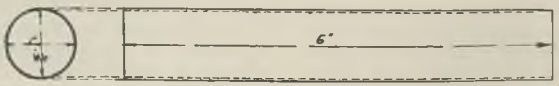
(*a*) On one side of the drill all geological details.

(*b*) On the other side all assays, both core and sludge, and corresponding core recoveries, with averages.

(*c*) Dip determinations.

CURVE FOR CORRECTION
FOR
ERROR DUE TO CAPILLARITY IN TESTING DIAMOND DRILL
— CURVE FOR TUBES. —





— TUBE —
(OPEN AT EACH END)

Fig. 3.

In addition, the survey co-ordinates and reduced level of the collar, starting and finishing dates, names, etc., were also recorded.

This section was traced and any number of copies giving complete information printed when required. A copy of the drilling log with geological information and core-recovery assays was also typed and filed. For convenience in averaging and for various calculations all assays were entered into a loose-leaf assay ledger.

CEMENTING PRACTICE.—It was found more satisfactory to insert the quick-setting cement (ferrocrete) dry into long linen bags and plug with these than to pump liquid cement into the holes. Enough moisture penetrates the cement to set it and ramming fills the side cracks effectively. When the wall of a hole is soft and inclined to cave a cement-wash down the hole was found to be very effective. Cement could be bored after eight hours, but it was safer after 16 hours. In certain fracture zones carbon dioxide gas was present in considerable volumes and acted adversly on the cement by preventing rapid setting. Only by repeated cementing could this gas be shut off.

MINERALS IN SILICOTIC LUNGS

An account of research on the minerals contained in silicotic lungs, by Dr. W. R. Jones, of the Geological Department of the Imperial College of Science and Technology, appears in the *Journal of Hygiene*, Vol. xxxiii, No. 3. The author in introducing his paper, which is referred to elsewhere in this issue, states that his object was not to deal in detail with each mineral residue obtained from all the lungs investigated, some of which were not silicotic, but, on the contrary, to give the general conclusions to which he had been led inexorably by the petrological examination, supported by chemical analyses, of the mineral residues obtained in particular from the silicotic and silico-tuberculotic lungs. The results of his investigations are based on the examination of the mineral residues obtained from 29 lungs, each lung being from a person whose death had been certified as due to silicosis or silico-tuberculosis. Five of these were from workmen employed in the pottery industry as follows: 2 earthenware biscuit placers, 1 china turner, 1 china biscuit placer, 1 jigger; 21 were from underground workers in collieries, of whom 6 were hard-heading workers, 11 colliers, 1 collier and sinker, 2 colliery repairers, and 1 colliery labourer. The remainder were from 1 stone mason, 1 stone dresser, and 1 silica-brick worker.

After describing the technique developed for obtaining mineral residues from silicotic lungs, the author goes on to say that these residues, which are markedly reddish brown in colour as the result of the presence of iron in the ferric state after the nitric acid treatment, are boiled in hydrochloric acid to remove most of the colour. This is not essential, but helps to bring into prominence the minerals under polarized light. The lighter minerals are then removed by separation in a bromoform-benzene mixture and the heavier fraction mounted in Canada balsam for examination by a petrological microscope.

The bulk of all the mineral residues of the silicotic lungs examined in the course of the investigations consisted of myriads of minute acicular fibres of sericite, many small grains of quartz, and some larger grains of that mineral from 5 to 10 microns in length. Minute scales of sericite are also present and, in some of the residues from underground workers, minute needles of rutile.

The author then goes on to give an account of sericite and of the chemical work by which the presence of this mineral in major quantities in the residues was confirmed, concluding by saying that it is not quartz, or any kind of free silica, that forms the bulk of these residues and suggesting that silicosis is not mainly due to free silica, as has hitherto been accepted, but to silicate minerals occurring in the form of minute fibres loosely held together in the rocks so that, during handling, drilling, and blasting, they are readily freed into the atmosphere and inhaled into the lungs.

Dr. Jones then goes on to deal with some outstanding cases of rocks, the dusts of which have been definitely proved to cause numerous cases of silicosis, and with other rocks which are very similar in their content of free silica and in the size and form of the quartz grains, but which have been worked extensively for long periods of years without causing a single authenticated case of silicosis. and his most outstanding comparison may be quoted here.

The gold-bearing quartz conglomerate ("Banket") of the Transvaal, South Africa, is one of the most notoriously dangerous rocks in this respect. "Up to October, 1929, 7,633 beneficiary miners were alive; 2,271 of these were in the ante-primary stage of silicosis, 2,306 in the primary stage, and 2,814 in the secondary stage. There were 2,014 widows and 3,538 children in receipt of pensions. . . . The real cost of miners' phthisis was said to be £1,000,000 per year. The Government Actuary estimated the outstanding liability of the mines at £6,400,000."[1] This quartz conglomerate contains between 80 and 90% of free silica in the form of quartz; in this respect it is very similar to the gold-bearing quartz worked in the Kolar goldfield, India, which, however, actually contains a little more quartz (over 90%) than the "Banket." Whereas the dust of the South African rock has given rise to some thousands of cases of silicosis, no single case of that disease has been diagnosed in the Kolar goldfield, where thousands of workmen have been employed over long periods of years and where the precautions enforced by law in the South African gold mines to prevent silicosis—such as the use of wet drilling to lay the dust—are not in force. The very process—namely, dry drilling with pneumatic drills—which proved so extremely dangerous in the South African mines, has been in operation for many years at Kolar and is still in use in these gold mines, some of which are now worked to depths exceeding 6,000 ft. If quartz is the cause of silicosis, why is it that with its 90% and more quartz the gold-bearing rock at Kolar does not give rise to dangerous dust?

Two suggestions have been made to account for

[1] Statement by Mr. Barry in the *Records of the International Conference on Silicosis*, held at Johannesburg, August, 1930, p. 84.

this hitherto puzzling fact : (1) That there may have been cases of silicosis at Kolar, but not diagnosed, (2) that the rock adjacent to the gold-bearing quartz gives rise to dust that enables the inhaled quartz dust to be ejected from the lungs. It is sufficient here to state, relative to the first suggestion, that the workmen at Kolar are periodically examined under X-ray by medical experts who are actually on the look-out for cases of silicosis, but are unable to find any, and that the statistics relating to various diseases of workmen are as carefully kept at Kolar as they are in this or any other country.

Hitherto no acceptable explanation has been given why the inhaled dust of the South African quartz-bearing rock is so extremely dangerous in its silicotic effect and why the dust of the Indian rock, with still more quartz, has not caused a single case of silicosis. The real explanation, it is here submitted, is simple : Whereas in the South African rock there are, between the quartz pebbles and quartz grains, aggregates of minute acicular fibres of sericite, hundreds of which fibres can be seen in microscope sections of this rock, such acicular fibres are absent from the Kolar quartz rock, or are very rare. A reference to the accompanying figure makes this clear. The quartz grains in the Kolar rock are interlocking ; there is no fibrous mineral to be seen between the sharp boundaries of the individual grains. Between the quartz pebbles and the quartz grains in the "Banket" acicular crystals of sericite are very abundant ; in fact, sericite ranks next to quartz as the most common mineral in this South African rock. It is not suggested here that all the sericite present is in fibrous form ; much of it is in the form of minute scales, but the point is that countless fibres of this mineral do occur throughout this rock.

The author's final summary and conclusions are quoted in full :—

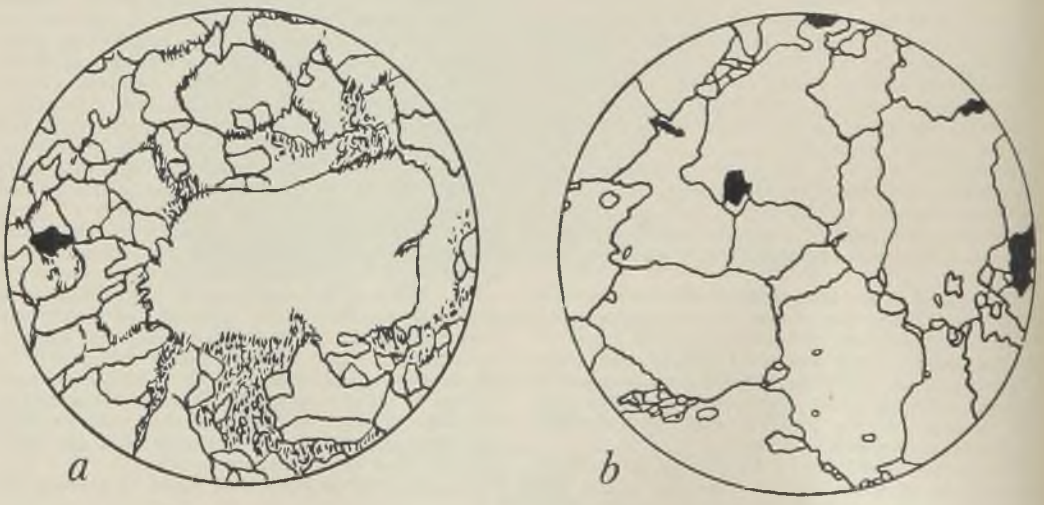
The results of these investigations on the mineral residues obtained from 29 silicotic lungs and of the examination of the rocks and materials which gave rise to the inhaled dusts causing these cases of silicosis lead to the following conclusions :

(1) The bulk of the mineral residues obtained from every silicotic lung investigated by the author consists of minute fibres of the mineral sericite, a hydrated silicate of aluminium and potassium known also as "secondary white mica." This mineral is abundantly present also in all the rocks and materials which gave rise to the inhaled dust and it is present in these rocks and materials in minute fibres and scales of the size it is found in the residues and also in the lung tissue.

(2) Silica in the uncombined state, as quartz, is also present in these residues as relatively coarse and fine grains ; it occurs, however, in amounts subordinate to sericite. Especially is this so with regard to the small number of quartz particles, as compared with the countless fibres of sericite.

(3) One relatively large grain of quartz, measuring 10 by 8 by 5 microns, such as is found in the residues, is equal in volume to 800 fibres of sericite measuring 2 by 0·5 by 0·5 microns and contributes as much silica in the chemical analysis of a residue as would 16,000 fibres of sericite. This would appear to be out of all proportion to the silicotic effect of one such quartz grain in the bronchi and bronchioles, compared with the effect in the alveoli of hundreds of fibres of sericite.

(4) Silica in the uncombined state, as quartz, is not the chief cause of silicosis in these and certain other cases. This appears to be conclusively established, it is submitted here, by the following facts : (*a*) The amount of quartz and the size and form of the quartz grains in the sandstones occurring in the underground working-places in the Scottish Coalfields and in the South Wales Coalfield are alike. The latter sandstones give rise to dust that has caused scores of cases of silicosis, whereas no authenticated case of silicosis has been produced in the Scottish Coalfields. (*b*) The gold-bearing quartz conglomerate of South Africa gives rise to dust that has caused thousands of cases of silicosis : the gold-bearing quartz rock of the Kolar Goldfield,



Sketch Microscopic Sections of (*a*) Banket and (*b*) Kolar Gold-Bearing Quartz, showing prevalence of fibres in (*a*) and their absence in (*b*).

India, contains more quartz than the South African rock and yet produces dust that has caused no case of that disease. (*c*) No quartz-bearing rocks investigated by the author are known to have given rise to silicosis-producing dust except those which also contain abundance of fibrous aggregates of sericite or of fibrous silicate minerals, loosely held together and easily freed into the atmosphere when the rock is drilled and blasted. (*d*) Rocks which contain a relatively small percentage of quartz (well below the minimum amount in the rock-types named in the Silicosis Schemes under English law), but which do contain fibrous silicate minerals such as sericite and sillimanite—as, for example, at Broken Hill Mines, New South Wales—produce dust that has caused a large number of silicosis cases.

(5) These investigations are not concerned with the pathological condition produced by the minerals in the lungs. Whether they merely act as mechanical irritants causing the growth of fibrous tissue, as advocated by some well-known authorities, or induce chemical changes, as maintained by certain eminent pathologists, is a question entirely beyond the province of the author. His conclusions do not militate against either theory ; on the contrary, they provide the former school with evidence of the presence in the lungs of thousands of acicular fibres that presumably could act as mechanical irritants and the latter school with evidence of the presence of silicate minerals less stable than quartz and which, because of their physical form, expose far greater surface to volume for any chemical action than do the more compact grains of quartz.

(6) Lastly, it is submitted that it is mainly the presence in the exploited rocks and materials of fibrous minerals, be they sericite, sillimanite, tremolite, etc. (or a fibrous form of free silica as in chert, or of a fibrous rock as in pumice), in aggregates which, during the impact of drilling, blasting, or crushing, become freed into the atmosphere as individual fibres, that enables sufficient material in course of time to enter the lungs to cause silicosis. It is not suggested that sufficient minute particles of quartz could not, under any circumstances whatever, enter the lungs to cause silicosis, although the cases hitherto investigated appear to show conclusively that they have not done so ; but it is maintained that the fibrous minerals hasten the process so very considerably that their presence in the exploited rocks and materials is of far greater importance in causing this disease than is the presence of quartz.

ITABIRA IRON ORES

In the *Bulletin* of the Institution of Mining and Metallurgy for July Bernard H. Sanders describes the iron ores at Itabira, Brazil. The author recalls that the Itabira regions, in the State of Minas Geraes, Brazil, was discovered by prospectors from Sao Paulo, about the year 1720, who established a settlement, now the town of Itabira do Matto Dentro, on the eastern slopes of a prominent range of hills in which they had found gold in large quantities. The Itabira hills are a portion of the main ridge which divides the watersheds of the River Santo Antonio and the River Piracicaba ; these being two of the largest tributaries of the River Doce which drains most of the south-eastern portion of Mineas Geraes and reaches the coast 60 miles north of the port of Victoria, on the Atlantic seaboard of Brazil. Itabira is 230 miles due west from the mouth of the River Doce and the same distance nearly due north from the capital, Rio de Janeiro.

The iron formation at Itabira forms the backbone of the range of hills referred to, whose smooth steep-sided summits and shoulders, nearly bare of vegetation, are characteristic of the iron formation, both here and in other parts of Minas Geraes. The most striking features of the peaks and ridges of the range are the outcrops of hard hæmatite rocks of the iron formation. Many of these outcrops form precipices of 100 ft. and more, the greatest of them culminating in cliffs 350 ft. in height at the peak of Caue, the highest point of the range. The formation extends over a distance of rather more than six miles in a N.E.–S.W. direction.

Outside of Itabira only a minute amount of underground exploration has been done in the enormously extensive iron formation of Minas Geraes. At Itabira, however, there has been considerable underground exploration in recent years and here 38,500 ft. of workings have exposed extensive portions of the iron formation at different horizons, especially in the regions of Caue and Conceiçao.

The iron formation, as a whole, lies conformably between soft arenaceous and argillaceous schists. The bulk of the formation is made up of banded quartz-hæmatite rock, which shows vividly contrasted layers or bands of dark grey to black specular hæmatite and white crystalline quartz. Structurally the rock may be described as built up of a series of very irregular, flattened, overlapping lenses, composed of agglomerations of white crystalline quartz grains, alternating with similar flattened lenses formed of minute plates of specular hæmatite. The rock is unquestionably highly metamorphosed and should properly be classed among the crystalline schists. Enormous bodies of very high-grade hæmatite ores are found within the formation : these occur as lenses or masses of nearly theoretically pure specular hæmatite. There is no essential difference of structure between these large masses and the small hæmatite layers of the general formation.

The high-grade ore-bodies vary in their physical condition from very hard and compact rocks, some of which provide the striking outcrops already noted, through a long range of types to soft, flour-like powder. The soft variety, which does not outcrop, is not known to have defined contact planes. It grades gradually into the soft variety of the banded quartz-hæmatite, or fingers into the hard variety of high-grade ore. It has not been found in contact with hard banded quartz-hæmatite.

After dealing with the geology and mineralogy of the deposits, the author describes individual deposits and mining methods and goes on to say that there is not the slightest doubt that Brazilian iron ores will sooner or later become an important factor in the world's markets. Lack of suitable transport is the main thing which has prevented, and still prevents, their use. Even the highest

grade of iron ore is a low-priced commodity, necessitating not only cheap mining, but also cheap transport from mine to market.

The Itabira deposits are exceptionally well situated for cheap mining by means of heavy equipment in open-cast workings. These deposits, in common with the other principal Brazilian iron ore deposits, are situated at such a distance from the coast that the successful placing of their ores on the market could only be accomplished if exceptionally cheap freight rates, from the mines to the coast, were available.

The ore districts lying within the basin of the River Doce, of which Itabira is by far the most important, have the advantage over all the other iron ore regions of Minas Geraes, because their ores could be taken on a continuous down-grade from the mines to the coast. In all the other regions the ores would have to be hauled over one or more major mountain ranges before the littoral could be reached. The natural outlet for the former is by the route running down by the River Doce and deflecting southwards, near its mouth, to the port of Victoria on the Atlantic seaboard, or better still to Santa Cruz which lies 30 miles north of that port. Itabira is thus in the most favourably situated district, but even under the best conditions its ores would require a haul of some 300 miles to reach the coast. There is already a metre-gauge line within 25 miles of Itabira, which connects to the port of Victoria, but its heavy grades and sharp curvature make it unsuitable for heavy mineral traffic.

From the engineering point of view there are no insuperable obstacles to prevent the construction, from the coast to Itabira and to the districts of less importance in the River Doce basin, of adequate railway connexion which could be made with downgrades always in favour of the ore load, but the capital cost required for constructing some 300 miles of first-class line such as would be necessary in order to obtain very low freight costs, would be, of course, very large indeed. Stable conditions, comparative world peace, and a normal state of commerce, are the requisites for such a venture ; and these have not been much in evidence during the past twenty years. Once normal conditions are restored in Brazil and the rest of the civilized world, we shall hear more about Brazilian iron ores—and Itabira ores in particular.

THE SCOTTISH ALUMINIUM INDUSTRY

(*Continued from the July issue, p. 51*)

The electrodes used in the aluminium reduction furnaces are small, the sizes varying from 10 in. by 10 in. by 12 in. high to a cube of about 17 in., the dimensions depending on the size of furnace and on the opinions of the officials of the different companies. The life of the electrodes in the furnace is short—seven to twelve days only—so that many thousands of electrodes are needed per year. A portion of the electrode is not consumed and is returned to the carbon factory, where it is ground and used for the production of new electrodes.

The presses used at Kinlochleven will each turn out 40 electrodes per hour. The pressure of the Kinlochleven water for power purposes as it comes from the reservoir and pipes is 400 lb. per sq. in. No pumps are required, therefore, and all that is necessary is an intensifier to bring the final pressure in the press cylinder up to 2 tons per sq. in. Whilst under pressure each electrode has been stamped so that it can be identified as to materials used, mix, binder, date, etc., in case of need. After pressing the electrodes are spread out on floors to cool and harden, as they are still very warm and sensitive to rough handling. At this stage they weigh from 70 lb. to 280 lb., depending on the size.

Electrodes are also produced by extrusion, but there does not appear to be any justification for the use of the slower extrusion presses for the production of short anode blocks and difficulty may be found in using the high pressures necessary. Where long electrodes are needed the extrusion presses can be used with advantage. Apart from the production of electrodes, the factory has to provide carbon paste and carbon powders suitably graded for Kinlochleven and the other reduction works to enable them to prepare the linings of reduction furnaces.

The final act in the preparation of the electrodes is that of baking. At the outset all the volatile matters were extracted from the solid constituent of the electrodes, but there has been added from 16% to 20% of binder made of tar and pitch; during the baking operations about 50% of this binder will be coked and the balance driven off. The baking ovens are large brickwork erections, either above ground with openings in the side walls to the chambers or, alternatively, sunk so that the top is approximately level with the floor, in which case the electrodes are lowered into the cells. The actual baking operation starts with the arrival of truck loads of green electrodes which are lowered into the cells by means of an overhead travelling crane fitted with long tongs. A cell is 90 in. deep by 75 in. long and 20 in. wide. As the filling in of electrodes takes place, carbon packing powder is poured in and around them in such a manner that each electrode is surrounded by a layer of powder. When the cell is filled a concrete lid is placed over it and according to the position of the cell *vis-à-vis* to the firing point there will be a gentle preheat as the waste gases pass along the outside walls. As the firing moves along there will be an increase in heat until the time comes to receive the burning mixture of producer gas and preheated air. As the firing passes on, the outer walls of the cells are swept by the air which has been admitted from behind and which will pick up heat by passing around the hot cells. The air naturally cools the cells gradually until they are cold enough to allow the lid to be taken off. The packing powder is sucked out and the electrodes are lifted out by tongs on an overhead crane. They are then placed on a roller conveyor which takes them to the store ready for use, except that adhering packing powder has to be cleared off. A furnace of the type described will bake 130 tons of electrodes per week. The capacity of the works is in excess of 20,000 tons of electrodes per year.

There are three factories producing aluminium in Scotland and, as the methods followed are similar, the author considers it sufficient to describe the working of the Lochaber plant and at the same time to sketch the development of these works, including the power supply.

Before water power can be developed in this country on the scale necessary for aluminium production an Act of Parliament has to be obtained so that landowners, farmers, railways, county councils, etc., whose interests are, or may be, affected, can obtain compensation and redress for any disturbance or losses sustained by the diversion of water or the construction of the various works. In this case the necessary Act of Parliament was obtained by the Lochaber Power Company. The catchment area is 303 square miles, with an average rainfall of some 74 in. per annum. The heaviest rain falls on the west of Ben Nevis and less on the Spey to the east. Dams are built to raise and impound the waters in Loch Laggan and Loch Treig and these two lochs are being connected by a 2¾-mile long tunnel. A 15-mile long tunnel, 15 ft. in diameter, runs from Loch Treig to the surge chamber, from which the water is carried to the power house by two pipes 3,240 ft. long with a maximum diameter of 5 ft. 9½ in. Ultimately three further pipes will be required and when the scheme is complete the power house will have a capacity of 120,000 h.p. The details of the plant to be installed have not been decided, but the winter load will be in excess of 75,000 k.w. Loch Treig has a storage capacity of 7,800,000,000 cu. ft. with a total depth of storage of 124 ft. and will receive from Laggan all water collected in that area apart from its own area of supply. The main tunnel is designed to take a maximum of 1,600 cu. ft. per sec. and it may be of interest to mention that this quantity of water would suffice for a population of twenty-one millions taking 40 gallons per day per head. The streams flowing above the tunnel are diverted into shafts and into the tunnel, so that in very rainy weather these streams may be sufficient to supply the power house, and water may even flow back into Loch Treig. A description of the civil engineering works in connexion with the first development of the Lochaber Scheme will be found in a paper by W. T. Halcrow,[1] Engineer to the company for the civil engineering work.

The head of water available at the turbines in the power house varies from 650 ft. to 800 ft. and the five units installed at present were designed to work efficiently within these wide limits. Alteration to the speed of revolution is made to correspond with the net head available. Each unit consists of one Pelton wheel direct coupled to two direct-current generators in tandem developing 6,600 k.w. together. An exciter is fitted at the outboard end of each unit and is designed so that it can excite two units or four generators if these are run in parallel. Safety devices are provided in the exciter circuits and there is inter-connexion of these circuits so that any one unit can be run in parallel with any other unit. No circuit breakers are provided in the main circuits, but only links in the feeder systems to allow for changes of machines. Each generator has one double-cell commutator delivering 10,000 amperes so that each unit will give 20,000 amperes and when two are working in parallel then 40,000 amperes at 300 volts pass to a series of furnaces. The complete turbine and generator units were supplied by the English Electric Company and include cylindrical balanced valves to shut the water supply off completely. The governing devices on the turbines were specially designed to allow of the control necessary for the aluminium-producing furnaces.

(To be continued.)

[1] *Proc.* Inst. C.E., 1930–31, vol. 231, p. 31.

Void Content of Close-Packed Powders.—In *Industrial and Engineering Chemistry* for May 15 the effect of particle size, shape, and texture on the void content of close-packed mineral powders is discussed by R. N. Traxler, L. A. H. Baum, and C. U. Pittman. The authors have made a series of experimental determinations of void content. Several commercial mineral powders were divided into five or six definite size fractions and the void contents of the unfractionated powders and the various fractions determined by three methods—dry compaction, liquid absorption, and briquetting. For most of the powders the lowest void content values were obtained by the briquetting method. The data for limestone, silica, marble, and black slate powders indicate that particle size has no appreciable effect on the void content, but the results for trap rock and soapstone apparently do not agree with this generalization. The void content values of the various size fractions of powdered Tripoli and argillaceous silica, minerals which possess peculiar characteristics, are discussed. Although texture has an effect on void content, regularity in particle shape is probably of greater importance.

SHORT NOTICES

South Shaft, West Rand Consolidated.—C. S. McLean describes the sinking of the South shaft, West Rand Consolidated Mines, Ltd., in the *Journal* of the South African Institution of Engineers for June.

No. 7 Shaft, Broken Hill South.—A description of the sinking of No. 7 shaft, Broken Hill South Ltd., by H. H. Carroll, appears in the *Proceedings* of the Australasian Institute of Mining and Metallurgy, New Series, No. 88.

Bi-Cable Ropeway.—A bi-cable, high-speed, continuous ropeway installed by the Northern Peru Mining and Smelting Company is described by W. L. Graham in the *Engineering and Mining Journal* for July.

Coal-Mining in South Africa.—In the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for May A. E. Edge gives an outline of the methods of mining adopted and the equipment used at the new Betty shaft of the Cornelia-Colliery, Transvaal.

Concentrating at Broken Hill South.—Concentrating practice at Broken Hill South is described by T. A. Read in the *Proceedings* of the Australasian Institute of Mining and Metallurgy, New Series, No. 88.

Gravel Mining.—The equipment of a gravel quarry for completely automatic working is described by C. Pruvot in *Mines, Carrières, Grandes Entreprises* for July.

White Metal for Winding-Rope Sockets.—J. Wilson describes some tests on white metals for winding-rope sockets in the *Colliery Guardian* for July 7.

Compressed-Air Distribution. In the *Engineering and Mining Journal* for July L. Eaton discusses the distribution of compressed air underground.

Automatic Pumping. — Modern automatic pumping as instituted at Consolidated Copper Mines, Nevada, is described by W. B. Clark in *Mining and Metallurgy* for July.

Coarse Flotation.—An article written by the staff of the Denver Equipment Company discussing the merits of coarse v. fine flotation appears in the *Canadian Mining Journal* for July.

Magnetic Separation.—What is cited as an up-to-date mill for the treatment of a finely disseminated magnetite ore by magnetic separation at Scrub Oak, New Jersey, is described by H. M. Roche and R. E. Crockett in the *Engineering and Mining Journal* for July.

Zinc-Copper Separation.—A process for the separation of sphalerite and copper minerals that is being applied on the Prince Leopold mine, Katanga, is described by R. E. Barthelemy in the *Engineering and Mining Journal* for July.

Milling at Mount Lyell.—M. E. Playford describes milling practice at Mount Lyell, Tasmania, in the *Proceedings* of the Australasian Institute of Mining and Metallurgy, New Series, No. 88.

Filter Press Design.—Some notes on filter press design and operation are given by J. A. B. Forster in the *Proceedings* of the Australasian Institute of Mining and Metallurgy, New Series, No. 88.

Sand Flotation for Coal.—J. Sinclair describes the Chance sand-flotation coal-washing plant at the Newmarket Colliery, Yorkshire, in the *Colliery Guardian* for July 21.

Elutriation.—In the *Proceedings* of the Australasian Institute of Mining and Metallurgy, New Series, No. 88, H. K. Sherrifs and A. F. Evans discuss the technique for elutriating finely-ground mineral grains and examining them under the microscope.

Cobalt Determination.—L. A. Sarver describes the volumetric determination of cobalt by means of ferrous sulphate and potassium dichromate in *Industrial and Engineering Chemistry* (Analytical Edition) for July 15.

Gympie Goldfields, Queensland.—W. H. Reeve describes the geology of the Gympie Goldfield, Queensland, and discusses its revival in the *Chemical Engineering and Mining Review* of Melbourne for June 5.

Ymir-Sheep Creek District, B.C.—In the *Canadian Mining Journal* for July H. G. Nichols describes the Ymir-Sheep Creek goldfield.

Rouyn—Bell River Area, Quebec.—Gold prospecting in the Rouyn-Bell River region, Quebec, is discussed by A. H. Lang in the *Canadian Mining Journal* for July.

Platinum in Brazil.—The platinum deposits in the State of Minas Geraes, Brazil, are described by F. W. Freise in *Metall und Erz* for July 2.

Gold in Georgia.—An account of gold-mining activities in Georgia, United States, is given by C. S. Anderson in Contribution No. 57 for July to the American Institute of Mining and Metallurgical Engineers.

Metal Sheets for Survey Plans.—A paper by R. McAdam, J. S. Reid, and S. K. Templeton read before the Institution of Mining Engineers on July 12, dealt with the application of metal sheets for survey plans.

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.*

24,187 of 1931 (393,307). R. F. Bacon, New York. Sulphides are treated at elevated temperatures in an atmosphere of SO_2 and in the presence of an alkaline earth compound with the object of recovering elemental sulphur.

24,417 of 1931 (393,607). Cuban-American Manganese Corporation, New York. Manganese ores are calcined and treated by a froth flotation process in the presence of fish-oil soap and hydrocarbon as a reagent with the object of concentrating the manganese values.

27,883 of 1931 (393,637). L. M. C. Seamark, Chagford, Devon. An internal blow-out preventer or plug for bore-holes or wells adapted for fixing within the tubing while this is being run in or withdrawn.

33,266 of 1931 (393,971). L. F. W. Leese, London. Sulphides are treated by superheated steam in a special reaction chamber with the object of recovering elemental sulphur.

33,346 of 1931 (392,980). N. E. Lenander, Norway. Alkaline metal compounds are caused to move in counter-current through molten sulphur in order to remove impurities such as arsenic, antimony, or bismuth.

35,019 of 1931 (393,997). L. F. W. Leese, London. Lead and other values are recovered from complex sulphide ores by a process of heap treatment, the heaps after sufficient exposure being washed by a chloride solution.

6,961 of 1932 (394,082). Fried. Krupp Grusonwerk A.-G., Magdeburg-Buckau, Germany. Ores of volatile metals, such as zinc, are treated in muffles placed in a rotary furnace for distillation purposes.

11,486 of 1932 (394,114). American Smelting and Refining Co., New York. Improvements in the desilverizing of lead.

17,450 of 1932 (393,092). E. Popper, Czechoslovakia. Metals and metallic compounds are produced by an electric arc process.

24,278 of 1932 (393,447). W. Hertzsch, Dresden. China clay is treated in centrifugal separators for purification purposes.

25,565 of 1932 (393,144). Metallgesellschaft A.-G., Frankfort-on-Main, Germany. Rotary tube-furnace for the desulphurization of zinc blende or similar ores, wherein the waste-gas flue and charging device are arranged at the same end.

NEW BOOKS, PAMPHLETS, Etc.

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

The Porphyry Coppers. By A. B. Parsons. Cloth, octavo, 581 pages, illustrated. Price $5·60. New York: American Institute of Mining and Metallurgical Engineers.

Igneous Rocks and the Depths of the Earth. By R. A. Daly. Cloth, octavo, 598 pages, illustrated. Price 30s. London: McGraw-Hill Publishing Co.

Reports of H.M. Inspectors of Mines, 1932. 1.—Scotland Division. By J. MASTERTON. 7.—Swansea Division. By T. ASHLEY. Each part in paper covers, price 1s. London: H.M. Stationery Office.

Canadian Department of Mines: Investigations in Ceramics and Road Materials, 1930 and 1931. Paper covers, 175 pages, illustrated. Ottawa: Department of Mines.

Nova Scotia: Annual Reports on Mines. 1931, part 2, paper covers, 91 pages, illustrated, with maps. 1932, paper covers, 285 pages, illustrated. Halifax: Department of Public Works and Mines.

Victoria District, Southern Rhodesia: Notes on Gold Mining in the Victoria district. By B. LIGHTFOOT. Southern Rhodesia Geological Survey Short Report, No. 28. Paper covers, 23 pages, illustrated. Salisbury: Geological Survey.

Tanganyika Territory: Mines Department Annual Report, 1932. Paper covers, 18 pages. Price Sh. 1. Dar Es Salaam: Mines Department.

Geological Map of Tanganyika: Provisional Geological Map of Tanganyika with Explanatory Notes. Geological Survey Department Bulletin No. 6. By E. O. TEALE. Paper covers, 32 pages, with map. Price Shs. 4. Dodoma: Geological Survey Department.

Rangoon: Geology and Underground Water of Rangoon (with special reference to tube-wells). By P. LEICESTER. Paper boards, 78 pages, illustrated, with plans. Price Rs. 15. London: High Commissioner for India.

Mineral Resources of the United States, 1931. Part II, pp. 331–347, Natural Gasoline, by G. R. HOPKINS and E. M. SEELEY; pp. 349–372, Natural Gas, by G. R. HOPKINS and H. BACKUS; pp. 373–414, Coke and By-Products, by F. G. TRYON and H. L. BENNIT. Each part in paper covers, price 5 cents. Washington: Superintendent of Documents.

Unwatering Mines: Unwatering Flooded Coal Mines in Washington. United States Bureau of Mines Technical Paper 549. By S. H. ASH and T. MURPHY. Paper covers, 18 pages, illustrated. Price 5 cents. Washington: Superintendent of Documents.

Transvaal Chamber of Mines: Annual Report, 1932. Cloth, octavo, 187 pages. London: 202–203, Salisbury House, E.C. 2.

Boiler Insurance: British Engine Boiler and Electrical Insurance Co., Ltd., Technical Report, 1932. Paper covers, 149 pages, with 141 figures. Price 7s. 6d.

COMPANY REPORTS

Tanganyika Concessions.—Formed in 1899, this company holds important interests in the Union Minière du Haut Katanga, the Benguela Railway, the Rhodesia-Katanga Company, and other companies operating in Central Africa. The report for 1932 shows that the Union Minière produced 54,000 tons of copper, against 120,000 tons in 1931, the Lubumbashi works producing 27,000 tons, Panda 15,200 tons, and Chituru 11,800 tons. During the year 720,000 tons of ore was mined, but development sufficed to increase the reserves available. The cobalt and radium plants were maintained in operation, operations being regulated to meet customers' demands. The Kikole tin mine was reopened during the year, while operations were started on two small gold deposits. The company's liabilities under guarantees to debenture holders in the Benguela Railway have been relieved by the decision of such holders to accept their cancellation and to accept 75 six per cent "B" preference shares in Tanganyika Concessions, Ltd., for each £100 debenture so cancelled. Active operations at the Kansanshi mine of the Rhodesia-Katanga Company were suspended in November last, pending more favourable times. The company has renewed its option on the properties of the Eldoret Mining Syndicate in the Kakamega field and intense development work is in hand. The accounts for the year show a profit of £272,297. After adding the sum brought in from the previous account and allowing for preference dividends amounting to £2,639, there was an available total of £440,938, which has been transferred to reserve and utilized in the plan of reorganization necessitated by the arrangement with the Benguela debenture holders.

Zambesia Exploring.—This company was formed in 1891 and is closely associated with Tanganyika Concessions, Ltd., which it floated in 1899. The accounts for 1932 show a loss of £34,589, which reduced the credit balance brought in to £16,021.

Rhodesia Broken Hill.—This company, formed in 1910, works lead-zinc-vanadium deposits in Northern Rhodesia. The report for 1932 shows that 363 tons of fused vanadium oxide was produced, in addition to 1,204 tons of vanadium concentrates. The accounts show a profit for the year of £23,169 and, after deducting the debit balance brought in and allowing for payments in respect of options not renewed, there was a credit balance of £7,668 to be carried forward. The electrolytic zinc plant was restarted on January 1 last and the outputs of zinc for 1933 and 1934, estimated at 18,500 tons and 20,000 tons respectively, have been sold. The hydro-electric power plant, it is stated, operated satisfactorily during the year.

Juga Valley Tin.—This company was formed in 1927 and works alluvial tin areas in Northern Nigeria. The report for the year to February 28 last shows that the company's quota under the International Restriction Scheme was 50·6 tons, against 88 tons for the previous year, but a quota purchase of 25 tons allowed a total output of 75·6 tons, produced by hand labour at a total cost of £71 14s. 5d. f.o.r. Bukuru. The accounts show a profit of £265, reducing the debit balance brought in to £30,687.

Tin Properties.—Formed in 1912, this company owns alluvial tin properties in Northern Nigeria. The report for the year to September 30, 1932, shows that as the allotted quota was further reduced during the period under review the mines remained closed down. The accounts show a loss of £2,714 after allowing for depreciation and, after adding the debit balance brought in, there was a total debit of £24,174 to be carried forward.

Angola Diamond.—This company was formed in 1917 in Portugal and works diamondiferous deposits in Angola. The report for 1932 shows that 407,945 cubic metres of gravel was treated, against 397,526 cubic metres in 1931, the total production of diamonds being 367,334 carats, against 351,495 carats. New workable deposits are stated to have been found on tributaries of the Luembe, Chiumbe, and Luana Rivers. The accounts show a profit of £107,909, the balance available, after making

various allowances and adding the amount brought in, being £107,487. Of this amount £100,000 was distributed as a dividend, leaving £7,487 to be carried forward.

North Kalgurli (1912).—This company was formed in 1912 and works gold-mining properties at Kalgoorlie, Western Australia. The report for 1932 shows that 15,117 long tons of ore from development and stoping was treated for a recovery of 8,366 oz. of gold, while the tribute ore treated at public crushing mills amounted to 1,659 tons, yielding 1,737 oz., the royalty accruing to the company being £1,619. From the Croesus Proprietary and Kalgurli leases, tribute areas of the South Kalgurli Consolidated, Ltd., 32,524 tons of ore was treated, yielding 13,384 oz. of gold. Ore treatment for the year yielded a credit balance of £11,457 after allowing for expenditure on surface equipment. The ore reserves at the end of the year were estimated to be 197,000 tons, averaging 9·6 dwt. in value, in addition to 109,000 tons of probable ore, averaging 8·62 dwt. Arrangements have been made for ore-treatment at the Boulder Perseverance, which company has agreed to duplicate its new bromo-cyanide plant, increasing its capacity from 7,000 tons to 14,000 tons per month. The cost to the North Kalgurli company of these extensions has been estimated at £45,000 and in order that revenue may be available for dividend purposes it is proposed to increase the company's capital to £100,000 by the creation of 250,000 new 2s. shares, which it is proposed to offer to existing shareholders at a price of 5s. per share. Resolutions to this effect will be proposed at the annual meeting of the company to be held in London this month.

Kent (F.M.S.) Tin Dredging.—This company was formed in 1926 and operates alluvial tin properties in the State of Selangor, F.M.S. The report for 1932 shows that the dredge was under operation for part of January of the year under review, treating 104,900 cu. yd. of ground and recovering 14·85 tons of ore. An arrangement was then concluded with Gopeng Consolidated, Ltd., for the production of the balance of the company's quota on a profit-sharing basis. Operations resulted in a profit of £922, increasing the credit balance brought in to £4,701.

Kamra Tin.—This company, formed in 1927, operates alluvial tin property on the island of Puket, Siam. The report for 1932 shows that 1,594,000 cu. yd. was treated yielding 584·44 tons of tin concentrates, capacity having been reduced in compliance with the Restriction Enactment. The average price realized for the concentrates was £85 14s. 4d. per ton, while costs were estimated to be £51 6s. 3d. per ton. The accounts show a profit of £7,691 and, after deducting the debit balance brought in, there was an available total of £5,046. After making various allowances a sum of £1,959 was carried forward.

Malaysiam Tin.—Formed in 1929, this company operates alluvial tin properties in the State of Perak, F.M.S. The report for the year to March 31 last shows that 426,620 cu. yd. of ground was treated during the year, the output of concentrates, under restriction agreements, being 150 tons, which realized £13,928, equal to £92 16s. per ton. Operations resulted in a profit of £3,613, making, with the balance brought in, an available total of £3,747. After making various allowances, there was a balance of £712 to be carried forward. The finance of the Glami property was arranged during the year and called for the creation of £18,000 7½% debenture stock, of which £12,672 was issued up to the end of the year.

Kramat Pulai.—This company was formed in 1907 and owns tin and scheelite properties in the Kinta district, F.M.S. The report for 1932 shows that 88 tons of tin ore was produced, as compared with 149 tons in the previous year, ore sales realizing £7,400, equal to £77 3s. per ton. Production was restricted in conformity with the International Tin Restriction Agreement. Scheelite ore sold during the year realized £21,033. The profit for the year was £3,631, making, with the sum brought in, an available total of £11,368. A dividend equal to 2½% absorbed £2,500, leaving a balance of £8,868 to be carried forward.

Aramayo Mines.—Formed in 1916, the Compagnie Aramayo de Mines en Bolivie operates tin-silver-wolfram properties in Bolivia. The report for 1932 shows that operations in Bolivia were conducted at a loss of Fr. 735,570, after making the usual provision for amortization. Revaluation of stocks and investments, however, and allowance for interest and dividends received created a credit balance of Fr. 635,959 and, after adding the balance of Fr. 708,577 brought in, there was an available total of Fr. 1,344,537, which has been carried forward.

Poderosa Mining.—This company was formed in 1908 and owns copper properties in the province of Tarapaca, Chile. The report for 1932 shows that no ore was extracted, the mine remaining under water. Revenue from investments and other items amounted to £5,686, while expenditure totalled £11,839, giving a loss for the year of £6,153. The debit balance carried forward now amounts to £50,996.

DIVIDENDS DECLARED

Broken Hill South.—1s., less tax, payable September 22.

Burma Corporation.—4 annas, free of tax, payable October 14.

Consolidated African Selection Trust.—1s. 3d., less tax, payable August 4.

Gold Coast Consolidated Lands.—½%, less tax, payable July 31.

Johannesburg Consolidated.—3s., less tax, payable September 21.

Meyer and Charlton.—8s. (liquidation dividend), payable August 8.

North Kalgurli.—6d., less tax.

Petaling.—5%, less tax, payable August 4.

Rawang Concessions.—6d., less tax, payable July 28.

Wankie Colliery.—6d., less tax, payable July 25.

NEW COMPANIES REGISTERED

Birbir Mines.—Capital: £8,000 in £1 shares. Objects: To adopt agreement with Societe Anonyme des Concessions Prasso en Abyssinie, A. Prasso, and C. A. H. Edwards, to acquire concessions. Directors: Charles A. H. Edwards, George T. Eve, John F. Hipwood, Alberto Prasso, and Arthur G. Marshall.

Gold Coast Exploration.—Capital: £250,000 in 2,500,000 2s. shares. Objects: To adopt an agreement with Chas. E. R. Stewart and to acquire any concessions for any mining purposes.

Orinoco Oilfields.—Capital: £200,000 in 10s. shares. Objects: To acquire oil concessions and distribute petroleum and by-products.