# The Mining Magazine

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# EDITORIAL

IN order to save would-be purchasers trouble, we are asked by our Technical Bookshop to state that President Hoover's *De Re Metallica*—which we published in 1913—is now out of print.

THE 1929 edition of Mr. Walter E. Skinner's "Oil and Petroleum Year Book" has just made its appearance and contains its usual valuable store of information concerning that industry.

IN various issues of the MAGAZINE in 1927 reference was made to a new tin extraction process being developed at the Geevor Mine in Cornwall, and we hope to publish next month the details of a new patent which has just been granted to the same investigators.

LAST week an extensively signed statement was published favouring an arrangement between the various tin-producing companies. Several important groups were, however, not represented among the signatories and in view of their abstention it is not easy to see how any agreement in this matter can be reached.

ELSEWHERE in this issue a description is given of some of the exhibits at the North-East Coast Exhibition, which the Prince of Wales opened on May 14 and which is to run through the summer season. An attempt has been made to reproduce on a smaller scale the Wembley Exhibition and it is not too much to say that in this its organizers have been entirely successful.

IN our issue of July, 1928, attention was called to a proposed memorial to Edward Suess, to be erected at his birthplace in Islington. On May 28 the Austrian Ambassador, in the presence of a distinguished company of geologists, unveiled a plaque and Professor J. W. Gregory in the course of a tribute said that Suess ranked as the greatest original force of the geological philosophy of his time.

AMONG the Birthday Honours the mining and metallurgical community will have noticed with interest three names: Dr. H. C. H. Carpenter, Professor of Metallurgy in the Royal School of Mines, is made a Knight, while Sir John Cadman becomes a G.C.M.G. and Dr. F. Dixey, Director of the Geological Survey of Nyasaland, is given the O.B.E. Interest also attaches to the conferment of a C.M.G. on Mr. W. J. D. Deacon, M.R.C.S., L.R.C.P., Director of the Gold Coast Medical and Sanitary Services.

ABYSSINIA is a country about which very little is known and for this reason Mr. H. P. Robertson's account in this issue of his experiences there will be welcomed. Apart from this, however, the country is of interest in view of the recent Nile waters agreement between the Egyptian and the home Governments, in carrying out some of the projects resulting from which the co-operation of the Abyssinian Government will be required. Another matter which brings this region into prominence is the proposal to build a railway from Gambella to the Sudan frontier along the valley of the Baro River, a tributary of the White Nile.

IMPORTANT issues resulting from origins of the science which is known as Geophysical Prospecting are raised by the revelations contained in the article by Dr. W. R. Jones which concludes in this issue, and in connection with the prowess of British scientists and designers in this field it gives us pleasure to place on record the fact that the Gravity Gradiometer designed by Capt. H. Shaw and Mr. E. Lancaster-Jones, and described by them in the MAGAZINE last month, has been successfully employed in surveys of the brown coal fields of Victoria, Australia, and elsewhere.

### Power House Chimney Effluents

The matter of deleterious fumes and dust from power house chimneys, first alluded to in the MAGAZINE for January last in connection with litigation between the Manchester Corporation and a neighbouring farmer, has aroused a veritable storm of criticism because of the London Power Company's proposed generating station at Battersea. While mining men generally are not concerned with the possible ill effects of power station effluents on London

and Londoners, except perhaps for sentimental reasons, yet the matter has a definite bearing on the subject of power generation and it is on this account that we take the opportunity afforded by the above-mentioned circumstances to review the position further.

The present tendency in power generation, as is evidenced by the recently passed Electricity Act in this country, is for large-scale high-power generation at points geographically suitable and for transmission at high potential to distributing transformer stations. A difficulty inherent in this otherwise sound principle is the local intensification of the "smoke nuisance," a difficulty which is rendered additionally involved by reason of the sulphur content of the coals.

The realization of these "snags" in the path of the power engineer has aroused a feeling that these problems, like many others that have gone before, are capable of solution. Broadly speaking the problem is a threefold one—the discharge of dust or ash (which may be and often is siliceous) resulting from the use of pulverized coal, the actual content of sulphur compounds in the flue gases, and the smoke itself. Various lines of attack on these serious evils present themselves and as it is not our purpose to deliver a thesis on what is after all a considerable subject it will be necessary only to touch lightly on the salient points.

The ash and smoke nuisances can be overcome. Here the tendency is for better coal washing and more efficient combustion of clean fuel. In the case of pulverized-coal installations development in the direction of the better slagging of the ash must proceed apace. When, however, we come to the elimination of sulphur-containing gases the question is not a simple one and it is a plain fact which cannot as yet be controverted that no effective method for the prevention of these dangerous effluents of big generating stations has been adopted.

On the other hand, a number of interesting proposals have been advanced which will bear some consideration. One suggestion that has been made is for the use of finely-divided lime, which is to be injected in some manner into the flue gases at a stage in their progress to the stack and should result in the fixing of the sulphur content of the gases as calcium sulphite, which in turn might be removed as a solid by one of the accepted dust-catching methods. Another proposal which cannot be lightly dismissed is to pass the gases through a scrubber system in which rain or other clean water is employed as a solvent for the sulphur contents. Yet another proposal may be offered as the outcome of important experiments which it is understood are proceeding in Germany. These have as their objective the recovery of sulphur dioxide as such and the problem appears to have resolved itself into that of finding some liquid or liquids in which the dioxide in dilute gas mixtures is readily soluble. Likely solvents of this character have been found by these workers to be the cyclic ketones—cyclohexanone and methyl-cyclohexanone. These substances in their normal commercial grade of purity have been employed on dilute sulphur dioxide with decidedly promising results on a laboratory scale. The efficiency of the ketones has, moreover, been considerably enhanced by the presence of small quantities of certain metals, notably mercury. The temperature at which the best extraction is effected has also been taken into consideration. The dioxide is, furthermore, recoverable from the ketones in which it is contained by heating to a suitable temperature. So much for specific alternatives.

In dealing previously with this subject, on the occasion noted already, we indicated the possible bearing of coal carbonization thereon. It may be that a product of some such process will be burnt under the boilers of the power houses of the future, but it is as yet difficult to see how such a procedure is going to affect the issue, since sulphur is still present in the residual fuel, unless it be that this fuel is in the form of gas, in which state it is quite amenable to pre-treatment for sulphur extraction, as an gas engineer knows. Thus it would appear that the best solution, if it can be found, probably lies in means for the elimination of the sulphur from the fuel before its use under the boilers.

## The Institution's Annual Meeting

The annual general meeting of the Institution of Mining and Metallurgy held on May 16 was a remarkably interesting occasion owing to the fact that, in addition to the retiring President's address, the proceedings included the presentation of the Institution's Gold Medal to the Hon. W. L. Baillieu and Mr. W. S. Robinson.

The recipients of this great honour were selected for it on account of their services in the development of the lead and zinc

resources of Australia and a more fitting choice could hardly have been made. In these circumstances members listened with peculiar attention to the two speeches delivered in acknowledgment of the gift of the medal.

Mr. Baillieu indulged in a review of the past which made attractive history and gave an impression to his hearers of the problem which confronted the Commonwealth lead industry at the time of the outbreak of the War, when it will be remembered producers had to find a market for concentrates which had hitherto been bought largely in Germany under contract. A temporary relief was found when the Broken Hill Proprietary Company, which owned the Port Pirie smelter, agreed to take the concentrates, and later the arrangement whereby the ownership of the smelter passed to all the big mining companies in Australia very considerably eased the position.

This was about 1915, when Mr. W. S. Robinson, taking a long view and foreseeing the protraction of the world struggle, advised an increase of production and a later step was the offer of the entire output of the Port Pirie smelter to the British Government free of cost. The Ministry of Munitions refused that offer, but made a counter suggestion for a fair price, which price-fixing agreement had a marked and salutary effect on ruling world prices, which it has been estimated saved the British Government 50 millions sterling. Following this came the development of the zinc industry and the commencement of the Risden works.

Before concluding, the speaker alluded to the steps now being taken to develop a low-grade but extensive ore occurrence on the west coast of Tasmania. This work is proceeding under the direction of Mr. Colin Fraser, to whom he also paid a well-deserved tribute for his services to the industries during the period under review in his capacity as joint managing director of the Associated Smelters at Port Pirie.

Mr. W. S. Robinson dealt at first more specifically with facts and figures, comparing the production of both lead and zinc within the British Empire in the present day with that up to 1914. Thus he showed that the lead output had risen from 100,000 to 400,000 tons of metal annually, while the corresponding figures for spelter were from less than 50,000 tons to nearly 200,000 tons, the tendency being for still further improvement. Again, as to the treatment of mine products for recovery of metal, whereas in 1913 less than 5% was treated by British metallurgists, he estimated that in 1931 all Australian mine ore would be reduced within the Empire. This brought him to his argument that, while mining engineers and metallurgists had done and were doing their best to increase yields and improve the position of the Empire mineral and metal productions, the commercial side was lagging behind, and he uttered a strong plea for a reasonable level of prices and the ending of slumps, market booms, and suchlike obstacles to orderly progress. In this connection he ventured the suggestion that if metallurgical efficiency fluctuated as much as do the prices of some of the metals themselves boards of directors would be very much perturbed.

At this point General Sir Granville Ryrie, the High Commissioner for Australia, on being called upon to add his congratulations to the recipients of the honour, raised, literally, shouts of laughter during an all too brief but breathless period of anecdotal reminiscence.

At the conclusion of the transaction of other formal business Professor Truscott rose to deliver his presidential address. The subject of this is "Scientific Management" and in order that there may be no misapprehension it is important to emphasize that the implication here is the application of scientific principles to all departments of the functions of management and not, as might be supposed in view of recent Institution topics, the mere rôle of scientifically-trained men in the conduct of industrial affairs. From his thesis emerges the fact that Professor Truscott is to a considerable extent a champion of the American attitude towards this matter. Thus we find that nearly all his bibliographic references are to the periodicals or to the proceedings of learned societies in that country.

Space does not permit a detailed analysis of Professor Truscott's thesis, even if such a course were desirable in these columns, and we will, therefore, conclude these few remarks by sincerely commending the published address to the notice of all those who have the best interests and the advancement of their great profession at heart.

The final ceremony was the induction of the new President, Dr. William Cullen, to the chair. May we offer him our hearty congratulations on his attainment to this high office.

## Rhodesian Developments

The greatest interest attaches to the decision lately arrived at to remove the capital of Northern Rhodesia from Livingstone. The capital has for long been thought to be inconveniently situated, inasmuch as it is in the extreme south of the territory it dominates, but the objections have not hitherto been strong enough. Now, however, the mining developments in the north have been so rapid and the future importance of this part of the country is becoming so


RAILWAY COMMUNICATIONS WITH THE KATANGA AND NORTHERN RHODESIA COPPER FIELDS.

increasingly evident that it is felt that the centre of gravity has shifted and a site is being sought on which to build a new capital. The area being considered is the plateau surrounding Lusaka, a thriving farming centre on the railway between Livingstone and Broken Hill, not far north of the Kafue River, and the probable choice is a point rather to the south of Lusaka and near Chilanga.

Side by side with the attention which change of government headquarters will attract is the importance of the transport facilities, present and in prospect, at the disposal of the copper producers. On June 10 the Portuguese Minister of Colonies opened the Benguela railway, connecting the Katanga with Lobito Bay, on the west coast of Africa, in the presence of Prince Arthur of Connaught, the former Governor-General of South Africa, and representatives of the Governments of Northern and Southern Rhodesia and of the Belgian Congo. This railway was begun as long ago as 1903, mainly owing to the initiative of Sir Robert Williams (as we now know him), and is only now completed after interruptions due to the War and other vicissitudes. This line must obviously have a definite bearing on the economics of the development of the copper area since, when the extension to Tshilonga is completed in 18 months' time, it will give direct access to a port which is 2,600 miles nearer to this country than is Beira, the railway route itself being many miles shorter than any routes at present existing.

Interest must also attach to other proposed railways and links for the service of this field, which are clearly indicated in the accompanying map. The Sinoia-Kafue project has at the moment been defeated, but there is a strong feeling that the prevailing persistent demand for this short cut to Beira will result in present objections being overcome. With the completion of the bridge over the Zambezi at Chindio the journey to Blantyre will be made easier and the extension of this line to Fort Jameson will be eagerly anticipated.

# REVIEW OF MINING

**Introduction.**—Although the General Election is over, the feeling of uncertainty which preceded it has not altogether disappeared, owing to the change of Government and the prospect before many months are passed of another appeal to the country. Business has been generally good. Metals are a trifle lower, but the decline has not been serious. The latest tin statistics showed a decrease of over 600 tons in the visible supplies, whilst the total deliveries for May at 13,265 tons and the United States consumption of 8,480 tons both established records.

**Transvaal.**—The output of gold on the Rand for May was 858,991 oz. and in the outside districts 38,607 oz., making a total of 897,598 oz. The natives employed on the gold mines at the end of the month totalled 195,733, as compared with 197,412 at the end of April.

The report of the Central Mining and Investment Corporation for 1928 shows that a further £150,000 has been added to reserve, which now amounts to £1,900,000, which is well ahead of half the capital of the company. As stated in our May issue, the profit last year was approximately the same as for 1927 and there was no change in the dividend. Whilst the company continues to be largely interested in South African gold mining, it has many other important interests, including Trinidad Leaseholds and the North Venezuelan Petroleum Company and its subsidiary, the Tocuyo Oilfields. In his report the consulting engineer, in dealing with operations on the Rand mines, states that it is remarkable how year by year the increased cost of working in old mines at greater and greater depths is almost entirely offset by improvements in technique.

Owing mainly to the reduced price ruling for the metal, the Leeuwpoort Tin Mines showed a loss of £2,985 last year. The ore milled was 73,400 tons, an increase of 3,600 tons, and the concentrates produced 666 tons, or 56 tons in excess of 1927. The average price realized was, however, £60 lower, being £223 against £283. The ore reserves at 110,494 tons show an increase of 1,828 tons. It is stated that improvements in the treatment plant are giving better extraction results and that experiments carried out with a new process indicate an economical means of eliminating the iron, whereby further improvement in the grade of the concentrates can be expected.

To add to its other difficulties, a fire started last month in one of the old drives of the City Deep, but has not proved serious. Operations were temporarily affected, not only on the mine mentioned, but also on the Meyer and Charlton and Wolhuter, resulting in last month's output of the former being somewhat lower.

The falling off in the monthly returns doubtless prepared shareholders of the Sabie (Transvaal) Gold Mining Company for the news that the directors have decided to suspend operations. An unexpected and consistent fall in the value of the ore has occurred simultaneously in all parts of the mine and the company does not possess the necessary funds to undertake an exhaustive scheme of development.

**Cape Colony.**—As foreshadowed by Sir David Harris at the De Beers meeting towards the end of last year, news is now to hand from South Africa of the formation of the Kimberley Diamond Cutting Company, Limited, with a capital of half a million sterling in £1 shares. The directors comprise Mr. Frederick Hirschhorn, Mr. R. F. P. Philipson-Stow, and Sir David Harris, all of whom are on the De Beers board.

Although the Namaqua Copper Company's output for last year at 2,491 tons was 63 tons less than for 1927, owing to the higher prices obtainable for its product a profit of £10,058 was shown, against a loss for the previous year of £14,147. This enabled the company to re-enter the dividend list with a distribution of 2s. 6d. per share, absorbing £9,433. The estimated reserves at the end of 1928 were 72,072 tons, a decrease of 8,279 tons as compared with 1927.

**Rhodesia.**—The gold output of Southern Rhodesia for April was 48,210 oz., as compared with 47,388 oz. for March. Other outputs for April were: Silver, 10,626 oz.; coal, 84,526 tons; chrome ore, 25,236 tons; asbestos, 3,582 tons, and mica, 7 tons. The value of the mineral output of Southern Rhodesia for 1928 was £4,448,311, as compared with £4,238,257 for 1927, the improvement being mainly due to the increased output of asbestos.

Speaking last month at a luncheon of the Royal Empire Society on "Recent Developments in Rhodesia," Sir Edmund Davis stated that on four of the copper propositions there would within the next few years be

a total outlay for plant of some three and a half millions sterling, and he urged that special attention should be paid to the question of deliveries, a most important matter in the case of properties which had to be equipped during certain seasons of the year.

The Southern Rhodesia Base Metals Corporation have granted the Rio Tinto Company an option until the end of the current year to purchase 75,000 of its unissued shares at par. The Rio Tinto Company is, at its own expense, sending its chief geologist to inspect the properties.

As it is now more closely identified with mining than railways, its railway having been taken over by the British South Africa Company in September last, it was decided last month to alter the name of the Rhodesia-Katanga Junction Railway and Mineral Co. to the Rhodesia-Katanga Co. The activities of the company are in future to be directed to the development of the Kansanshi mine and its other mineral concessions. In the new company, which will have a capital of £1,500,000 in £1 shares, shareholders of the present company are to receive share for share, no fresh issue of capital being contemplated.

**Nigeria.**—The work connected with the absorption of the Keffi group by the Associated Tin Mines of Nigeria delayed the presentation of the report, which covers the eighteen months to December 31 last. The output of tin concentrates for the period mentioned was 3,061 tons, the average cost of production being £94 5s. per ton f.o.r. Bukeru and the average price realized £158 2s. 1d. per ton. The net profit for the eighteen months was £174,594, from which a dividend of 1s. absorbed £16,000. After transferring £10,850 to reserve account, which now stands at £260,000, the carry forward was £116,098, the directors considering it advisable, in view of the necessity of making full provision for altering the existing plant from steam to electrical operation and the uncertain position of the tin market, to conserve the company's resources. The ore reserves on the company's areas at the end of last year were estimated at 19,000 tons.

The output of the Northern Nigeria (Bauchi) Tin Mines for the quarter ended March last was 450 tons, the same as for the preceding three months, but with the advent of the wet season an increase in the production is anticipated. During the quarter prospecting added 468 tons to the reserves.

**Tasmania.**—Mails to hand confirm the cabled news as to the disaster at the Briseis mine, to which reference was made in this column in April last. It would seem that all the men working in the mine at the time of the cloudburst were rescued, the loss of life being among those engaged on the surface. The cost of rebuilding the Cascade dam and repairing the damage done is roughly estimated at £60,000, the provision of which is to be considered by the directors. It must have been a severe disappointment to Mr. Lindesay Clark, who has been in charge of the Briseis for so many years, to see what was almost a life's work destroyed in a few hours.

The decline in the price of tin, the poorer quality of the lodes, and increased production costs were responsible for the Mount Bischoff showing a loss of £2,014 for last year, although the total income was £98,191. The output was 348 tons of tin oxide and the company's smelting works treated 1,402 tons of tin oxide for 960 tons of metallic tin. The directors seem to have struggled to keep the mine going, but legislation increasing the burden of costs left them no alternative but to close down. The large quantity of low-grade ore in the mine will, therefore, not be worked again until there is a substantial rise in the price of tin or a considerable decrease in working costs.

**New Guinea.**—As the result of the report of Mr. Arthur Dickinson on the Ellyou Goldfields and in accordance with his recommendations, it has been decided to form what is called the Final Company to continue operations and to liquidate the present development corporation. The Final Company is to be registered in Sydney, N.S.W., with a capital of five millions sterling, of which approximately 4½ millions will be issued, £1,000,000 being subscribed in cash, the remaining £500,000 being held in reserve for future requirements. The proposal is for shareholders of the development corporation to receive shares in the Sydney company to the nominal value of their present holding and on the carry g through of all contractual obligations a distribution of bonus shares.

**Malaya.**—Mr. G. E. Greig, Senior Warden of Mines F.M.S., in his report for 1928, states that the tendency is for companies after a successful start with one dredge to increase the number of dredges on their properties,

thus shortening their life and inflating the output of tin ore for a few years instead of spreading it over a large number of years. As he points out, this may be profitable for the companies, but it inevitably leads to overproduction now and a prospect of scarcity in the future.

At the annual meeting of the F.M.S. Chamber of Mines last month Mr. Windeatt foreshadowed the keenest competition between oil engines and electrical power. Whilst at the present time oil engines were largely used for driving gravel pumps on Chinese mines, thus effecting a great reduction in mining costs, electricity was finding its way. Mr. Windeatt also referred to the great advance made during the past few years in the efficiency and capacity of tin dredges, adding that jigs were now almost universally employed, owing to the large quantity of material they were capable of treating.

Last year the Kinta Tin Mines output was 368½ tons, the ground treated being 823,600 cubic yards. The total revenue was £50,833 and the working profit £33,244. The dividends for the year took £30,000, equal to 25%.

For 1928 the Tanjong Tin Dredging, Ltd., treated 1,352,900 cubic yards, the output being 437 tons. The total revenue was £57,962 and the working profit £34,818. Dividends totalling 25% absorbed £20,000.

**India.**—The report of the Indian Copper Corporation for 1928 states that development was confined to the blocking out of known orebodies down to the fifth level in preparation for stoping. The proved ore reserves were increased during the year by 131,091 short tons, totalling at December 31 last 755,630 short tons, averaging 3·78 per cent. copper, with an estimated copper content of 28,584 short tons. There were, too, probable ore reserves estimated at 190,000 tons of 3·15 per cent. copper. These reserves are all between the second and fifth levels and the lateral extension of the known ore shoots between these has yet to be determined.

**Burma.**—The output of the Consolidated Tin Mines of Burma for the six months to April 30 last was 544 tons of mixed concentrates, but a steady increase in production is anticipated after next month. Whilst the company's profits have been adversely affected by the fall in the price of tin, this has been to an extent offset by the rise in the market value of wolfram.

**Canada.**—The copper production of the Dominion for 1928 at 100,970 tons shows an increase of more than a third over the tonnage for 1927. Towards last year's output British Columbia contributed more than a half and Ontario a little more than a third. Last year's output makes Canada fourth in the list of the world's copper producers.

Last year the minerals produced in British Columbia were valued at $65,000,000, as compared with $60,750,000 for 1927. Although the value of the 1928 output was $1,800,000 below the record year of 1926, the total production of minerals was the largest in the history of the Province, being nearly 6,250,000 tons, against 5,500,000 tons for 1927.

**Cornwall.**—For the year to March 31 last the Geevor Tin Mines milled 49,920 tons, the total output being 739½ tons of black tin, which realized £98,375, an average of £133 0s. 7d. per ton. The reserves at March 31 last were estimated at 148,591 tons. The profit for the year was £19,654 and dividends absorbed £16,425.

**Mexico.**—The report of the Buena Tierra Mining Company for 1928 shows a total output of 10,205 short tons of ore averaging 11·89% lead and 8·631 oz. of silver. Owing to the failure to open up any high-grade orebody of importance and the low price of lead, a loss of £4,634 was shown.

**Spain.**—The Esperanza Copper and Sulphur Company reports a reduction in the output of pyrites for last year, as the orebodies now being worked are approaching exhaustion. Whilst working costs were higher, owing to the decreased output, the exchange was more favourable. The profit for 1928 was £16,875, and the dividend of 7% recommended will absorb £17,500.

**Russo-Asiatic Consolidated.**—At the meeting on June 4 the scheme for the segregation of the assets of the company was approved. The proposal is to transfer the company's non-Russian interests to a new company, to be called the Mining Trust, Limited, in which shareholders are to receive one fully paid £1 share for each eight shares of 2s. 6d. each at present held. They will also receive share for share in the new Russo-Asiatic company, whose interests will consists of the Russian properties and claim, in addition to £50,000 in cash. It is considered that the scheme when carried through will place the company in a better position to prosecute its claim for the return of its properties and also render possible the payment of dividends when profits are made on its Mount Isa and other interests.

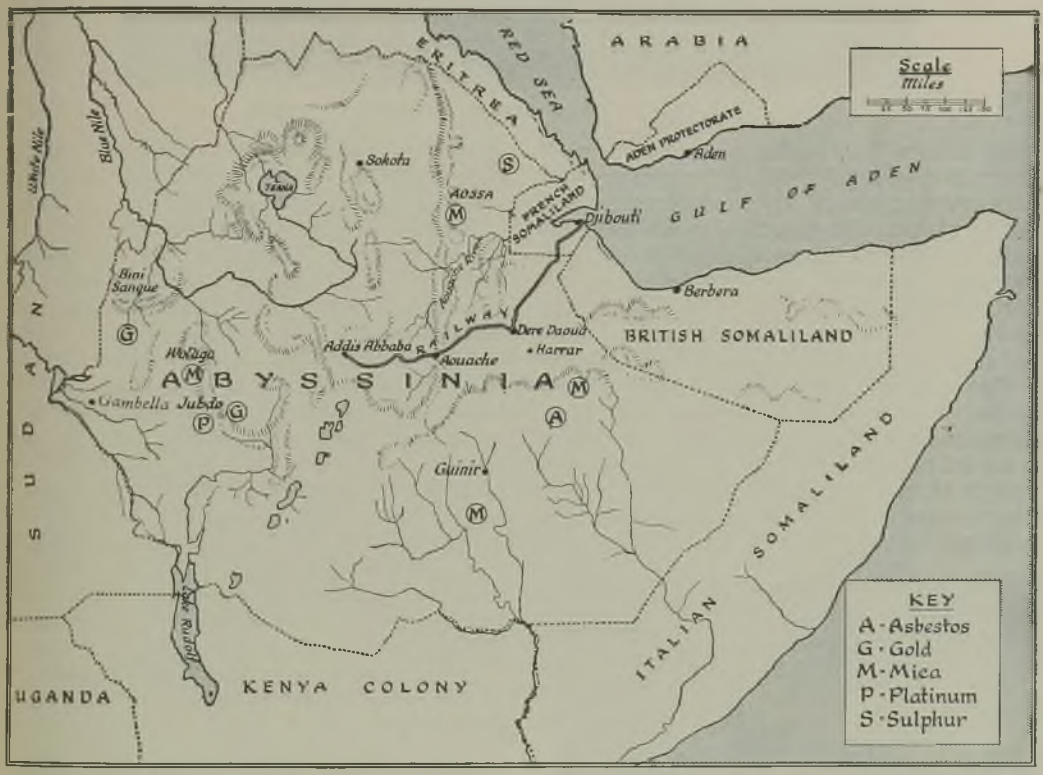
# TRAVELLING IN ABYSSINIA

By H. P. ROBERTSON, M.Inst.M.M.

The author gives his impressions and tells of the mineral possibilities of a region about which little is known.

Djibouti in French Somaliland is the only port in direct communication with the interior of Abyssinia. It is a well-laid town with several good hotels. From Djibouti the French have a concession for a railway into Abyssinia. It is now constructed to Addis Ababa the capital, and has taken over 20 years to build. The total distance is 500 miles and at present it takes three days to do the journey as the trains only travel in the daytime. A special train, however, chartered by an American millionaire while I was at Djibouti, took only 18 hours over the journey. Ordinary passengers stay the first night at Dere Daoua, about 200 miles, and the second night at Aouache, about 345 miles from Djibouti, and Addis Ababa is reached on the afternoon of the third day. When travelling on the railway fairly good meals can be obtained at the wayside stations and at both Dere Daoua and Aouache there are comfortable clean hotels. The line is climbing all the way to Addis Ababa, Dere Daoua being 4,000 feet above sea level and Addis Ababa 7,500 feet.

For the first 100 miles from Djibouti the country is dry, barren, rocky and rough with a few shrubs and peaks of extinct volcanoes. Fresh water can always be obtained in the valleys from wells. After the first 100 miles the country is fairly well grassed and there are large herds of sheep, cattle and camels but hardly a tree and not much population until Dere Daoua is approached. Travelling through this country in November was very pleasant, delightful weather with balmy breeze and bright sunshine being experienced. At Dere Daoua there are really two towns ; one, where the better class Abyssinians and the Europeans live, is a nice clean town with a good hotel, a bank, and modern houses of the bungalow type. The other town, on the other side of the river, is a native town, with a very cosmopolitan population. Dere Daoua is the headquarters of the railway company with workshops etc. After leaving




SKETCH MAP OF ABYSSINIA SHOWING RAILWAY AND SURROUNDING TERRITORY.

British Legation, Addis Ababa.

Dere Daoua the landscape becomes more interesting—rough broken country with permanent running rivers and occasional fertile plains. At the railway stations the natives sell fruit—grapes, peaches, oranges, pawpaws, bananas etc. The cattle in this part of the country look exceedingly well as the result of the good pastures. Before arriving at Aouache a very high railway bridge is crossed which spans the deep narrow ravine where the Aouache river runs. Aouache is only a wayside village but there is a good comfortable hotel for the accommodation of the passengers, and it is in telephonic communication with Addis Ababa.

About 20 miles from Aouache Metakarra is reached and here there is a large volcano now dormant. I was informed that it was last in eruption about 80 years ago. Streams of lava flowed down from this mountain and spread over the fertile plain for a width of over a mile. The railway passes through this recent lava flow. On the fertile plain at Metakarra there is a small lake and the scenery is very fine. I met a German here who has a small coffee plantation. After leaving Metakarra the railway passes through older lava flows, all however more or less recent, and on these lava flows the vegetation is much more luxuriant than on the surrounding country. For the last 60 miles before reaching Addis Ababa splendid agricultural and pastoral country is traversed. Rolling downs with crops of wheat and maize, and ranges of hills with occasional old volcanic peaks.

Manager's House, Bank of Abyssinia, Addis Ababa.

Addis Ababa itself is beautifully situated on the side of a range of hills overlooking a large fertile valley. The houses in the town are hid to a great extent by plantations of eucalyptus trees and the whole town is well wooded. I understand that King Menelek when choosing Addis Ababa as his capital some 40 or 50 years ago made the inhabitants plant eucalyptus trees and to-day his wisdom is shown in that there is a town surrounded with trees. The climate is delightful. European flowers bloom in profusion—roses, carnations, and violets all the year round. The British Legation and also the Bank of Abyssinia are situated in beautiful grounds and there are numerous other very fine houses and gardens.

While here I had an interview with King Teferi Maconen who is very progressive and lives in European style. He is under 40 years of age, and, I believe, favours the development of his country.

The high class Abyssinian although black in colour is semitic, not negroid, in origin, is well educated and behaves like a gentleman. French is the second language of the country and all the high class Abyssinians speak this language as well as their own Amharic. The French have a good school in Addis Ababa, and it is on account of this that the French language is so widespread. These high class Abyssinians live like the old feudal barons in Europe of 1,000 years ago, travel with a large crowd of retainers, while the lower classes and conquered races are for the most part slaves or serfs. Although the country is so backward there are signs that it is awakening, the high class Abyssinians are sending their children to Europe to be educated. Belatin Gebba Heraui, the minister for foreign affairs, who speaks English, told me that he had one son at Cambridge, another son at school in Alexandria who is going on to Oxford, and a daughter at school in Southsea. King Maconen has also a daughter at school in Southsea.

Abyssinia has been called the Switzerland of Africa, the whole country being very mountainous and rough with great deep ravines. The Samen mountains rise to a height of 15,000 feet above sea level. In late tertiary times the country must have been the theatre of immense volcanic activity, which has now diminished to a few thermal springs in the interior and rare eruptions on the coast of the Red Sea.

I had a trek for four weeks from Dere Daoua in the Harrar province through a very interesting mountainous and rich agricultural country, leaving Dere Daoua *en route* for Harrar and ascending abruptly 2,000 feet on to the Harrar plateau. Harrar is an old walled town very different to the modern Addis Ababa. The streets are mostly narrow and dirty and while there are some good well constructed buildings, especially the churches, the houses are for the most part small and like those generally seen in the

Author's guard of Abyssinian soldiers.

East. Before leaving Addis Ababa to go on trek it was necessary to obtain permission from King Maconen to travel in the country. I obtained a letter from him to General Imaru the Governor of the province of Harrar. Imaru is a pleasant well educated man, a cousin of King Maconen and one of his greatest supporters. On arriving at Harrar I delivered my missive and received in exchange letters to various government officials in the districts I was visiting. I was also provided with a guard of six soldiers. I travelled through the country on mule back and all my loads were carried on pack mules, which small animals made extraordinarily light work of the rough country traversed.

Mining and other companies that have been working in this country in the past have not been very successful. This has been in

part due to the men in charge but chiefly due to the adverse conditions. Some of the highly placed Abyssinians are very reactionary and there is a good deal of opposition to the progressive policy of King Maconen. Bribery was rampant and outside Addis Ababa there are no roads or railways, making transport very difficult.

Abyssinia is virtually a new and rich country for exploration from a mining point of view. Gold, platinum, silver, lead, copper, sulphur, nitrate of potash, asbestos and mica deposits are known to exist and have only to be opened up and proved. I believe that in the future some of these deposits will be profitably worked. The mica deposits in the Harrar district which I examined are about 50 miles to the south of Dere Daoua. These deposits had been worked by an American company to a small extent and about 6 tons of marketable mica shipped to London, New York and Prague. Through management difficulties and those others of the country already alluded to the American company abandoned the concession. The marketable mica so far obtained has not paid for the cost of its extraction. It is found in pegmatite dykes traversing crystalline schists in proximity to granites, which have intruded through these old sedimentary rocks. The pegmatite dykes are exceedingly numerous and occur over an area of about 3,000 square miles. They vary in size from a few inches to 30 or 40 feet in width, and in a great number of cases the mica occurs in large books. This muscovite mica varies from ruby clear to heavily stained brown. In some cases it is of very good quality but in many others it is crossed grained and cracked. One of the features of these dykes is the occurrence of very large garnets. During my examination of this district I came across several promising dykes for the production of marketable mica and I feel sure if suitable terms of purchase could have been arranged that these dykes would warrant the expenditure of capital in proving them. Marketable mica also occurs in the Wolaga province about 250 miles to the west of Addis Ababa. At present, on account of the cost of transport, it would only pay to export the large sizes of mica from this area. Marketable mica is also said to exist in the Guinir district 200 miles south-west of Dere Daoua and in the Aossa district 150 miles to north of Dere Doua. Speaking generally the mica deposits are promising and some of them will be worked profitably in the future.

OPEN CUT AT MICA MINES.

There are German, French, Italian, and American syndicates in the country looking out for mining properties. An Italian company is working some large nitrate of potash deposits profitably. A French company, the Societe Miniere des Concessions Prasso en Abyssine, with a capital of

9,000,000 francs, is working alluvial platinum deposits at Jubdo on the Birbir river near the head waters of the Blue Nile about 16 days trek on mule back west of Addis Ababa. I understand that some of these so-called alluvial deposits are in reality tailings from very ancient gold workings, gold having been obtained from Abyssinia in the time of the Queen of Sheba. The alluvial deposits are from 6 to 12 metres in depth, and average about ½ gramme of platinum to the cubic yard. In this depth there is a streak of ground about 2 inches thick, near the bottom, which carries up to 15 grammes of platinum per cubic yard. The bed of the river is also rich, but the alluvium in the river bed is not deep. At the present time these deposits are being worked in a very primitive manner by tributors and all the platinum is obtained by panning, no sluicing being carried on, and the native tributors only work the rich streak. The concentrates obtained contain from 70 to 75 per cent. platinum or metals of the platinum group and 3 per cent. gold. I understand that the Prasso company is obtaining from 6 to 10 kilogrammes of platinum per month. I was told also that a London syndicate, the Abyssinian Development Syndicate, had this property at one time and were working it for gold. Other companies and syndicates are also working platinum deposits and producing platinum. The manager of the Bank of Abyssinia told me that he was buying a very considerable amount of this metal. A German syndicate has sent an expedition to Bini Sangue near the Western boundary of Abyssinia to prospect for gold. This expedition came into Abyssinia from Khartoum.

Near the boundary of Abyssinia and Italian Eritrea and about 100 kilometres from the Red Sea, in eastern Abyssinia, is a large deposit of sulphur estimated to contain over 1,000,000 tons of 90 per cent. sulphur. It is in a very hot, dry and desert country, and there is no water within 15 miles of the deposit. A motor road could be made to the area from the coast but the difficulty of obtaining native labour and Europeans for supervision would be very great as the district has one of the most trying climates in the world.

ANOTHER VIEW OF MICA MINES SHOWING PEGMATITE DYKES.

At the present time in Abyssinia there are no mining laws or regulations, any disputes with regard to concessions coming before the Special Court which in the case of a British company consists of a representative of the Abyssinian Government and the British Consul. King Maconen has, however, now appointed a German mining engineer, Dr. Robert Hesse, as Conseiller du Gouvernement Imperial Ethiopien Departement des Mines. Dr. Hesse is now preparing mining regulations and trying to formulate mining laws. It is, however, difficult to say whether these laws and regulations when drafted will be adopted by the Government.

# A REVIEW OF THE CONTINENTAL DRIFT HYPOTHESIS

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The author discusses the Wegener hypotheses and some possible causes of continental drift.

(*Concluded from May issue, page* 288)

LATE CARBONIFEROUS GLACIATIONS.—Clearly it is at least as difficult to sink continents as it is to tear them forcibly apart, and in the absence of a clear geophysical lead one must choose between the alternatives of vertical or lateral displacement on their individual merits in relation to other problems. Here continental drift has undoubtedly more than one decided advantage. The opponents of drift have no way of explaining the distribution of the late Carboniferous glaciations of Gondwanaland, which accordingly continues to be the basis of Wegener's most powerful argument. The presence of extensive tillites of the same geological age in regions such as South America, South Africa, India, Tasmania and Western Australia (including many widely distant parts of the present tropics) constitutes a hopeless riddle unless we assume with Wegener that the glaciated lands were then grouped about South Africa, which in turn is assumed to have been very near the South Pole. With this arrangement the ice-sheets all fall within an area of about the same size as that glaciated in the Northern hemisphere during the Quaternary ice-ages. As to the actual date of the late Palæozoic glaciation there is still some doubt. Most British geologists regard it as late Carboniferous, but Schuchert (**26**) has recently forcibly maintained his view that it was Middle Permian. In both readings of the stratigraphical evidence it is recognized that there were somewhat earlier and later glaciations in New South Wales than can be recognized elsewhere.

In a recent book of fascinating interest Dr. C. E. P. Brooks has made a valiant attempt to demonstrate that these astonishing climatic events "were the logical result of the distribution of land, especially high land, and sea during that period, the poles being supposed to have kept their present positions" (**13**). For this purpose he adopted as a working hypothesis "a great plateau in the interior of Gondwanaland, rising gradually to an elevation of 10,000 feet." This assumption of great height certainly eases the meteorological problem, but it has no geological justification. Moreover, it doubles the difficulty of the physical problem, for now we should have to explain, first a great thickening of the sial of Gondwanaland and then its total disappearance from the very extensive oceanic areas that now intervene between the existing southern continents.

Brooks himself is not satisfied that his geographical solution explains the glaciation of India, and the non-discovery, so far, of satisfactory evidence of Antarctic glaciation during the late Carboniferous or early Permian is certainly more damaging to this attempt at a solution than it is to the less rigid hypothesis of continental drift. In the geographical solution the belt of Upper Carboniferous coalfields that stretches from North America through Europe and on to China naturally cannot be regarded as representing the tropical swamps of Köppen and Wegener (**14**). Nevertheless these authors seem to be justified by the weight of criteria, and if so, there remains in the field no alternative to some form of continental drift.

Additional evidence of positive value has been assembled by Harrassowitz (**15**) in his recent monograph on laterite. Fossil laterite profiles with more or less complete associations of laterite, bauxite, and kaolinite deposits have been found in the Upper Carboniferous of the United States (Kentucky and Ohio); Scotland (Ayrshire); Germany; Bohemia; Russia (South of the Moscow Basin) and China (Shantung). The inference that the equatorial zone of the time is roughly indicated by this belt is irresistible. It is, moreover, consistent with the correlation of the corresponding coal belt with tropical swamps. If the climatic conditions had then been such that laterite could have been produced over a wider zone than is possible to-day, then it is certainly remarkable that the only known remains should lie along a belt that would have been near the equator if the coast of Natal had at the same time been situated near the site of the South Pole.

Although the attempt to solve the problem made by Brooks fails to carry conviction—it is frankly put forward with diffidence—it remains an extremely interesting example

of how palæogeographical and meteorological data can be correlated and interpreted. Its methods, considered along with those of Dr. G. C. Simpson (**13**), are likely to prove valuable in pointing a way towards possible explanations of certain scattered inconsistencies that still remain. One of these is provided by the position of the Squantum tillites, near Boston, Massachusetts. Wegener himself discusses this special difficulty in his contribution to the Symposium. If the beds in question are truly of glacial origin, they appear to stand in flagrant contradiction to his views, since they occur near his Permo-Carboniferous tropical belt. He pleads for an independent and impartial investigation of the problem, but he adds, not without justification, that the glacial hypothesis of these puzzling beds is also hopelessly in conflict with the adjoining palæoclimatic evidence of the time. Neither the drift nor any other theory can be expected to explain interpretations that are mutually destructive.

Schuchert, for example, in a recent review of the subject, writes (**26**): "The presence of tillites means either very high mountains or a great lowering of the snow line, and both of these physical conditions react decidedly on the organic world, for which there is no evidence in the Pennsylvanian or Permian of North America." He nevertheless accepts the glacial origin of the beds, and considers that they were formed by alpine glaciers that originated in a high mountain range that lay to the south-east. He believes that the Coal Measures flora and the insects indicate a warm climate, but that there was a later change towards much cooler conditions, culminating in a world-wide glacial climate in the Middle Permian." It follows therefore that the difficulty may be partly one of faulty correlations, and that the Squantum tillites represent deposits from a Himalaya-like range that was a local centre of glaciation at the time when Gondwanaland was buried under a great continental ice-sheet. If this could be established it would be an interesting proof of a world-wide temporary lowering of temperature, the origin of which would therefore be cosmic. It would, moreover, leave Wegener's deduction unshaken as to the Polar position of Gondwanaland. Glaciers can occur in the tropics, but ice-sheets covering millions of square miles over a much longer period of geological time could surely occur only around one or other of the poles.

The Relation to Mountain Building.—Bailey Willis (in the Symposium) raises the objection that the sial must be weaker than the sima if the mountains of Western America are to be interpreted as a result of resistance encountered by the westward drifting sial of the American continents. Bowie points out that if the sima have no strength, as postulated by Wegener, the continental front could not be crumpled up into mountains; for, to use Longwell's simile, the sima would then yield like water before a floating raft. These three authors (**1**) —and many others—have thus drawn attention to a serious inconsistency in Wegener's discussion of the mechanism of drift. From the point of view of crushing strength the surface representatives of sial are certainly weaker than those of sima. For crystalline basalt or gabbro (grain size here is of little importance) the crushing strength is $12 \times 10^8$ dynes per sq. cm., whereas for granite the corresponding value is $8 \times 10^8$.

But these results only touch the problem superficially. In the first place the mountains of Western America represent not sial crushed against sima, but a vast geosynclinal belt of sediments crushed between two relatively approaching jaws of sial. Now a belt of thick sediments must necessarily be weaker than the bordering continental blocks. During the growth of the geosyncline the subsiding sial floor must have become thin as a result of the stretching or outflow of the lower levels of the sial (**7**). In either case the feebly radioactive lower levels are thinned very much more than the more strongly radioactive upper levels. The latter are deeply buried beneath a thick load of sediments which themselves are often more radioactive on an average than the original sial, since they are necessarily derived from the upper levels of the sial of the adjacent lands. Thus, in short, the continental blocks undergoing denudation at the top become uplifted, less radioactive, cooler, and therefore stronger; while the subsiding belt becomes filled with sediments, more radioactive, hotter, and therefore weaker. Granted a certain amount of drift, there is consequently no difficulty in promoting mountain building; the eastern block would necessarily squeeze the geosynclinal belt against the western block and mountains would be raised by compression and splaying out over the borderlands. The fact that only a narrow strip of the western block

(the *Cascadia* of Schuchert) can now be recognized may mean that most of it has been buried beneath deep-seated overthrusts from the east. According to this conception, much of the Atlantic could have been formed by the advance of the eastern block across the site of the Cordilleran geosyncline, and only later would North America as a whole have been enabled to push forward against the Pacific floor.

It must not be overlooked, of course, that a sedimented continental shelf may also be relatively weak, and may be piled up into mountains against the oceanic obstacle.

Here a second point arises suggesting that the superior crushing strength of crystalline basalt (= dolerite or gabbro) may be a misleading guide to its actual behaviour under stress differences in the earth. It is a well-known fact of metamorphic geology that old dolerite dykes in Pre-Cambrian gneissic areas have commonly been recrystallized to hornblende-schists, garnet-amphibolites and even eclogites while the adjacent gneisses show no sign of any comparable degree of recrystallization. The proof appears to be complete that a long-continued stress difference acting at moderate depths and temperatures finds dolerite more responsive than granite. In so far as rock-flowage can occur by recrystallization—a process well exemplified under more familiar conditions by the flowage of glaciers—dolerite or gabbro are certainly to be regarded as weaker than granite. Consequently, as the granitic rocks of the continents are pressed against the gabbro floor of the ocean, the rising stress difference will first overcome the opposing strength of the gabbro which will then be continuously deformed by flowage while the continental edge remains effectively strong.

It is next of importance to notice that the effect of a powerful stress difference on a thick floor of initial gabbro would not be to produce folded mountains of hornblende-schists and eclogites. The change of density from 3 to 3·3 or more and the simultaneous action of isostasy would lead, on the contrary, to marked subsidence, and oceanic deeps would result (**16**). On this hypothesis we should expect to find deeps along peripheral belts of the ocean floor where the compression is known (from the mountainous edges of the sial), to have operated recently; precisely, in fact, where they do occur.

In the Symposium it was recognized by Singewald that no one can say whether the ocean floor be folded or not, and van der Gracht pointed out that even if a mountainous bulge were produced in sima it could not possibly be maintained. My own view, for the reasons outlined above, is that the two kinds of material, *sial* and *sima*, adopted by Wegener to explain the two dominant levels (continental and oceanic-floor) of the earth's solid surface, serve equally well to explain the marked upward and downward departures from those levels. Compression and overthrusting lead to the uplift of plateaus and mountain ranges, when acting on deeply sedimented belts of the sial; and to equally marked subsidence (producing oceanic deeps) when acting on sima having the chemical composition and, to begin with, the mineral composition of an olivine-gabbro. The metamorphosed, folded and overthrust tract of heavy sima would be pressed down or would sink into the substratum, so making way for the continents to advance. Thus we get a definite clue to a possible means of "engineering" the drifting process.

A further clue is obtained from the early geological history of the Urals, which has been clearly described by von Bubnoff. The Urals are bounded on the west by the Russian shelf and on the east by the Siberian shelf, and until the close of the Silurian the Ural tract was itself part of the two stable regions which it now separates. At this time radiolarian rocks appear along a meridional belt, accompanied by basic lavas and intrusions of peridotites and gabbros, suggesting, as von Bubnoff says, "a great split invaded by foreign rocks from below." This particular geosyncline continued to develop until the end of the Devonian when compression and folding occurred, accompanied by granite intrusions. The evidence here points to distension as the cause of geosynclines rather than to magmatic denudation of the base of the sial layers. Now, if the triangular Russo-Fennoscandian block began to move away from the Ural belt at the end of the Siberian, one would reasonably expect evidence of contemporaneous mountain-building on the further sides. The movement would have components towards both the Scandinavian or Caledonian geosyncline and the Caucasus geosyncline. Fitting the expectation, each of these repositories of early Palæozoic sediments suffered acute orogenesis at the same time as the first Uralian geosyncline began to open. Lateral continental movement on a limited but demonstrable scale

is thus proved to have taken place, leaving a rift behind and raising mountains in front. On the other side of the Urals the Siberian shelf probably moved towards the rigid block of Angoraland, closing up the Yenisei geosyncline that lay between. Here, however, we cannot as yet be certain that the two events were strictly simultaneous.

A careful study by Dr. G. M. Lees of the Oman mountain arc, a range of middle Cretaceous age that trends across the easternmost corner of Arabia, and strikes out abruptly against the Indian Ocean at Ras Madhraka, leads him to the conclusion that its geological history is inconsistent with Wegener's scheme (**17**). In so far as the latter involves a movement of Africa to the west this criticism is certainly valid, and, as


Fig. 3.—Section across India and Central Asia to illustrate the Hypothetical Underthrusting of Asia, 2, by Gondwanaland, 1. Horizontal scale, 1 : 14,000,000. Vertical scale greatly exaggerated. Black represents *sima* supporting the *sial* (white) of the continental blocks. The dotted portion indicates the accumulated sediments of the Tethys which formerly lay between Gondwanaland and Asia. From Emile Argand (**18**, p. 349).

we shall see, Wegener has certainly insisted far too strongly on the dominance of a drift to the westward. The Oman arc seems to imply a Cretaceous movement of the Afro-Arabian block towards the east or north-east. At that time there was no Red Sea and India was probably still more or less attached to Africa and Arabia. It may therefore be suggested that the lost continuation of the Oman arc originally lay along the northern shore line of the primordial Indian block (of which only a southern triangular remnant is now visible). After the formation of the Oman arc the Afro-Arabian and Indian blocks parted company, and only the latter continued moving in the north-easterly direction. The missing part of the arc may therefore have been pushed far into Asia, and if so it possibly now lies deeply hidden below the great plateau of Tibet (e.g. between the figures " 1 " and " 2 " under " Kouen " in Fig. 3). This interpretation is—naturally perhaps—not considered by Lees, but clearly, if it be true in principle, it solves a very real difficulty along lines that involve the acceptance of some form of continental drift hypothesis.

In the Himalayas and the elevated region that stretches away for nearly a thousand miles to the high walls of the Kuen Lun and Nan Shan we have a magnificent and formidable example of a phenomenon that is precisely the reverse of that involved in the formation of oceanic basins on sites that were previously continental. Over this vast region, which was formerly below sea level, the sial has been greatly thickened, and in the higher parts even doubled. It is clearly impossible that contraction could have produced such an effect on this gigantic scale ; yet indubitably it has happened. According to the continental drift hypothesis a great northward extension of Peninsular India has been bodily thrust under the Tibetan plateau. Argand's bold and eloquent picture of the structure, here reproduced from his *Tectonique de l'Asie* (**18**) shows graphically that the mechanism portrayed thickens the sial to the appropriate order required for isostatic equilibrium. Wild though this conception may seem, it is nevertheless in harmony with the extravagant geological history of Tibet and the Himalayas ; it explains the mysterious disappearance of the Oman arc ; and it recognizes the almost incredible northerly drift of India that is implied by the facts (*a*) that in late Carboniferous times India was glaciated from the south ; whereas (*b*) from the Eocene onwards it became the active site of laterite formation.

The Directions of the Dominant Movements.—Several of the authors of the Symposium (**1**) differ from Wegener with regard to the direction of drift. The contribution made by F. B. Taylor (who advo-

cated a drift hypothesis two years before Wegener delivered his famous 1912 address) is worthy of serious attention in this respect. He draws an apt analogy between continental sial-blocks and continental ice-sheets, and pictures the crustal movements as having been radial and dispersive from both polar regions. Like du Toit (**2**) he regards the land of the northern hemisphere as being surrounded by an orogenic ring, nearly closed except across the Atlantic, and he describes the arcuate ranges as marking the terminal regions of " currents in the crust." The ring is obvious if one follows on a globe the following ranges: Alpine-Himalayan system—Asiatic Island festoons—Alaskan ranges—Cordillera of Western North America—Ranges of Honduras and the West Indies. Within it lie the great disruptive basins of the North Atlantic and Arctic oceans. Similarly in the south, as was first clearly recognized by Dr. J. W. Evans, the movements appear to have been more or less radially outwards from Africa towards the Pacific, the South Atlantic, Indian and Southern oceans being the corresponding disruptive basins left between.

Considerable movement from Asia towards the Pacific is indicated by the echelon structure of the island festoons. The analysis of these remarkable arcs by Tokuda (**19**) and his Japanese colleagues, and his success in imitating the structures by simple but illuminating experiments, point to a series of outward movements from continent to ocean. The orogenic forces cannot have been applied from above, and therefore movement of a substratum towards the Pacific seems to be implied. In each case the maximum amplitude of movement has been towards the middles of the arcs, becoming gradually less towards the more stable buttresses (Kamchatka, Yezo, Formosa, etc.) intervening between successive arcs. This conclusion agrees with the original surmise of Suess and indicates that Wegener's view of the island festoons as lag structures left behind during the westward drift of Asia cannot be maintained.

E. C. Andrews (**20**) has made a valuable comparative study of the mineralization of the lands bordering the Pacific, and particularly of Australasia, East Asia and North America. Despite the fact that on the American side the tectonic elements are closely pressed together, he has made it clear that there has been a marked outward growth of each of these continental areas. With advancing time, from the Pre-Cambrian onwards, the ore-deposits of each region appear successively further and further towards the present periphery, as if there had been a sub-continental outward spreading of ore-carrying material. Speaking generally, the ore-deposits are related to zones of mountain building and igneous activity—often in arcs—with the youngest nearest the ocean and the oldest farthest within the continents.

The movements involved in the changes that have affected the face of the earth since the close of the Palæozoic, thus appear to involve a breaking up of Laurasia and Gondwanaland with in each case a radially outward drift of the individual parts towards the Pacific and the Tethys. But this is not all. It is also necessary to assume a general drift, probably involving the whole of the crust, with a northerly component on the African side sufficient to remove Natal from the neighbourhood of the late-Carboniferous South Pole, and Britain from the late-Carboniferous tropics. This analysis results in a picture very different from Wegener's, but it is believed to be an accurate representation of the general tendency of the movements that seem to be required by the evidence.

Some Possible Causes of Continental Drift.—As early as 1875, Suess deduced from his early studies of Alpine structure that " A mass movement, more or less horizontal and progressive, should be the cause underlying the formation of our mountain systems," but not unnaturally his conception of the process was cloudy. Bailey Willis in his well known text-book " Geologic Structures " draws a sound deduction when he writes (p. 131) " the evidences of movement noted in rock structures are so numerous and on so large a scale that it is clear that dynamic conditions exist from time to time; that is to say, conditions of very active movement. These require the development of unbalanced forces and, since rocks are exceedingly rigid and exceedingly strong, these unbalanced forces must be very great." Our next tasks are to deduce from the evidence what kind of unbalanced force is implied, and to try and identify a natural process competent to wield it effectively.

There can be no doubt that the reluctance on the part of many geologists to accept the straightforward testimony of the rocks in favour of continental drift is due to the fact that no gravitational or other force adequate to move the continental blocks in the required

directions has been recognized. The two chief forces discussed by Wegener have been already mentioned (p. 206). Considering the drift from the poles towards the equator, Jeffreys has recently shown that, assuming the absence of strength in the substratum, the present viscosity that resists the movement is such that it would take about 3,000 million years for the whole crust to become symmetrical—as regards the distribution of continents—about the equator. With a less viscous substratum the time required would of course be less; and just after the separation of the moon, the sial regions of the earth must have been symmetrical about the equator, for, had they not been, a very short time would have sufficed to make them so. As the earth is believed to have passed through the whole range of mechanical conditions from those attending the birth of the moon to those of the present day, it follows that the continents should never have got away from the equatorial belt at all. Thus it appears that the very distribution of the continents relative to the equator is itself an indication that some unrecognized agency has been at work to move the continents into the positions they now occupy.

The potential westerly drift due to tidal friction is wholly incompetent to move one continent relative to another, since the strength of the ocean floor would first have to be overcome. I am indebted to Dr. Harold Jeffreys for the information that tidal friction would have to be ten thousand million times as powerful as it is to produce the effects ascribed to it, and that incidentally it would then produce the fatal but unavoidable effect of altogether stopping the rotation of the earth in about a year. The special interest of this *reductio ad absurdum* is to show that if continental drift has occurred, the motive force cannot be of external origin (as tidal friction is) but must arise within the earth itself.

This conclusion shows that Taylor goes astray in the Symposium when he suggests that the "crust-moving force was of external origin." His particular hypothesis is that tidal forces would be adequate to explain the phenomena provided that the moon had been captured by the earth during the Cretaceous period. Unfortunately, even if this extravagant claim could be justified, we should be as far as ever from an explanation of the Hercynian, Caledonian, and older systems of folded mountains.

Joly's well known hypothesis of thermal cycles should also be mentioned here. According to this there is produced periodically a fluid substratum, which (if it were less viscous than the existing substratum) would undoubtedly facilitate slipping between the crust and the interior. Tidal drift aided in this way, would be likely to affect the whole crust, and could not do much in the way of initiating differential movements between the different parts. Joly makes a short contribution to the Symposium, and his most interesting point is that an aggregate of continents such as Wegener's hypothetical Pangaea could not exist permanently on account of the generation and accumulation beneath it of heat of radioactive origin, some means of escape for which would have to be provided. Unfortunately it has to be recognized that the theory of thermal cycles in its present form has not fulfilled the high hopes that it originally encouraged. I have elsewhere given a list of reasons for thinking it unsatisfactory and these need not again be repeated (**22**).

In the light of this preliminary survey it should now be clear that what is needed to move the continents about, as they appear to have moved, is a mechanism operating beneath the continents capable of stretching or splitting them and of dragging the parts away from each other. The radially outward movements of Laurasia and Gondwanaland suggest at once that a system of overwhelmingly powerful convection currents was generated beneath each great land mass. Mobility of the substratum is here undesirable; only currents in a highly viscous glass could get a sufficient "grip" on the continental under-surfaces to exert the requisite drag upon the overlying material. The possibility of the existence of such currents was recognized by A. J. Bull eight years ago in a paper (**23**) that has not received the attention it deserves. More recently Jeffreys (**21**) has made the important statement "that the viscosity found for the lower parts of the shell (i.e. of the substratum down to a depth of 2,900 km.) is not enough by itself to prevent convection currents."

All, then, that is necessary to start such currents is that adjacent regions of the substratum should be unequally heated, and that, as in Joly's hypothesis, more heat should be generated at some depth beneath the continents than can escape through the overlying rocks by conduction. A slow but massive current (which might be reinforced

by magmatic differentiation as it progressed) would then rise up beneath any region underlain by material having a greater heat output than that of the surrounding regions. One example of such a region would be a large continent (implying a radioactive cover) surrounded by oceans (free from such a cover). As the ascending currents approached the base of the crystalline crust they would turn over and exercise a powerful drag on the under-surface in radially divergent directions. The complementary downward currents would become strongest beyond the continental edges.

Each part of the continental mass would be enabled to move forward by the fracturing and foundering of the heavy ocean floor immediately in front, probably accompanied by over-riding of the ocean floor along thrust planes more or less lubricated by magmatic injections from the substratum. The sites of the ascending currents would become disruptive basins. Here the accumulation of excess heat responsible for the process would be discharged by the development of a new ocean floor and the current would consequently fade out. Meanwhile mountain building would have been accomplished on the continental margins or on the sites of former geosynclines and thus a totally new heat distribution would arise which would gradually generate a correspondingly different set of convection currents. The squeezing out of the more mobile parts of the substratum to form crustal magmas is an attractive side issue that opens up a new vista of possibilities in petrogenesis, and gives a hint as to the origin of basalts.

A point of great physical importance is that the currents move both their own boundaries and the sources of the heat responsible for their existence. Thus on every kind of scale from saggings of the crust to ocean basins, or from broad domes to great mountain systems, the vertical distribution of radioactivity in any one region may be periodically varied as geological history proceeds—specially hot regions tending to be opened out so that they become sites of rapid cooling; and specially cooled regions tending to be closed up or pushed down into the depths.

The case of a geosyncline lying between two continents, and filled with sediments more radioactive than the surrounding sial, will clearly give rise to a very complex interplay of opposing currents, such as may be necessary, for example, to explain the extraordinary phenomenon of the western basin of the Mediterranean between the Alps on the north and the Atlas on the south. The foundering of blocks of the compressed borders of the ocean floor is also a process which will contribute towards the constantly changing distribution of the radioactive elements. In general, convection currents on the gigantic scale here envisaged provide a physically sound mechanism for bringing about alternate accumulation and discharge of heat in any one region. The process is consistent with the proved simultaneous occurrence of tension and compression, this being a combination that speaks strongly against the validity of both the contraction hypothesis and the hypothesis of world-wide thermal cycles.

The convection currents hypothesis has also a great advantage over that of thermal cycles in so far as its alternations of compression and tension are not periodic on a world-wide scale. In this respect the ingenious mechanism conceived by Joly is far too ideal to match the facts of geological history, and my own first efforts to bring in a little more variety by adding peridotite cycles to the original basaltic cycles (**24**) equally fail to meet the requirements. The very complexity and the incalculable variety of the interactions of convection currents hold out a distinct promise that a theory based on them is much more likely to be ultimately successful than either of its predecessors. Moreover, it provides an answer to those critics of Wegener who wonder—like Schuchert, Longwell, and White (in the Symposium)—what forces can have conspired to hold the sial together in the great land-mass of *Pangaea* until Mesozoic time. There is of course, neither proof nor probability that there ever was a single *Pangaea*, and it is reasonably suggested by van der Gracht that there may have been a pre-Carboniferous "Atlantic" that was closed up during the Caledonian orogenesis. He is careful, indeed, to commend Wegener for not leading us into a discussion of remote periods concerning which our knowledge is still very meagre. The difficulty was nevertheless a real one so long as only gravitational forces were considered. Granted convection currents, the continents may open out and reclose in an endless variety of patterns.

This is not the place to develop the physics of the process that is here advanced as a contribution toward the solution of the tectonic problems of geosynclines, mountain-building and (at least in considerable part) of continental drift. So far as I can judge,

there is no direct evidence adverse to the assumptions made, and a preliminary attempt to evaluate the shearing stresses involved shows that they are of the right order to do the work required and to do it in the given time. The confident assertion that it is "impossible" can, at any rate, no longer be brought against the hypothesis of continental drift. Merely to prove Wegener wrong is no longer an important issue.

There still remains, however, one very serious difficulty. On p. 344 I indicated that in addition to the radially outward movements of Laurasia and Gondwanaland there appeared to have been a general drift of the whole crust over the interior with a marked northerly component on the African side. Convection currents may explain the former; they cannot, unfortunately, have much bearing on the latter. But it must be remembered that there are other processes at work besides those that are due to gravitation and heat. No one has yet solved the problem of terrestrial magnetism to the general satisfaction, and until there is a solution it would be hazardous to speculate too far as to the possibilities of forces that may be set up by the interaction of magnetic and electric fields. Meanwhile, until these are adequately explored—and they are undoubtedly of the kind called for to solve this final riddle—no one can say that the crust may not be able to move relative to the poles. I am assuming the truth of the orthodox opinion that the poles themselves do not shift to any considerable extent relative to the earth as a whole, and that the real problem to be solved is therefore that of a bodily movement of the whole crust which can be superimposed on those more easily intelligible movements here ascribed to convection.

It is perhaps fitting to close on a note of perplexity, tempered, however, with the assurance that the circumstantial evidence of geology is not likely to be leading us far astray so long as we read it aright. One valuable feature of the continental drift hypothesis is that it is everywhere arousing interest in world-geology and in the geophysical methods of exploring the depths; methods which, by X-raying the earth, will sooner or later put the hypothesis to severe and searching tests. Meanwhile, we may perhaps be forgiven for attempting an interpretation of such data as we possess. Pierre Termier in an eloquent address on the same subject as this paper (**25**) well expresses the mental urge with which some of us, steerage passengers on the good ship Earth, are afflicted. "The least ignorant among us," he says, "the most daring, the most restless, ask ourselves questions; we demand when the voyage of humanity began, how long it will last, how the ship goes, why do its decks and hull vibrate, why do sounds sometimes come up from the hold and go out by the hatchway; we ask what secrets do the depths of the strange vessel conceal, and we suffer from never knowing the secrets."

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# EARLY GEOPHYSICAL PROSPECTING

By WILLIAM R. JONES, D.Sc., D.I.C., F.G.S., M.Inst.M.M.

The author gives a valuable historical record of the work of British pioneers in establishing principles.

*(Concluded from the May issue, page 272.)*

Early in 1853 Mallet obtained permission from Mr. Rendel, the Engineer-in-Chief of the Government quarries at Holyhead, to carry out experimental determinations of wave-transit in the neighbouring rocks, and received a grant from the British Association for this purpose. It was not, however, until 1856 that he was able to superintend this experimental work, largely because two shipping companies, named in his paper, "refused to render any assistance whatever," whereas, it is cheerful to add, Messrs. Rigby, the contractors of the quarries, "afforded every possible help."

More interesting conditions could scarcely be found for these experimental determinations of the transit-rate of earth waves, because "one of the rocks chosen, a schist, presents in the highest degree the properties capable of producing dispersion, delay, and rapid extinction of the wave impulse."

To ensure that the gunpowder charges in different parts of the quarries were fired at the same instant, the "electro-positive wires were connected with one mercury cup, and the electro-negative wires were led into the other mercury cup." Mallet himself, at a given signal, fired the charges and the necessary data for his purpose were then obtained from the recorded chronographs and seismographs.

The results obtained fell into two groups, corresponding with the smaller and larger charges of gunpowder, and Mallet concluded that the velocity of wave propagation "really does increase with the force of the original impulse." The general mean derivable from the whole of the experiments gave 1,176·407 feet per second for the transit rate. "The experiments of Mr. Goldingham in Madras on the retardation of sound in moist air, and the terrestrial researches of Mr. Earnshaw both, by analogy, rendered *à priori* probable what is now for the first time," as Mallet states, "proved experimentally." He came to the conclusion that the three elements upon which the wave-transmissive power of a rock formation mainly depends are (1) the modulus of elasticity of its material, (2) the absolute range of its compression by a given impulse, and (3) the degree of heterogeneity and discontinuity of its parts.

To test the relation between the velocity of impact and that of recoil, a quantity that bears the most intimate relation to the wave transmissive power of rocks, he dropped billiard balls on masses of quartz and slate, and upon large isolated blocks of these rocks, making the impacts both transverse to the stratification and foliation, and along their planes.

A very complete series of experiments, to determine the compressibility and modulus of elasticity of different rocks, were carried out at this time for Mallet at the Royal Arsenal, Woolwich, and the tabled results are given in Mallet's paper.[1] It was shown, for example, that in the direction of the laminae the compressibility of slate is twice that of compact quartz whereas, in a transverse direction, its compressibility is almost equal to that of quartz. Mallet draws attention to the fact that twice as much work is necessary to crush slate in one direction than at right angles to that direction, and points out the economic significance of this fact to builders.

The importance of Mallet's pioneer work becomes apparent when we consider that before conclusions can be drawn about the physical character of rock formations from the behaviour of elastic waves, produced artificially in the Seismic Method of geophysical prospecting, the elastic constants of the particular rocks traversed by these waves must be known, or determined experimentally. The interpretation of the behaviour of these elastic waves demands highly specialized knowledge, for when the waves reach the boundary of two rock formations of different elastic properties, reflection and refraction take place, and for every longitudinal and transverse wave which encounters the boundary, a refracted and reflected wave of each kind is produced, resulting in a highly complicated state of wave motion, made still more complex by the fact that several types of surface waves are produced. As early as 1848 [2] Mallet had

[1] Robert Mallet, "Report of the Experiments made at Holyhead, North Wales, to ascertain the Transit Velocity of Waves, analogous to Earthquake waves, through the local Rock Formations." *Reports* of the Brit. Assoc., pp. 201–136, 1861.

[2] Robt. Mallet, *Trans.* Royal Irish Academy, Dublin, vol. 21, pp. 50–106, 1848.

discovered the existence of transverse waves ; and in 1887 [1] Lord Rayleigh had shown that the most important of the surface waves were those which, even to this day, are known as the Rayleigh waves.

The data obtained by Mallet, and his deductions, were later modified by John Milne, the famous authority on earth tremors, who drew attention in 1892 [2] to the great importance of resonance phenomena and period length of these waves, pointing out that the greatest amplitude of vibration is increased in proportion to the acceleration ; and in 1903 [3] he published time distance curves and tables based on reliable practical and theoretical data. It must not be forgotten, also, that so far back as thirty-four years ago [4] earth tremors were produced artificially by Milne by means of falling weights ; and in 1923 Professor Jeans explained the conditions for the observed appearances and development of vibration perpendicular to the direction of propagation of the surface waves.

The Magnetic Survey Method of geophysical prospecting is based on the different effects produced on sensitive instruments by magnetic, paramagnetic, and diamagnetic minerals. Much of our present knowledge of the direction and intensity of terrestrial magnetism is due to the careful work of the Rev. Humphry Lloyd, F.R.S., assisted by Captain Edward Sabine and J. Clarke Ross, F.R.S., who, on the recommendation of the British Association, determined the direction of the lines of magnetic dip and intensity in Ireland during 1834 and 1835. Their results are given in great detail in the Report of the British Association for 1835, one of the instruments employed by these investigators being a magnetic vertical balance designed by Lloyd.

R. W. Fox, the first to discover the existence of natural electrical potential differences in the earth's crust, invented, some time prior to 1838,[5] a " dipping needle deflector " which could be used successfully to find the magnetic declination, to ascertain the dip, and to determine the terrestrial magnetic intensity by means of weights, instead of observed angles. Fox had used his instrument in England as well as " various places on the continent " previous to 1838, and the Editor, in a footnote to Jordan's paper,[1] states " We have long solicited Mr. Fox for a description of his ' dipping needle deflector,' being well aware that many of our readers would be much interested in it." The graduations on the parallel circles of the instrument being coincident, they served to direct the line of sight and to prevent parallax in determining the position of the needle ; and by taking off the deflectors and placing the fine silk, with hoops attached, on the grooved wheels, suspending weights to one of the hooks to coerce the needle to a given distance (say 50 degrees from the actual dip of the station) and changing the weights to the other hook till the needle is coerced 50 degrees on the opposite side, the weights required will indicate the magnetic intensity at the place of observation as compared with that ascertained in the same manner at another place. Fox found that if the needles were " tempered very hard throughout, and after having been magnetized, heated to 180 to 200 degrees, they retained their force without any appreciable loss for a long period " ; and he found also that the needles attained their maximum force after having been rubbed by a magnet two or three times only. Fox's instrument was found to be useful for geophysical prospecting where pronounced magnetic disturbances occurred.

W. H. Barlow showed in 1849 [2] that the disturbance field produced by the daily fluctuations of the normal magnetic field was caused by cyclones of electric charges, or " those disturbances which circulate in the highest part of the earth's atmosphere and were influenced by the sun's rays " ; and A. W. Rucker and T. E. Thorpe later conducted a very thorough examination, in their magnetic survey of Great Britain, of the regions of magnetic disturbance, their conclusion being that such disturbances were caused by rock masses of higher magnetic permeability than the surrounding formations. A. M. Field, and A. Harker the world-renowned petrologist, contributed valuable information [3] on the magnetic anomalies

[1] Lord Rayleigh, *Proceedings* of the London Mathematical Society, vol. 17, pp. 4–11, 1887.

[2] *Nature*, London, vol. 45, p. 127, 1892.

[3] *Nature*, London, vol. 67, pp. 538–539, 1903.

[4] John Milne, *Transactions* of Seismological Soc. of Japan, vol. 1, p. 82, 1885.

[5] " Description and Use of a Dipping Needle Deflector invented by Robt. W. Fox, Esq.," by T. B. Jordan, *Annals of Chemistry*, vol. 3, pp. 288–97, 1838–9.

[1] Op. cit.

[2] W. H. Barlow, *The London, Edinburgh and Dublin Philos. Mag. and Journal of Science*, London, pp. 344–347, 1849.

[3] A. M. Field and A. Harker, *Proceedings* of Cambridge Philosophical Society, Cambridge, vol. 10, pp. 268–278, 1900.

observed in the Hebrides due to the mineral composition of the rocks of the neighbourhood. The extent to which terrestrial magnetism can be used for geological purposes was summarized by A. Strahan and H. Cox.[1]

The application of the Radio-active Method of geophysical prospecting has the advantage of simplicity, but hitherto it has not been much practised and is best considered, for the present, to be in the experimental stage so far as it concerns prospecting for ore deposits. It has been claimed for this method, however, that it has been used successfully in locating faults and fissures, and that it has proved of great value in examining the nature of foundations intended for large buildings, and the sites for dams and tunnels.

Lord Rayleigh was the first to hypothecate [2] that the radio-active minerals are concentrated only in the uppermost parts of the earth's crust, and the correctness of his hypothesis has more recently been upheld by Koenigsberger.[3] In 1904 Burton [4] drew attention to the high radio-activity of petroleum, and suggested that this was due to its great solubility for emanations. Joly and Rutherford [5] came to the conclusion in 1913 that the relative age of radio-active minerals could be determined from the special study of the related pleochroic haloes, and Holmes [6] did valuable research work in this connection. Joly and Smith had already, in 1911,[7] shown that the emanation content of the atmosphere, for extensive areas, runs parallel with the average content of the radio-active constituents of the rocks forming the subsoil, and that slowly accumulating sea mud is very radio-active.

The claim is made, in this brief historical record of the work of British pioneers, that Robert W. Fox is the father of geo-electrical prospecting. Much valuable information, used in this method, has been contributed also by other British workers. In 1862 Walker [8] showed that atmospheric conduction, and electric cables, could be considered as equivalents to artificial connection between electrodes, and that the return current must be comparatively deep beneath the earth's surface. From his observations of earth currents on different sections of telegraph lines, with variable currents, he came to the interesting conclusion that there was a relation between the earth currents and the geological nature of the subsoil. Horace Lamb, in 1883, showed that by the reaction of the current lines to one another, a certain distortion would be produced in the current lines as well as in the equipotential lines, of an alternating current system as contrasted with the direct current system; and also through the electromagnetic reaction of magnetic substances in the earth's crust. His two articles [1] are entitled "On the Induction of Electric Currents in Cylindrical and Spherical Conductors" and "On the Induction of Electric Currents in a Cylinder placed across the Lines of Magnetic Force." The method of measuring the magnetic permeability of substances by observing the change in the inductance of two rigid coils, when a core of the substance was inserted, is due to Hughes and Rücker who have described this method [2]. From a series of experiments conducted at Ben Nevis in Scotland, Dickson [3] hypothecated that in mountainous country the current almost invariably flows upwards, that is, the electrode at the greater height becomes charged negatively in relation to the lower electrode, but pointed out that this was true only so long as the summit remained clear; when cloudy, the earth current is in the reverse direction.

Leo Daft and Alfred Williams are the undoubted pioneers of the "flying searching auxilliary circuit" for the detection of the distribution of electric currents in the earth's crust, and the present application of geo-electrical prospecting is, to a great extent, a modification of that originated by these co-workers, and described in their British Patent No. 14142 of the year 1902, under "Improved Apparatus for Detecting and Locating Underground Metallic Lodes." References to their "new method" will be

[1] *Nature*, vol. 101, pp. 257–258, 1918.
[2] *Proceedings* of the London Mathematical Society, vol. 17, pp. 4–11, 1887.
[3] J. Koenigsberger, *Geologische Rundschau*, Berlin, vol. 1, pp. 241–249, 1910.
[4] E. F. Burton, *The London, Edin., Dublin, Phil. Mag. and Jour. of Science*, vol. 8, pp. 498–508, 1904.
[5] J. Joly and E. Rutherford, *ibid.*, vol. 25, pp. 644–57, 1913.
[6] A. Holmes, *Age of the Earth*, Benn Bros., 1913.
[7] J. Joly and L. B. Smith, *Nature*, vol. 87, p. 101, 1911.
[8] C. V. Walker, *Philos. Trans.* of Royal Society, London, vol. 152, pp. 203–219, 1862.

[1] H. Lamb, *Proceedings* of the Mathematical Society, London, pp. 139–149 and 270–274, 1883.
[2] *Nature*, vol. 20, pp. 77–81. 1879.
[3] H. N. Dickson, *Proceedings* of Royal Society of Edinburgh, vol. 8, pp. 530–46, 1886.

found in the *Electrical Review*,[1] and in the *Electrician* of the same date on page 977, with diagrams; and in the New Zealand Mines Records of Oct. 17, 1904, an account is given by S. F. Franco of the results obtained by the application of "electrical prospecting by the Daft and Williams method." It is interesting to note, also, that Messrs. H. T. F. Lundberg and J. T. H. Nathorst, in their complete patent Specification No. 129621 "Apparatus for Discovery and Determining Electrically the Location of Veins of Ore or Mineral" (accepted Feb. 26, 1920) make reference to this method.

Daft and Williams employed a primary source of electrical energy supplied from a battery at a comparatively low voltage, which was transformed to a high voltage ranging from 30,000 to 150,000 volts. By means of a specially constructed spirit break and spark gap, waves of any desired frequency could be obtained from the secondary, and the high voltage current impulses were conducted by surface wires to the desired spot. One wire was connected with a short rod, the point of which was thrust into the ground and served as a pole or electrode. A similar rod, forming the second electrode, was fixed at a chosen spot, either on the surface or underground in a mine or tunnel.

The position of an orebody was determined by means of a separate apparatus consisting of about 10 yards of insulated wire attached to a delicately constructed "resonator," tuned to receive from the earth the electrical oscillation produced by the inductor, and connected to two spiked earthed rods, or electrodes. Any difference of potential between two points would cause a current to be shunted through the telephone and a note would be heard, the degree of loudness varying with the difference of potential, silence indicating two points of equal potential. The investigator "placed the detector in the position which, in his judgment, was most likely to lead him to the discovery of any vein or ore in the vicinity. The normal sound in the telephone receivers would be noted, and the detector line would then be moved gradually round at a distance of 40 or 50 feet and the character of the sound noted. If no other sound than the clear note were perceptible within this radius, the instrument would be moved to a fresh area, and this would be similarly explored." In the event of any clear variation from the normal sound, that part of the area would be tested as closely and accurately as possible to obtain data on electrical potential differences resulting from the probable occurrence of an orebody.

[1] No. 1323, vol. 52, p. 559, of April 3, 1903.

## Conclusion.

When, some five years ago, the writer was engaged in collecting material for his book "Tinfields of the World," he came across some very interesting references to the early experimental geophysical work, in Cornish tin mines, of Fox, Bennets, Henwood, Hunt and others; and recently, when opportunity occurred, his investigations were extended, resulting in this brief history of the work of British scientists in establishing the principles on which are based the present-day geophysical methods of prospecting for ore deposits, and for determining tentatively certain tectonic and other geological features. Geophysical prospecting has undoubtedly a great future; it is to the geologist, when conditions are suitable, what X-rays are to the surgeon, and it is of the greatest importance that the application of geophysical methods should not be unduly restricted by patent rights, such as are claimed by some geophysical companies.

From this investigation of the early history of the subject it would appear that validity of many of such patent rights at the present time is open to question, because the principles on which they are based were founded by our countrymen, and given freely to us. It may be that the designs of certain geophysical instruments are copyright, but fortunately the methods would seem to be our birthright. The writer has pleasure in acknowledging the help he has received, in his search for references, from the published works of Dr. R. Ambronn, of Göttingen.

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**The Institute of Metals.**—The annual autumn meeting of the Institute of Metals is this year being held at Dusseldorf, at the invitation of the Verein Deutscher Ingenieure and of the Deutsche Gessellschaft für Metallkunde, from September 9 to 12. This is the first time the Institute has met in that country and will also be the first post-war gathering of metallurgists and engineers there. A large attendance is anticipated.

# LETTER TO THE EDITOR

## Solubility of Cassiterite

The Editor:

SIR,—Dr. H. C. Boydell's remarks on the solubility of cassiterite in the February, 1929, Bulletin of the Institution of Mining and Metallurgy remind me of my letter on this subject in the January, 1928, number of THE MINING MAGAZINE. In that letter I asked if anyone could lend me a specimen of amorphous tin dioxide from a tin-vein, or a specimen of "immature tin" or "tin-stone in the making" for examination. I had one reply to that request. A correspondent very kindly sent me a specimen of a Cornish greenstone said to contain tin dioxide in a form soluble in a mixture of hydrofluoric and hydrochloric acids. The specimen was very carefully examined here optically and chemically and found to contain only a very minute trace of tin which may have been present in stannite but the amount was so small that nothing definite could be said about it. I am still anxious to see a specimen of amorphous tin dioxide from a tin-vein, "immature-tin" or "tin-stone in the making," and shall be grateful if anyone will lend one.

Yours faithfully,
J. B. SCRIVENOR,
Director, Geological Survey,
Federated Malay States.

Batu Gajah.
*April* 6.

# BOOK REVIEWS

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

**Petroleum and Coal: The Keys to the Future.** By W. T. THOM, JR. Cloth, octavo, 223 pages, illustrated. Price 11s. 6d. Princeton University Press, New Jersey, U.S.A. London: Humphrey Milford, Oxford University Press.

This little book is an attempt to portray the vital importance of coal and petroleum to modern civilized man, both from the point of view of the individual, and of nations. In addition to this the author attempts a description of how the two mineral substances originated, and how they are distributed in the earth's crust. In these laudable attempts he is unfortunately not strikingly successful. Coal and petroleum are not human foods, but the fact remains that if, at the wave of a magician's wand, all the coal and petroleum of the world disappeared to-day, at least half of the civilized world would die of starvation within a month. A perusal of the book leaves one wondering whether the author fully appreciates this sort of thing.

Concerning the origin of coal the author says: "To those who have seen coalified tree stumps still standing in coal beds and the multitudes of roots and rootlets in the under-clays, the origin of coal is clear and easily to be read." I should like to ask the question: How many people have seen coalified tree stumps standing in coal seams with their roots still attached to them and firmly embedded in the under-clays? The author also tells us that "a normal woody coal is composed of alternating bands of bright and dull coal, the brighter bands representing flattened tree trunks or fragments of relatively well preserved wood, whereas the duller bands are composed either of the organic mucks formed from finely macerated leaves and rotted matter, or of mineral charcoal." When it is realized that frequently a bright band in coal is continuous over a large area, it is perhaps permissible to borrow an Americanism and say: "Some tree." We are further told that coal is transformed peat, the transformation being accomplished "in part by the weight of the sediments beneath which the peat bed becomes buried; in some instances by the heat of lavas injected near the bed; and principally by the heating and squeezing produced by compressive forces in the earth's crust which causes folding of stratified rocks, visible in most mountain regions." All this is the old, old, text-book theory, which long ago has been realized to be incapable of explaining satisfactorily all the known facts in regard to coalfields. Similarly in the case of petroleum, the general theory of origin given is by no means up to date.

The distribution of the world's coalfields, as portrayed in the book, is astonishingly inaccurate in places, and the fact that the inaccuracies are on maps stated to have been adapted from the U.S. Geological Survey World Atlas of Commercial Geology comes as an additional surprise. In the map of the coalfields of Europe, for instance, we find that the whole of the Isle of Man is

mapped as a coalfield. In the map of the coalfields of Asia we find the Upper Assam coalfields placed in Burma ; the whole of the Khasia and Jaintia Hills shown as a coalfield, situated partly in India and partly in Burma ; the Salt Range of India appearing as one large coalfield ; while Darjeeling appears to be fortunate enough to have a large coalfield on its doorstep. The Burma coals are ignored, on the other hand. In the text we read that " the coal measures of India and Burma are as yet imperfectly known." I would assure the author that this is hardly the case, and would refer him to the Geological Survey publications and maps. The coal measures of India and Burma are probably as well known as those of any other country.

With regard to the occurrence of oil we read that in Burma " two main groups of fields exist, occupying anticlinal flexures parallel to the mountain range west of the Irrawaddy, some of these folds rising as islands along the Arakhan coast. Some oil has been produced in Assam on folds related to those of the Burma fields." The Burma and Assam fields are old friends of mine, and I cannot but feel that the above is not a good description of them. In point of fact the descriptions given in the book as regards America are presumably accurate and illuminating, but with regard to the rest of the world they appear to be frequently sketchy and vague, and sometimes actually inaccurate. The statement that anthracite is the standard domestic coal, for instance, doubtless applies to the United States, but it is certainly not true for this country.

Taking the book as a whole, one is left wondering whether the hints of future wars for the possession of the world's remaining oil reserves, in the days when supplies are running dry, are quite unconnected in the author's mind with a feeling that America at present may be squandering her resources while certain other countries are being more prudent. Whatever the future may bring forth, America should never forget that she has been blessed with her full share of the world's store of petroleum, " and then some " (if one may be forgiven for borrowing again from her own expressive language).

The aim of the book is praiseworthy in the extreme, and because of this it should be widely read in spite of the foregoing criticisms.

MURRAY STUART.

**Instructions for using the Quantitative Mineralogical Classification of Eruptive Rocks proposed by S. J. Shand.** Pp. 16. T. Murby and Co., London, 1929. Price 1s. 3d.

The attention of those interested in rock classification is directed to this little booklet which has been prepared by Professor Shand for the use of students and others. The first eight pages deal with rocks that are completely determinable by means of the microscope and micrometer. Particular attention is given, not only to the importance of quantitative measurements of mineral proportions, but also to the necessity for making accurate determinations of the felspars, particularly of the alkali and perthitic felspars. In referring to his recording micrometer, Professor Shand severely criticizes the model put on the market by Messrs. J. Swift and Son on the grounds that the length of travel is too short. The actual length of travel in the instrument we have at Durham is 15 mm. During the last few years I have measured sections of about eighty rocks with this, and while I have often felt that a length of travel of 20 mm. would be a distinct improvement, I cannot agree with Professor Shand that the usefulness of the instrument has been " almost destroyed " in the Swift design. I have, indeed, had occasion to feel grateful to Professor Shand for describing his micrometer and to Messrs. Swift for constructing an instrument in which the Shand principle is applied. It may, however, be desirable to state that in their next batch of recording micrometers, Messrs. Swift intend to modify the mechanical construction so as to give an appreciably longer range. It is unfortunate that Professor Shand should not have been in a position to temper his criticism by holding out this hope of future improvement.

The next four or five pages are devoted to rocks that are not completely determinable by optical means. Professor Shand has himself published an interesting application of the suggested methods to a pitchstone from Fifeshire (*Geol. Mag.*, March, 1929, pp. 116–121). The pamphlet concludes with a tabular arrangement of the groups recognized in the classification. As a whole, the summary will undoubtedly prove of service to students using Professor Shand's textbook on " Eruptive Rocks."

ARTHUR HOLMES.

# NEWS LETTERS

## BRISBANE

*April* 15.

Mount Isa Mines.—A couple of days ago there arrived in Sydney two American metallurgical experts, Messrs. J. M. Callow and R. Carow, on their way to Mount Isa, where they are to superintend the installation of the plant for ore treatment. This will be the first unit of the preliminary plant, of a daily capacity of 2,000 tons, and will be afterwards followed by other units, capable together of treating treble that of the first one. This, Mr. Carow says, will make Mount Isa the second largest lead-mining centre in the world. He also states that a feature of the plant will be the number of its labour-saving devices, such as will wherever possible eliminate the human element. Mr. F. W. Draper, chief engineer of the Russo-Asiatic Consolidated, Ltd., has just returned to Brisbane after inspecting the Mount Isa property. He does not expect any difficulty in the treatment of Mount Isa ore. As yet, however, he says, no figures have been worked out covering the costs of milling and mining. The railway from Duchess to Mount Isa, 54 miles in length, was formally opened on April 6. This line gives the mine complete railway connection with the port at Townsville, *via* Cloncurry, the total distance being 603 miles. A consignment of structural steel, consisting of 300 tons, has been landed in Brisbane, and is being sent on to Mount Isa. Mr. Draper, as far as he can see at present, thinks the plant will be ready for a start early next year. One uncertain element is the water supply. The dam at Rifle Creek is ready for the storage of water to its full capacity (600,000,000 gallons), but this year's seasonal rains, which have been heavy in most parts of the far north-west of Queensland, have as yet been only light at Mount Isa, and there is but 16 ft. of water in the reservoir. About 40 ft. is needed to ensure safety as to requirements. At the mines Davidson's shaft had, at latest reports, reached a depth of 354 ft., and is still being sunk. Two smaller shafts, to be used for ventillating purposes, are being put down. In the latest four-week report, the total diamond drilling done in that period is recorded at 142 ft. on the Rio Grande lode and 709 ft. on that of the Black Star. The first boiler for the compressor plant at the central shaft is in position, and good progress is being made with other work in connection with the power plant.

Mount Isa's Magnitude.—The Mount Isa railway was formally opened by the State Parliamentary member for the district (Mr. J. Mullan), who is also Attorney-General in the Queensland Ministry. While the glowing picture which he presents of the future of the Mount Isa mines and township may be somewhat discounted by the fact that a general election is about to take place, the estimates and facts which were given were based on official reports, and may be taken as reliable. The cost of the new railway, which is of very substantial construction, is a little over £500,000. The total outlay on the Mount Isa mines has been £443,000, and yet a further expenditure of £1,000,000 will be necessary before commercial production begins. All difficulties in the water treatment of the ores and of carriage have been surmounted. The ore reserves on development to date have been calculated at 21,200,000 tons. A Government geologist estimates, conservatively, that a yearly output of 1,000,000 tons of ore may be anticipated, and that a hundred years may be regarded as the possible life of the mine. This officer also says that it must rank as one of the largest individual silver-lead mines of the world. While it is expected that the first unit of the treatment plant will be ready for a start early in 1930, its maximum capacity of 2,000 tons a day, it is anticipated, will not be reached before the end of that year. The cost of the dam just built at Rifle Creek, 20 miles up the Leichhardt River from the mine and township, is put down as about £50,000, and of the reticulation scheme connected with it at £60,000. About £100,000 is being spent on workmen's cottages, houses for the staff, mess houses, etc.

Mount Elliott and Cloncurry Copper.—A party of four experts in mining engineering and metallurgy, who have come from England and the United States as a skeleton staff for the re-opening of the Mount Elliott Company's copper mines, in the Cloncurry district, arrived in Sydney on March 31, *via* San Francisco. They consist of Mr. C. Q. Schlereth, mining engineer; Mr. James Heggie and Mr. R. Winter, metallurgists; and Mr. E. Maurer, a mining engineering expert on the constructional side. Mr. Schlereth states that, while most of the ores

of the Cloncurry field are of a low-grade nature, it is confidently believed that, by using the improved metallurgical methods that have been evolved during the past year or two, the Mount Elliott Company's mines can again be placed on a satisfactory dividend-paying basis. He mentioned that to complete the large amount of constructional work to be carried out by the company would occupy the greater part of two years, but that when actual mining operations begin employment will be offering for a large number of men.

In February, when copper was quoted at about £77 a ton for standard, the Cloncurry mining warden reported that the price then ruling had led to increased mining for that metal on the Cloncurry field, where several small mines that had not been worked for years were again being opened up. When the Mount Elliott Company last year decided to resume operations on a large scale in that district, the estimate of the directors, based on computations by Mr. Schlereth, was that, taking electrolytic copper at £65 a ton, an operative profit would be earned of £1,480,000 from the treatment of 1,000,000 tons of ore. A fortnight ago that class of the metal was up to £108, and even now, after a severe reaction in the market, the price is as high as £85. In making the Mount Elliott estimates it was expected that every £1 a ton advance on the £65 figure would result in a further profit at the rate of £10,000 a year. This position has naturally raised the hopes of those interested in Cloncurry copper, and indeed of all in Australia who are looking anxiously for a revival of mining in this country.

Another New Guinea Venture.—At the statutory meeting of the New Guinea Developments, N.L., held a fortnight ago, Mr. H. W. Clark, consulting engineer, mentioned that negotiations were in progress with a London group interested in the New Guinea field for the purchase of an area embracing 27 leases partly acquired and partly held under option by the Developments Company. It is understood that this British concern is not the Ellyou Company, which already has extensive interests in New Guinea. In regard to the 27 leases mentioned, a radio message from Mr. Clark's deputy in New Guinea reports that a reef has been cut in a costeen near the top of a mountain, showing, over a width of 6 ft., an estimated value of 3 oz. of gold a ton; also that another reef 6 ft. wide had been exposed in a crosscut to the north-east, but had not yet been cut through.

Royal Commission on Mining.—The Royal Commission on the mining industry in Queensland has been taking evidence in Brisbane during the past week. So far, the witnesses who have been examined have laid stress on the inadequacy, in point of numbers, of the State Geological Survey staff, and on what is considered the heavy taxation imposed upon mining transactions and upon profits of mining companies. The number of geologists in the employ of the Government, which at one time was seven, is now only four, and of these the Chief Government Geologist is now in Germany studying geophysical methods, and another has his time fully occupied with oil prospecting matters, leaving only two available for general work over the vast territory of the State. The importance of an adequate scientific staff to assist the prospector was especially emphasized, and it was considered that the heavy taxation imposed had the effect of checking capital from overseas.

## JOHANNESBURG

*May* 2.

Postmasburg.—Another very favourable report on the manganese ore deposits of the Postmasburg region has been published. The author, Dr. L. T. Nel, of the Union Geological Survey, spent several weeks in the area mentioned and his conclusions are highly encouraging to those who are endeavouring to establish a new industry in South Africa.

Extensive abstracts from his report appear elsewhere in this issue.

The following may, however, be quoted here.

"Taking everything into consideration, it is evident that in the manganese deposits of the Postmasburg region, South Africa has a valuable asset which promises to develop into an important industry taking the form not only of a manganese export trade, but possibly also of a local manufacture of ferro-alloys. There is no doubt that vast quantities of both rich and fairly high-grade ore are available, possessing superior physical properties which will ensure very little loss in transit, besides rendering it eminently suitable for storage should large reserves of high-grade ore be required."

New Manganese Company.—The company which is taking over the holdings of the Union Manganese Mines and Minerals (S.A.) Ltd., will be known as the Manganese Corporation (1929) Limited. Since the original agreement between the Union Manganese Co. and the British Swiss International Corporation was ratified it has been arranged that the Manganese Corporation shall purchase the Union Manganese Co.'s remaining mineral assets, certain copper interests in the Hay district Cape Province, for 12,500 £1 shares in the Manganese Corporation. The original agreement between the Union Manganese Co. and the British Swiss International Corporation provided for the sale of the company's manganese and asbestos interests in the Postmasburg district for the sum of £225,000 to a new company to be formed in South Africa by the British Swiss International Corporation, Ltd. The Union Manganese Company agreed simultaneously to subscribe and pay for 225,000 ordinary £1 shares in the new company, and in consideration for this subscription it was to receive a commission of £10,000 in cash. The new company will have a working capital of £400,000, and 200,000 £1 shares will be allotted to the distributors of the manganese, the guarantors of the working capital issue, and the promoters of the company. All the working capital of the new company having been subscribed privately no shares will be offered to the public. The Railway Administration is already calling for tenders for the construction of a branch line to the Postmasburg manganese fields, and the new company has started operations.

Asbestos Output Increasing.—The principal feature of the statistics of South African mineral production for March, 1929, is a new record for asbestos. The output of fibre amounted to £61,726, which beats the previous highest monthly total—that for January last—by £17,227. The chrysotile output has risen from £24,505 for January to £39,910 for March, and crocidolite from £10,545 to £12,814, while amosite has declined from £9,449 to £9,002.

Amosite Asbestos Fields.—A great deal of good work has been done in the Pietersburg (Transvaal) asbestos fields since they were brought prominently before the public over a year ago. Mr. W. F. H. Dudgeon, A.R.S.M., states in a recent report on the property of the South African Consolidated Asbestos, Ltd., that one small section has about 70,000 tons of Amosite fibre prospectively in sight and already partially developed ready for stoping. "When I first reported on this mine in the early part of last year," Mr. Dudgeon adds, "I certainly thought a great deal of its prospects, but now, after seeing the development work carried out underground, I may say at once that my expectations have proved to be very conservative, and, indeed, I can see no reason why even larger profits cannot be made for many years to come. The following figures may give some idea of this:—

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| Tonnage of fibre per month, say | 300 | 500 | 1,000 |
| Average cost per ton (Pietersburg) | £10 | 8 | 8 |
| Average value per ton (Pietersburg) | £25 | 25 | 25 |
| Profit per ton | £15 | 17 | 19 |
| Monthly profit | £4,500 | £8,500 | £19,000 |
| Annual profit | £54,000 | £102,000 | £228,000 |

The above figures will give some idea of the enormous possibilities of this property when worked on a scale commensurate with the ore reserves as already developed in only a small section of the property. I can see no reason to anticipate any marked fall in the price of amosite of the quality now being opened up here for some years to come, as the demand is constantly increasing and new uses are being found every month."

Transvaal Emerald Fields.—It is regarded as a very encouraging sign that South African mining houses have acquired blocks of claims in the Transvaal emerald fields. The African and European Investment Co. now owns a block of 600 claims (820 acres) and is starting prospecting operations on the property. The claims are situated about 2½ miles south-east of Gravelotte Station, on the Silati railway, and are distant seven or eight miles from the Somerset mine, which is being worked by the Beryl Mining Co. The H.E. Proprietary, Ltd., has exercised its option to organize the South African Emeralds, Ltd., the owner of a partially proved emerald mine and a large number of claims along the emerald belt. The Transvaal and Delogoa Bay Investment Co. will participate with the H.E. Proprietary in this new venture, which has been favourably reported on by the company's consulting engineer. It is understood that the exercising of the option by the H.E. Proprietary will entail the provision of over £17,000 working capital. This should be more than sufficient for the exploitation of the property. South

African Emeralds has received a communication from the Union Board of Trade and Industries, stating that the Board had received an inquiry from the Varlacoid Chemical Co., of New York, for supplies of beryl ore, which contains beryllium, the lightest metal known. Beryl ore, according to the latest information, is worth about £2,500 per ton. South American beryl ore contains 12% beryllium, while the Transvaal ore is said to contain 14%.

PROFITS FROM EMERALD MINING.—The Beryl Mining Company's mine in the Murchison Range, Transvaal, is now steadily producing from 300 to 350 lb. of crystals per week. Of these, from 5 to 10 lb. of crystals of true emerald colour are picked out every week, and sent to London to be examined by experts, who decide how each crystal is to be handled. On the present production of 50 tons (gross) mined per day, equal to 1,200 tons per month, the profits are approximately £700 to £800 per month, equal to about 12s. 6d. per ton of material mined. The total expenses at present are approximately £300 per month. When complete mining and treatment plant is running, and this is expected about the end of July, the tonnage mined will be raised to 200 tons per day or, say, 5,000 tons per month, while the working costs, everything, including head office and all salaries, are estimated not to exceed £400 per month. On that estimate of expenditure and taking past results as a basis it is expected that the profits from sales of the products of the emerald crystals can be fairly expected to be something round about 10s per ton mined. Taking into consideration only the mine area in which the main workings are situated, the tonnage to a depth of 300 feet is believed to be over 1,000,000 tons. This calculation does not take in a long but rather narrow extension of the mine to the east, which will certainly yield a very considerable and additional tonnage. To this depth of 300 feet there is no practical difficulty in continuing the present open-cast system of working. From an outcrop to the south, at the level of 300 feet below the top of the mine, crystals of the same class are obtained showing that the conditions for the crystallization of beryl continued down to at least that depth. When the depth of 300 feet is attained it may be possible to continue the open-cast system to still greater depth. The solid nature of the walls of the mine makes this very probable.

## VANCOUVER

*May* 10.

MINERAL PRODUCTION IN 1928.—Mr. John D. Galloway, who is responsible for the Annual Report of the Minister of Mines, is to be congratulated on the promptness with which he assembles his material and places the information at the disposal of the public. The report will be issued about June 30, but Mr. Galloway has provided your correspondent with advance sheets and through this courtesy I am able to place the following figures of production before the readers of THE MINING MAGAZINE: Placer gold, 8,424 ounces; lode gold, 188,087 ounces; silver, 10,627,167 ounces; copper, 97,908,316 pounds; lead, 305,140,972 pounds; zinc, 181,763,147 pounds; coal, 2,526,702 long tons; structural material and miscellaneous minerals to the value of $4,314,040. The value of the total production is estimated at $65,372,583, as against $60,729,358 in the previous year. The metal production in 1928 was obtained from the treatment of 6,241,310 tons of ore, an increase of 15·2 per cent over the previous year, and it is interesting to note, as showing the change that has taken place in methods of treatment during recent years, more than 92 per cent was subjected to some form of dressing, chiefly flotation, before it reached the smelters. All the large producers not only either maintained or increased their rates of output but, with the single exception of the Premier Gold Mining Company, did so without appreciably depleting their ore reserves, the amount of new ore developed being nearly equal to (in some instances more than) the amount of ore mined and treated. It is satisfactory, too, that despite the low ruling prices for lead and zinc during the year, the net profit to operators, that is, the amount received by them for their ores after payment for freight, treatment, and marketing, totalled $29,070,075, as compared with $27,760,364 in 1927. The amount disbursed in dividends by companies operating in British Columbia was $11,556,688, as compared with $10,800,838 in 1927 and $2,896,174 in 1924. These figures strikingly illustrate the growth of the mineral industry during the last five years.

The outlook for the future was never better. Nearly all the large operators are increasing their rates of output and an ever-increasing number of small concerns are

contributing to the total output. These small concerns generally either become absorbed by the larger ones or consolidate among themselves to make big companies. Last year was marked by the large number of scouting engineers that visited the Province; several properties were acquired and exploration and development work was started. Copper properties were in particular demand. A large amount of electrical prospecting was undertaken at both established mines and at prospects, but as yet it is too early to form any opinion as to the local value of this method of searching for metals. In base metal districts it seems to be effective in eliminating areas as unimportant and thereby saves the cost of diamond drilling and underground exploration. This, however, does not seem to apply to lode gold properties where the gold occurs in quartz unassociated with appreciable quantities of metallic sulphides.

Portland Canal.—The Premier Gold Mining Company disbursed a dividend of $300,000 on April 4, covering operations for the first three months of this year and bringing the total disbursements since the company acquired the property—9 years and 4 months ago—to the handsome total to $13,352,898. The annual report shows that, with the exception of an unrelated lens which has been mined out, no important new ore has been developed in the old mine, and it now is considered quite definite that commercial ore does not persist to No. 5 level. There is still in the mine, broken and unbroken, 465,200 tons of ore having an estimated value of $0·41 in gold and 11·38 oz. of silver per ton. This should be mined out before the end of next year, but it is hoped that before then the company will have brought the Porter-Idaho-Prosperity-Silverado group to production. It is understood, too, that negotiations are again under way for some arrangement between B.C. Silver Mines and Sebakwe and District Mines, whereby the Premier Company may either operate the mines or treat the ore in its mill and transport the concentrate along its 11½ mile tramway to tide-water.

Britannia Beach.—The Britannia Mining and Smelting Company has started to sink below its 2,700 ft. level with a view to determining if commercial ore extends to a sufficient depth to warrant the company extending the 4,100 ft. main-haulage tunnel below the ore-zone. It will be remembered that this tunnel was driven, not with a view to developing ore, but for the purpose of eliminating 3½ miles of outside tramways and the cost of keeping it in operation during the snows of normal winters. The abnormal snowfall of last winter at a time when copper prices were high and peak production desirable fully justified the expenditure. The 4,100 ft. tunnel is connected by a raise with the 2,700 ft. tunnel, and all ore is carried underground from mine to mill. The Britannia now is probably the largest contributor to the earnings of the Howe Sound Company, which during last year made a net operating profit of $2,649,068·31 and disbursed four dividends aggregating $1,984,152.

The Kootenays.—At an extraordinary general meeting of the Pend Oreille Lead and Zinc Company, held at Spokane on April 30, the shareholders authorized the reorganization of the company on the lines stated in my last news-letter. By the scheme ample capital is assured for the establishment of a 2,000 ton concentrator and 300 ton Tainton electrolytic zinc plant to treat the ores of the Pend Oreille and Reeves-McDonald companies. Lieut.-Col. H. H. Yuill, president of Reeves-McDonald Mines, announced recently that an important body of zinc ore had been struck in virgin ground, 850 feet from the portal of the main tunnel. It will take some time to determine the size of the deposit, which was opened quite unexpectedly, but assays of samples run up to 40 per cent of zinc.

At the annual general meeting of Whitewater Mines, Mr. W. H. Burgess, managing director, stated that the company was negotiating with a strong holding company to take over the management of the property and find funds to develop it in a way that the large ore-bodies seem to warrant. Operations have been hampered by lack of capital. During 1928 the company mined 24,741 tons of ore, shipped 81 tons of crude ore and milled the remainder with the production of 962 tons of lead concentrate and 4,798 tons of zinc concentrate, which brought a smelter return after payment of freight and smelter charges of $120,046. During the first half of the year, before the hydro-electric plant was put into operation, the mine was worked at a loss, but after at a slight profit. The operating loss for the year was $11,157. The cost of mining and milling, including current development was $3·90 per ton. Though no official statement has been made, it is understood that

the holding company referred to by Mr. Burgess is the Victoria Syndicate, of London, and that at the moment it is negotiating for the consolidation of the Whitewater, Lucky Jim, and Cork-Province companies, all of which own properties in the same vicinity that better could be operated under one management.

An interesting occurrence of stannite has been noted in the ore at the Snowflake mine, near Albert Canyon, in the Revelstoke division. The mineral has been found in several parts of the mine, but until recently has been mistaken for tetrahedite. An analysis of the clean mineral gave 23·8 per cent of tin. An assay of a sample taken across 37 inches in the face of a raise that is being put up from the 500 foot level on No. 6 vein gave 0·02 ounces of gold and 44·5 ounces of silver per ton, 25 per cent of lead, 3·7 per cent of zinc, and 3·6 per cent of copper. The copper content was said to be chiefly in grey copper, but in the light of the more recent analysis it probably was stannite. Construction work has been started on the 300 ton concentrator to treat the ores of the Monarch and Kicking Horse Mines, near Field.

Alice Arm.—The negotiations between the Russo-Asiatic company and Toric Mines fell through, and since then the assets of the Toric have again been bonded to the Britannia Mining and Smelting Company and the agreement has been ratified by the shareholders of Toric Mines. Under the new agreement Britannia will assume the indebtedness of Toric, will form a new company of 3,000,000 shares at $1 par, and will give Toric 750,000 of the shares but will retain the choice of two options on them. Britannia either may buy the whole block or 750,000 shares for $500,000 cash within two years or it may buy 100,000 within 18 months for 95 cents per share, 150,000 more within 30 months at 95 cents, 200 more within three years at $1, and the remainder within five years at $1·37½. In the meantime Britannia will continue the development of the property and if the work proves satisfactory equip it with a plant necessary for its economic production. A large tonnage of ore, said to average around $12 per ton in silver and gold, has been exposed by two crosscut tunnels and drifts connecting them; there is a 60 ton mill on the property, which may want remodelling. More than 90 per cent of the stock of Toric Mines is said to be held in Great Britain. The Esperanza Mining Company will extend No. 5 tunnel to the large ore-body opened in No. 7 (above) and drive an intermediate tunnel. If this work proves the downward continuation of the ore shoot the company proposes to erect a small hydro-electric plant and mill. The mine is 1½ miles from the settlement of Alice Arm; it has produced silver ore to the value of about $100,000.

Survey of Railway Mineral Lands.—The Provincial Department of Lands has announced that in conjunction with the Federal Government, the Canadian Pacific, and the Canadian National Railways, it will start immediately on the survey of the Pacific Great Eastern subsidy lands, or lands that have been set aside by an act of the Legislature as premiums to any company or individual that is prepared to take over the Pacific Great Eastern Railway and extend it into the Peace River region. Dr. R. W. Brock has been placed in charge of the geological part of the survey. A better choice cannot be imagined. He is dean of the faculty of science at the University of British Columbia and a former director of the Canadian Geological Survey. A few years ago he initiated a geological survey of Hong Kong and it was completed by members of the university staff under his supervision; members who, too, will assist him in the present work.

## TORONTO

*May* 18.

Sudbury District.—For some time past considerably greater interest has attached to base metal mining operations in this district than to gold production. Development work on the Frood mine of International Nickel has shown increased richness of the ore at depth, with a considerable increase of the copper content, which at a depth of 3,100 feet on the Mond section of the property is over 20%. Work has been commenced on the site of the new copper refinery to be erected by International Nickel in conjunction with the Consolidated Mining and Smelting Company at Copper Cliff, engineers of the American Metals Company being in charge of operations. Construction on the smelter addition is making good progress, and on a larger scale than originally planned. If the present progress is maintained it should be ready for operation by midsummer next year. In order to meet the increased demand for nickel, the tonnage of the Levack mine will

be increased from 65,000 tons per month to 100,000 tons. The shaft at the Falconbridge is approaching the 1,000 ft. level, and the ore indicated above that horizon is indicated at 10,000,000 tons, the copper content increasing at depth. Ground has been broken for the new smelter with an initial capacity of 225 tons per day, and a portion of the machinery has been placed on order. A branch line is being surveyed from Garson on the Canadian National Railway to the Falconbridge. Among other companies attracted to the district by recent developments is the Consolidated Mining and Smelting Company, which has taken options on a number of nickel-copper lands. It has started diamond drilling on some of these holdings, and has established an assay office with a permanent staff.

PORCUPINE.—Production of bullion in April shows a slight decrease, the output being valued at $1,498,671, as compared with $1,589,601 in March. The annual report of the Hollinger Consolidated for 1928 shows a considerable shrinkage in production and profits, due to adverse circumstances, as compared with the previous year. Operating profits were $4,279,280, as against $7,810,754, and net profits stood at $3,731,566, as compared with $6,648,308. The total tonnage of ore treated decreased from 2,178,329 tons to 1,778,470 tons; and the average value per ton from $6.96 to $6.28. The net value of gold and silver was $10,712,821, as compared with $14,548,899. A sharp decline in the ore reserves was reported, estimated gross value at the close of the year being $51,210,235 as against $60,225,539. At the annual meeting it was announced that the deep development programme is to be suspended, pending the report of L. C. Gratton, an eminent geologist of Harvard University, who had been engaged to examine geological conditions and make recommendations. It was explained that the decreased output was due to the extensive development carried on during the year, and that it was the intention to reduce the quantity of ore from development work and increase the amount going to the mill from the stopes. The position of the Dome Mines has been greatly improved by the opening up of a large deposit of commercial ore in the greenstone formation; it was encountered on the 10th level, and its downward continuation to the 16th level has been proved. The total amount of this ore is estimated at 862,900 tons. This discovery has considerably prolonged the life of the mine. The McIntyre Porcupine is steadily maintaining production and increasing its ore reserves. A vein opened up on the 1,875 ft. level and traced for 1,000 ft. has been cut on the 3,625 ft. level where it shows a width of 40 feet. In anticipation of increased tonnage No. 11 shaft, hitherto used exclusively for development, will be used for hoisting purposes, and a station has been cut at the bottom of the shaft for an underground crusher. The Hayden has completed an extensive diamond drilling campaign and a Radiore survey with encouraging results, has ordered an electrically operated mining plant, and arranged for a supply of power. The plans of the company are to crosscut from the 700 ft. level to open up the extensive vein system indicated by diamond drilling.

KIRKLAND LAKE.—The output of this field is well maintained, six mines reporting an aggregate production of bullion for April valued at $1,200,166. The Lake Shore is now treating ore at the rate of 1,200 tons per day, which in accordance with its programme of expansion will be increased to 2,000 tons before the end of the year. New ore has been encountered in the western section of the property above the 1,000 ft. level. During the quarter ended March the mill established a new record, treating 98,016 tons of ore and recovering $1,430,000. The Wright Hargreaves has come under new management with M. W. Summerhayes as general manager. Ore is being treated at the rate of 500 tons a day with a recovery of $10 per ton. The results obtained in the northerly part of the east claim have raised the average grade of ore. The development of a short shoot in a new vein at 2,000 ft. level has also helped the situation. The annual report for Kirkland Lake Gold Mine for 1928 shows a production of $414,596 from a treatment of 57,883 tons of ore, against a total expenditure of $383,319, and the average recovery per ton of ore milled was $7.16. During the year bodies of good ore were opened up on the 2,600 and lower levels, and cross-cutting was started on the 3,100 and 3,225 ft. levels. The central shaft of Teck-Hughes has been completed to 3,000 ft. and cross-cutting is under way to open up six new levels. In view of the results between the Nos. 10 and 19 levels the six new levels, 20 to 25, are expected to show ore that will justify an early addition to the milling capacity. The Sylvanite

cross-cutting at the 2,000 ft. level has encountered the continuation of a vein which yielded high values at 1,500 ft. and where cut shows high grade ore. Operations at the Murphy have encountered an obstacle owing to the faulting of the vein which is being opened up on the 600 ft. level. During the time occupied in ascertaining the extent of the faulting, it is proposed to open up the lower levels of the northerly vein system. The Patterson Copper Mine in the Boston Creek area of the camp is preparing to start work on four levels, and it is expected that it will shortly be in a position to make regular shipments to the smelter. The Swastika is also making shipments of copper ore.

ROUYN.—The position of the Noranda continues to show improvement. The ore reserves are now estimated at 500,000,000 pounds of copper, and over 500,000 ounces of gold, the supply being adequate to keep the smelter in operation for four years. This condition prevails as a result of only partial development of the first 1,000 ft. in depth. Recently the C. ore body was cut, at the 725 ft. level, and showed ore running from 7 to 8 per cent copper, in addition to gold. The concentrator has again been started, and is treating 150 tons daily and giving a high grade concentrate. During April the Waite property controlled by the Noranda, shipped 5,000 tons to the smelter. At the Abana a new three compartment shaft is being put down, to the 500 ft. level, its ultimate objective being 1,000 feet. Much development work has recently been done with encouraging results and costs have been materially reduced. At the Newbec important discoveries of ore have been made, and active development is proceeding.

PATRICIA DISTRICT.—With the resumption of navigation and the completion of the marine railway within a short time, the route from Hudson to Red Lake will be a busy one this summer, as there is much heavy machinery and equipment waiting transportation. The Howey has placed orders for machinery for its 500 ton mill. The results of underground work have been of a highly satisfactory character, the ore showing increased enrichment at depth. Production has been commenced at the Bobjo, where a small plant is treating very high-grade ore and has made its first shipment. Development work is making steady progress at the Red Lake Centre, Bathurst, Jackson Manion and other properties. The Patricia Dent, recently organized, has taken over 18 claims in the Clearwater Lake area and begun an active diamond drilling campaign. Important new discoveries have been made at Pickle Lake in the Crow River area, and many prospectors have been attracted to that section. The Smith-Watson claim in the Shoniah Lake area has been purchased at a high figure by New York financial interests. Several veins, some of which yield high assays, have been found on the property. The Metals Development Company is operating a claim at Clearwater Lake, where shaft sinking on a good vein is in progress, and the company has also started surface work on a claim in the Oxford Lake area.

MANITOBA.—The discoveries of tin are likely to result in an important addition to the mining industries of Canada, should the development work now being undertaken confirm their commercial value. A road is being constructed into the tin district east of Lac du Bonnet, in the south-western section of the province, to enable the transportation of machinery and supplies. At the Jack Nutt property the shaft is down to the 125 foot level and should surface indications be confirmed at this depth, will be continued to 300 feet. A test mill is being installed and should be in operation by June 1. The Shatford Basin Mines has been organized and has acquired 1,250 acres on which surface work has shown strong indications of tin, and operations will commence at once. At the Sherrit-Gordon in Northern Manitoba the ore placed in sight is estimated at a value of $75,000,000, an amount equal to supply the proposed concentrator of 2,000 tons daily capacity for seven years. Good progress is being made with the sinking of the third shaft, which is to be driven to a depth of 1,500 feet. The ore at the west end of the property shows an important increase in copper content. The company recently purchased an additional 1,500 acres of territory adjacent to its property on the west. The Manitoba Basin, operating a property at Herb Lake, has obtained good values in copper zinc and other metals by extensive diamond drilling. The company has also carried on explorations at its property at Jachfish Lake, where some promising discoveries have been made. Central Manitoba is steadily maintaining gold production and during April treated 4,615 tons with a recovery of $10.30 per ton.

## CAMBORNE

*June* 3.

Mount Wellington (Gwennap).—Last month reference was made to the work which was being carried out by Argus Concessions, Ltd., in the Gwennap district. The old adit which drains that portion of the famous old Gwennap United Mines and now known as Mount Wellington, has been cleared to a point where the water which was stored in the old workings has been tapped and drawn off. A complete examination of the deepest exposures so far made is thus possible, and systematic sampling is proceeding. The formation is undoubtedly a very interesting one, it being of great width and extent. If the sampling now in hand demonstrates the payability of the grade of ore from the surface to the horizon now exposed, it is evident that for a long time to come a large tonnage may be milled without the necessity of pumping operations. The workings are conveniently situated with regard to water for milling purposes, being at the mouth of the Great County Adit which drains about 30 square miles of country and is constantly discharging a large volume of water. The power line of the Cornwall Electric Power Company crosses the Lett.

Fowey River Alluvial.—It is understood that permission has been granted to the Siamese Tin Syndicate, Ltd., to prospect, by means of boreholes, for alluvial tin in the valley of the Fowey River near Lostwithiel.

East Wheal Lovell. — Prospecting operations at this mine, situated in the the parish of Wendron, which were carried out by the Anglo-Oriental group, are to be discontinued.

Poldary.—Work, on a small scale, is being carried out by this mine, on the back of the main lode. Poldary is an old mine situated near Trevince in Gwennap parish.

Polhigey.—This mine has now entered the list of the regular tin producers of Cornwall, having sold 20 tons of black tin during the month of April. Much satisfaction is expressed among local mining men at this event and strong hopes are entertained that Polhigey may now be looked upon as a worthy follower of Wheal Kitty.

Tindene.—Two tributors or "free-setters" have been working on the back of ore of the lodes of this mine for some time past.

Presentation to Dr. William Cullen.—Dr. William Cullen, the new president of the Institution of Mining and Metallurgy, and Mrs. Cullen, held a reception for Cornish members of the Institution and their friends at Tregenna Castle Hotel, St. Ives, on Saturday afternoon, May 25. It was certainly a happy idea of Dr. Cullen's and one greatly appreciated by the guests, who it may be said were fully representative of the mining industry of Cornwall. Advantage was taken of the occasion to present Dr. Cullen with a polished bowl made of Cornish serpentine and steatite as a mark of the esteem in which he is held.

# PERSONAL

W. E. Barron has been appointed Geologist and Mining Engineer to the North Charterland Exploration Co. (1910), Ltd.

Stanley C. Bullock has returned from East Africa.

A. R. Canning has returned from Tasmania.

L. Maurice Cockerell has returned from Italy.

A. F. Dick-Cleland has left for Nigeria.

J. V. N. Dorr is in Europe and expects to be in London early in July.

Richard Hamilton has been re-elected President of the Western Australian Chamber of Mines.

C. Baring Horwood has moved to 18, Abbey House, Victoria Street, S.W. 1, his new telephone number being Victoria 8365.

J. H. Jeffers has returned from Tasmania.

N. R. Junner was here from Sierra Leone on his way to South Africa.

H. P. T. Rohleder has gone to Rhodesia.

H. K. Scott has returned from Brazil.

K. S. Twitchell has passed through London on his return to the United States from Arabia.

A. T. Watson is home from Colombia.

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Francis L. Bosqui died at Johannesburg on May 4. At the time of his death Mr. Bosqui was consultant to the South African Townships Mining and Finance Corporation, which comprised some of the leading mining groups in Johannesburg, and was engaged in developing an improved method for treating platiniferous ores.

Charles W. Mann, who had acted first as secretary and then as director of the Ashanti Goldfields Corporation, died on May 27.

# TRADE PARAGRAPHS

**Hardy Patent Pick Co., Ltd.,** of Sheffield send us a leaflet devoted to a new electrical heading machine.

**Bruce Peebles and Co., Ltd.,** of Edinburgh, publish a pamphlet giving details with illustrations of the electrification of a quarry or open-cast mine.

**Fredk. Braby and Co., Ltd.,** of Petershill Road, Glasgow, send us a booklet describing dovetail steel sheeting useful for structural work of all kinds.

**Thomas Murby and Co.,** of 1, Fleet Lane, London, E.C. 4, issue a leaflet giving particulars of new books and new editions relating to geology, mineralogy and prospecting.

**Chapman and Hall, Ltd.,** of 11, Henrietta Street, London, W.C. 2, send two leaflets dealing with publications on mining, metallurgy and allied subjects recently published.

**British Engineering Standards Association** of 28, Victoria Street, London, S.W. 1, inform us that a new specification (No. 330 of 1929) covers round strand steel wire ropes for colliery haulage purposes.

**The Cassel Cyanide Co., Ltd.,** of 19, Vincent Place, Glasgow, issue booklets devoted to the casehardening and heat treatment of steel by sodium cyanide and the Cassel cyanide case-hardening furnace.

**Leonard Hill, Ltd.,** of 231–2, Strand, London, W.C. 2, have published the fifth edition of their catalogue of heavy and fine chemicals, raw material, machinery, plant and equipment, covering 400 pages, profusely illustrated and cross indexed.

**Becker and Haag,** Asbestos Merchants, of Berlin, S.W. 11, send us an admirably prepared book, covering 89 pages of text and numerous illustrations dealing with the sources, extraction, preparation, manufacture and industrial uses of asbestos.

**Adam Hilger, Ltd.,** of 24, Rochester Place, London, N.W. 1, have published two lists of spectroscopically standardized substances including certain rare earths and metals, all exceptionally pure and suitable for use as reagents or standards in analysis.

**The Bureau of Information on Nickel, Ltd.,** 2, Metal Exchange Buildings, London, E.C. 3, have published two further bulletins, one dealing with the aims and services of the Bureau generally, and the other with nickel cast-iron research at Birmingham University.

**Silica Gel, Ltd.,** Bush House, Aldwych, London, W.C.2, send us some leaflets describing the application of Silica Gel as an adsorbent in freight car refrigeration, to the refining of motor benzol, and the dehydration of air. Particularly interesting is its employment for drying the air for blast-furnace practice, which must result in considerable fuel economies.

**Ruston and Hornsby, Ltd.,** of Lincoln, have issued a 40 page booklet describing in detail with pictures, sectional drawings, and much ingenious arrangement, the many and varied functions of their No. 4 full circle, universal excavator, together with all its major working parts. All interested in excavating, quarrying and open-cast mining are invited to obtain a copy from the makers.

**Drayton Regulator and Instrument Co., Ltd.,** of West Drayton, Middlesex, send us a number of pamphlets devoted respectively to differential humidity regulators (for maintaining a fixed percentage relative humidity where it is not possible to control the temperature), thermo contactors (for control of temperature and humidity), and pressure and temperature operated electric switches.

**Head, Wrightson and Co., Ltd.,** of Stockton on Tees, send us a booklet devoted to the improved impact screen in which the frame carrying the screening medium is vibrated by means of the action of cams and tensioned supporting cables. We have also received a new edition of their booklet devoted to the "Marcus" screen and conveyor, which is more particularly applicable to coal dressing.

**The Mines Handbook** has been acquired by the Mines Information Bureau, Inc., of New York City, which will continue the publication of this standard manual. This new organization represents a complete change in ownership. Lenox H. Rand, lately associated with the Attorney General's office of New York State as investigator of mining companies, is president, with Edward B. Sturgis as editor-in-chief. It is not anticipated that Vol. XVIII will be ready before the early part of next year.

**Sullivan Machinery Co.,** of Salisbury House, London, E.C. 2, send us their March *Bulletin* which is devoted to a study of their angle compound air compressor and contains a great number of illustrations of this machine at work in different localities. The sizes in which these compressors are built range in capacity from 400 to 2,600 cu. ft. of free air per min. and their operating speeds are such that they can be direct-connected to Diesel engines. A special feature is made of this last-named characteristic as oil engines are so often preferred to steam.

**Edgar Allen and Co., Ltd.,** of Imperial Steel Works, Sheffield, send us their *Edgar Allen News* for March, which contains an article on the different kinds of hollow drill steels. As well as steels produced by the sand-core and copper-core processes, the results obtained by the processes known respectively as the austenitic core and stainless steel core are illustrated. The last named is self-explanatory, and the first is similar to the copper core except that a manganese or a nickel-chrome steel is inserted in the billet before rolling. The stainless lining has the obvious advantage of protecting the drill from internal attack by corrosive mine waters.

**International Combustion Grinding and Pulverizing Offices, Ltd.,** of 11, Southampton Row, London, W.C. 1, report that new orders have been received for the following equipment:— For England: One 10 ft. by 36 in. Hardinge ball mill and one 9ft. Hardinge superfine classifier for anhydrite; one No. 00 Raymond pulverizer for clay; one No. 3 Impax pulverizer for chalk; one 3 ft. by 5 ft., type 37, Hum-mer screen for starch cream; and two 3 ft. by 5 ft., type 37, Hum-mer screens for foundry sand. For Africa: One 7 ft. by 36 in. Hardinge ball mill for lead zinc ore; one 7 ft. by 36 in. Hardinge ball mill for gold ore; and two 10 ft. Gayco air separaters for phosphate. For Poland: One 8 ft. by 36 in. Hardinge ball mill and one 6 ft. Hardinge rotary classifier for zinc oxide. For France: One 6 ft. by 36 in. Hardinge ball mill and one 7 ft. by 22 in. Hardinge ball mill for lead-zinc ore; one 5 ft. by 22 in. Hardinge ball mill for charcoal and anthracite; two 6 ft. by 60 in. Hardinge ball mills for lignite; one 4-roller Raymond mill for barytes; one 3-roller Raymond mill for Gafsa phosphate; and one complete Raymond installation for Gafsa phosphate.

# BUCYRUS-ERIE 12-YD. STRIPPING SHOVEL

Reference has been made in these columns from time to time to the large mechanical excavators employed in different parts of the United States for overburden stripping in open-cast mining operations, and we are pleased to have the opportunity of referring to the machine here described.

The Bucyrus 750-B machine has a power unit of two 250 h.p. electric motors, together with a 100 h.p. motor for operating the crowd mechanism. No brakes or clutches are used for control, electric regenerative braking having been adopted. Ward Leonard direct-current field control with separately excited shunt-wound motors is the system used. The only brakes are for holding purposes.

for this heavier service. Outstanding among all these new features on the machine are four developments which make the fast operation and increased production possible. They are : (1) Two separate hoists ; (2) Twin swing machinery units ; (3) New type of support for the boom ; (4) A two-part cast dipper—built without a rivet.

Although holding 50% more material than the 8-yard dipper, the 12-yard dipper is only 15 inches wider, so that a heavier cut is needed to fill it at each pass. This calls for more powerful crowding by the dipper sticks, and a much greater hoist pull. The heavier cut and greater hoist pull that is necessary would not be practicable with a single central hoist—as the big dipper would twist or " wobble " in the bank, and unless this big dipper goes up through the bank without wobbling the operator will not fill it—no matter how much bail pull is available. The fast and steady cut of this

Bucyrus 750 B, 12 Cu. Yd. Shovel Electrically Driven.

Some idea of the great size of these machines is conveyed by the accompanying photographs, especially the second one, which shows somewhat ingeniously the relative dimensions of the bucket itself, of 12 cubic yards capacity. It is claimed for this shovel, nevertheless, that it works continuously at the same speed as the fastest 8-yard shovel—giving a 50 per cent increase in production with no increase in labour expense, and with a lower cost-per-ton for machinery and power.

As the operation of larger stripping shovels at high speed places a much heavier duty on the entire machine, older shovel designs were discarded in creating the 750-B. While it combines many features which have been developed through years of experience in constructing large stripping shovels, there are several important and very practical new features that years of close contact with stripping operations have shown to be advisable

shovel dipper is made possible by two separate hoists, one on each side of the dipper, which run over twin boom sheaves, giving the equivalent of a bail extending up over the boom point and down to the main drum. Each of the two single-part hoists is made up of equalized twin ropes, all wound on one single drum.

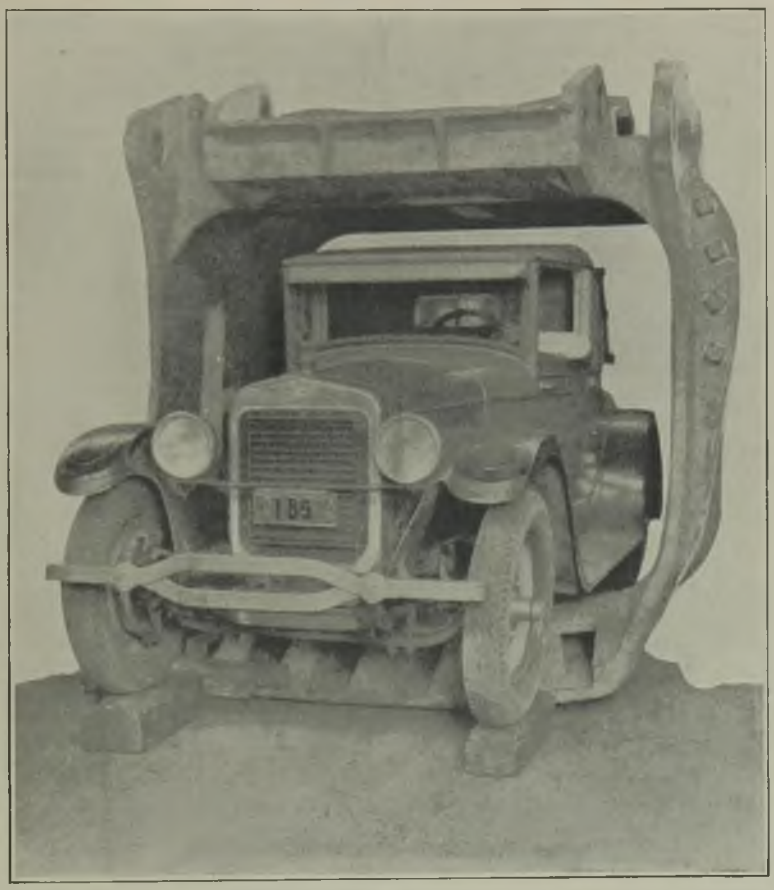
High-speed swinging, with quick starting and stopping, has been provided in the 750-B Bucyrus-Erie by means of twin swing machinery units, at opposite sides of the gearing. An added advantage of this design is that the twin swing units divide the stresses and distribute them equally at both sides—relieving the centre pintle (king post) of the strain that would result from the application of all of the swinging force on one side.

Provision has been made for the handling, at high speed, of the full 12-yard dipper out at the extreme length of the dipper stick. The boom

has been given unique support against the twisting strains set up by starting and stopping this heavy weight at high speed, at a long radius. Two sets of fixed suspension tackles support the boom point and, in addition, run to both sides of the boom at the shipper shaft in order to take away from the boom at this point—where they are put in by the handles—the twisting strains caused by starting and stopping the rapidly swinging loaded dipper.

The dipper is cast of special steel and is of a type that has proved most successful in standing years of steady digging in the hardest rock work; it is constructed without a rivet in it, and is divided horizontally, so that the upper part, that takes the wear in hard digging, can be renewed after long service. With this construction the digging strains are transmitted through solid steel, instead of through the several assembled units of a built-up dipper. The need for maintenance work on the front end of the 750-B has been cut down to the minimum by the box-girder-type boom, and outside or "straddling" dipper sticks. The twin sticks spread far apart, support the dipper at both sides—instead of only in the centre; the tremendous strains of swinging the loaded 12-yard dipper back and forth at high speed do not tend to pry the boom apart. The sticks are of all-steel construction, and are tied together at the upper and lower ends. The connection at the lower or dipper end takes the form of a flexible truss, which transmits the pull of the swinging loads directly to the A-frame (through the boom suspension cable at the shipper-shaft), but which permits the double hoist to take the stresses of uneven digging, such as are encountered in rock or when digging over only one corner of the dipper.

The boom is 7 ft. deep and 4 ft. wide at the shipper shaft. Its cast boom feet, with sockets resting on heavy lugs on the front casting of the revolving frame, provide a firm support, yet one that permits enough motion to avoid excessive strains in boom and handles. The boom load is distributed to the box girder front member of the revolving frame, and its deep side girders, by two complete A-frames—one on either side of the shovel. Each of these A-frames is capable of carrying all of the stresses. The design of the revolving frame does away with the distortion and concentrated loads which are the causes of a frame's loosening up, and the machinery losing alignment. Across the entire front of the revolving frame, carrying the front end boom-supporting casting, extends a box-girder 50 inches deep, and 84 inches wide. From this beam—which supports the boom at its centre, the front legs of the A-frame and the sway guys—six great backbone girders extend the entire length



of the frame. Tied together with cross girders, also with secondary members over the swing circle and under the machinery, the completed frame is a dependable unit that will stand up to hard service.

The " heart" of the base for the Bucyrus Erie 750-B is a huge centre pipe casting of steel. From this centre extend eight radial beams with a maximum depth of 7 ft. 3 in. Tying these radial beams together at their outer ends are four outside girders which are fastened to each other and to the diagonal members by corner castings—forming a rigid, unyielding corner. Under each corner of the base is a complete caterpillar-type mounting unit, composed of two endless traction belts, each forming the track for two tumblers and two rollers. There are only 27 gears below the deck, 3 bevel gears at the lower end of the vertical swing shaft, and 3 for each of the 8 caterpillar belts. The two units on one side support the base directly through a heavy, single-casting pedestal. On the opposite side, the two units support the ends of an equalizer beam, at the centre of which the base rests on a flexible support. At each end of this beam is an electrically-driven jack-screw, which is backed away from contact with the base while propelling, but is turned up to provide a firm support for the corner while the machine is digging. In this way the base is supported at three points only while propelling. But when digging, it is rigidly supported on all four corners. Each of the units may be propelled at either high or a low speed, so that the shovel can propel itself in an arc of surprisingly small radius.

An interesting additional feature is that this machine is so built that it will operate a bucket of 16 cu. yd. capacity without any alteration to the equipment or structure, except the replacement of the boom by a shorter one.

## NORTH-EAST COAST EXHIBITION

This exhibition which was opened in the second week in May will not be closed until October. It is an attempt on the part of industrialists and others who have the welfare and progress of this part of the country at heart to show something of the variety of local enterprises and the visitor is struck with the resemblance to the Wembley exhibition. In the Palace of Engineering particularly are the exhibits of interest and the more important of these from the mining man's point of view are alluded to in what follows.

**John Tullis and Son., Ltd.,** of Glasgow, exhibit leather and textile belting for driving and conveying purposes.

**A. Reyrolle and Co., Ltd.,** of Hebburn-on-Tyne, have an extensive display of switch gear of all types.

**James Walker and Co., Ltd.,** of Woking, exhibit " Lion " packings and jointings for all power purposes.

**Bruntons,** of Musselburgh, Scotland, are showing examples of wire rope together with a variety of other metal products.

**International Channelling Machines, Ltd.,** of Penistone Road, Sheffield, show a variety of coal getting drills, picks and cutters.

**Davidson and Co., Ltd.,** of Belfast, are showing Sirouo mine fan models arranged for reversal of air current, and also dust collecting plant.

**South Durham Steel and Iron Co., Ltd.**, of West Hartlepool, show among other products some bitumen lined and coated steel piping of large section.

**G. and J. Weir, Ltd.,** of Glasgow, show a variety of pumps of their own manufacture together with some the product of **Drysdale and Co., Ltd.,** also of Glasgow.

**R. Hood Haggie and Son, Ltd.,** of Newcastle-on-Tyne, on a stand devoted to ropes of all kinds include steel wire rope suitable for haulage and winding use.

**Bever Dorling and Co., Ltd.,** of Bowling Iron Works, Bradford, exhibit an overwind and over-speed prevention gear for winding engines and part of an endless rope haulage.

**George Angus and Co., Ltd.,** of Newcastle-on-Tyne, show their leather belting for driving and conveying purposes together with rubber and canvas belting and also hose.

**Bernard Holland and Co.,** of 17 Victoria Street, London, S.W. 1, have several examples of their rotary air-compressor together with models and sections to illustrate the operating principle.

**Michell Bearings, Ltd.,** of 3 Central Building, London, S.W. 1, have several working exhibits demonstrating the operation of the thrust block, pivoted type journal and film lubricated pivoted bearing.

**Cambridge Instrument Co., Ltd.,** of 45 Grosvenor Place, London, S.W. 1, exhibit a comprehensive range of engineering and metallurgical instruments such as gauges, stress recorders, and pyrometers.

**E. N. Mackley and Co.,** of Hawks Road, Gateshead-on-Tyne, are showing a number of pumps of all types—reciprocating ram and piston, centrifugal and turbine. Lined slurry and tailings pumps are a feature.

**John Russell and Co., Ltd.,** of Orchard Street, Newcastle-on-Tyne, exhibit pneumatic hose for rock drills and suchlike, conveyor and transmission belting in rubber, leather and mixtures, and packings.

**Petters, Ltd.,** of Yeovil, are represented by a number of their smaller oil engines notably a four-cylinder unit of 100 b.h.p., airless and springless injection, cold starting high compression; and also several electric lighting units.

**Vickers-Armstrong, Ltd.,** of Broadway, London, S.W. 1. On a large stand devoted mainly to their marine activities, the only exhibit of interest to mining men is a model of a cement plant, including a compound tube mill.

**Explosives and Chemical Products, Ltd.,** of Finsbury Pavement House, London, E.C. 2, are exhibiting samples of the various components of blasting explosives together with scale models to illustrate methods in mine and quarry.

**Head, Wrightson and Co., Ltd.,** of Stockton and Thornaby-on-Tees, have models illustrating Nissen stamps and Marcus conveyors and screens among their ore-dressing machinery products together with a number of other examples of their many activities.

**Babcock and Wilcox, Ltd.,** of Farringdon Street, London, E.C. 4, have as a main exhibit a steam-winch with totally enclosed single gear, also pipe work and wrought-steel valves and models of their boiler-house plant including low-temperature distillation.

**Ashmore, Benson, Pease and Co., Ltd.** (which is associated with the Power Gas Corporation, Ltd.), of Stockton-on-Tees, exhibit plant for chemical works and suchlike notably examples of

lead-lined tubes demonstrating the K.K.K. process of homogeneous lead lining.

**Stewarts and Lloyds, Ltd.,** of Glasgow, have a comprehensive range of pipes and fittings including bitumen lined pipes and Victualic and other joints. In addition there are a number of tubular pit props of adjustable types, and also non-adjustable cut away to reveal the wood core.

**Clarke Chapman and Co., Ltd.,** of Gateshead-on-Tyne, have on exhibit a large coal pulverizing unit suitable for dealing with 10 tons per hour at 960 r.p.m. with 180 h.p. motor together with a smaller unit and various boiler parts. The remainder of the stand is given over to marine equipment.

**International Combustion, Ltd.,** of Africa House, Kingsway, London, W.C. 2, have a comprehensive collection of models, photographs and sections illustrative of their various power generation specialities and accessories—notably a complete power house, burner types, stokers, grinding, screening and separating plant, and instruments.

**C. A. Parsons and Co., Ltd.,** of Newcastle-on-Tyne, have as a main exhibit a 3,000 r.p.m. reaction turbine coupled to a 6,250 k.w. alternator. This is shown in comparison with a small set built 44 years ago which ran at 18,000 r.p.m. and developed 4 k.w. An early radial-flow turbine built in 1891 and generating 100 k.w. at 4,800 r.p.m. is also shown. Other exhibits include accessories and the products of subsidiaries.

**Imperial Chemical Industries, Ltd.,** of Imperial Chemical House, London, S.W. 1, have a large stand devoted to many of their wide activities. Principle among these features was the section devoted to explosives, while, in addition, among films being shown at frequent intervals, is one depicting the use of explosives in winning stone at the quarries of the Buxton Lime Firms Co.—one of their subsidiaries.

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# METAL MARKETS

Copper.—During May the Standard Copper market in London weakened further, though the movement was not at all comparable to the decline witnessed in the previous month. In New York prompt electrolytic for export was steady at 18 cents per lb., but as regards forward deliveries there was a rather easier tendency. This seemed to indicate that the market there was inclined to take a pessimistic view of the future, and it was indeed somewhat significant that one of the biggest producers should have decided to curtail output by 10% at both its North and South American properties. With stocks tending to expand, the immediate outlook is rather "bearish," and producers may find in addition that by their unfortunate price policy they have definitely discouraged a considerable volume of consumption.

Average price of cash standard copper: May, 1929, £75 2s. 6d.; April, 1929, £81 2s. 7d.; May, 1928, £62 11s. 9d.; April, 1928, £61 14s. 1d.

Tin.—This market presented a pretty colourless aspect throughout the past month. Demand from consumers everywhere was dull, but "bull" operators continued to prevent prices from falling. Sentiment was further stimulated to a moderate degree by statements that producers were in negotiation with a view to securing some sort of control over the position. Failing an early industrial revival, however, the outlook does not seem particularly brilliant.

Average price of cash standard tin: May, 1929, £197 12s. 8d.; April, 1929, £206 19s. 7d.; May, 1928, £230 19s. 3d.; April, 1928, £234 6s.

Lead.—The market was rather easier last month, arrivals of fresh metal proving, as a matter of fact, rather heavier than anticipated. With rather too much metal about for the market's actual needs, with industry and trade in Great Britain disturbed by the Whitsun holidays and the General Election, and with business on the Continent hampered by the protracted Reparations discussions, it was not surprising that values of lead should have given way slightly. There was a feeling, however, towards the close of the month that values had about touched bottom and that in the near future they might improve.

Average mean price of soft foreign lead: May, 1929, £23 16s. 11d.; April, 1929, £24 11s. 10d.; May, 1928, £20 12s. 11d.; April, 1928, £20 8s. 8d.

Spelter.—The London spelter market was steady throughout May, as was also the American market. Demand was not very insistent, but it seemed to be sufficient to absorb the bulk of the metal coming out, as producers reported that their stocks were low and might indeed be increased with advantage. Owing to the output-control scheme, producers certainly seem to have the position under command to quite a considerable degree. The outlook at the close of the month was fairly good and there was indeed a noticeable amount of professional support in evidence.

Average mean price of spelter: May, 1929, £26 13s. 4d.; April, 1929, £26 13s. 8d.; May, 1928, £25 18s. 6d.; April, 1928, £25 8s. 1d.

Iron and Steel.—The Cleveland pigiron market remained very firm during May and with the furnaces booked up some months ahead there was very little prompt material available for either home or export business. Consequently, it was impossible to secure pigiron at the official minimum prices, No. 3 G.M.B. commanding fully 70s. per ton. Production is being gradually increased, but, of course, the dearness and scarcity of ore and fuel are serious hindrances. East Coast Mixed Nos. were maintained at 74s. the hematite market being firm, and there was a feeling that in view of the harder aspect of the Continental market an advance might soon occur in this section. The home quotations of certain descriptions of material were advanced by 5s. per ton.

Antimony.—At the close of May English regulus was priced at about £48 to £52 10s. per ton. Chinese material was also rather easier on the month at about £35 per ton ex warehouse and £31 to £31 10s. c.i.f. for shipment.

Iron Ore.—This was a good market, with mines well sold ahead and very little prompt ore available. Best Bilbao rubio remained at about 23s. per ton, c.i.f., nominal.

Arsenic.—Business continued quiet, with prices unaltered around £16 to £16 2s. 6d. per ton, f.o.r. mines for 99% Cornish white.

Bismuth.—The market was steady throughout May, the official price of 7s. 6d. per lb. for 5-cwt. lots and over remaining unchanged.

Cadmium.—Steady and moderately active at about 4s. 2d. to 4s. 3d. per lb. for nearby metal. For large lines about 4s. 1d. is being accepted.

## LONDON DAILY METAL PRICES

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

| | COPPER. | | | | | | | | | | | | TIN. | | | | ZINC (Spelter). | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standard. | | | | Electrolytic. | | | | Wire Bars | | Best Selected. | | | | | | | | | |
| | Cash. | | | 3 Months. | | | Near. | | | Forward. | | | Near. | | | Forward. | Cash. | | | 3 Months. | | | Near. | | | Forward. | | |
| May | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. |
| 10 | 74 | 15 | 0 | 75 | 0 | 0 | 84 | 10 | 0 | 85 | 0 | 0 | 85 | 0 | 0 | 78 | 10 | 0 | 79 | 15 | 0 | 201 | 10 | 0 | 203 | 2 | 6 | 26 | 16 | 3 | 26 | 16 | 3 |
| 13 | 73 | 5 | 0 | 73 | 3 | 9 | 83 | 15 | 0 | 84 | 15 | 0 | 84 | 15 | 0 | | — | | | — | | 199 | 10 | 0 | 201 | 15 | 0 | 26 | 15 | 0 | 26 | 15 | 0 |
| 14 | 71 | 18 | 9 | 71 | 16 | 3 | 84 | 0 | 0 | 84 | 5 | 0 | 84 | 5 | 0 | 75 | 0 | 0 | 76 | 5 | 0 | 198 | 15 | 0 | 201 | 5 | 0 | 26 | 13 | 9 | 26 | 13 | 9 |
| 15 | 73 | 5 | 0 | 71 | 17 | 6 | 83 | 0 | 0 | 84 | 5 | 0 | 84 | 5 | 0 | | — | | | — | | 199 | 0 | 0 | 201 | 10 | 0 | 26 | 13 | 9 | 26 | 11 | 3 |
| 16 | 74 | 10 | 0 | 72 | 17 | 6 | 83 | 0 | 0 | 84 | 10 | 0 | 84 | 10 | 0 | | — | | | — | | 200 | 5 | 0 | 200 | 10 | 0 | 26 | 13 | 9 | 26 | 11 | 3 |
| 17 | 76 | 5 | 0 | 73 | 17 | 6 | 83 | 12 | 6 | 84 | 12 | 6 | 84 | 12 | 6 | 76 | 0 | 0 | 77 | 5 | 0 | 196 | 10 | 0 | 199 | 12 | 6 | 26 | 16 | 3 | 26 | 11 | 3 |
| 21 | 74 | 7 | 6 | 73 | 0 | 0 | 83 | 12 | 6 | 84 | 12 | 6 | 84 | 12 | 6 | 75 | 10 | 0 | 76 | 15 | 0 | 196 | 5 | 0 | 199 | 2 | 6 | 26 | 16 | 3 | 26 | 11 | 3 |
| 22 | 73 | 5 | 0 | 72 | 5 | 0 | 84 | 0 | 0 | 84 | 7 | 6 | 84 | 7 | 6 | | — | | | — | | 196 | 15 | 0 | 199 | 0 | 0 | 26 | 16 | 3 | 26 | 11 | 3 |
| 23 | 72 | 10 | 0 | 71 | 17 | 6 | 83 | 10 | 0 | 84 | 10 | 0 | 84 | 10 | 0 | | — | | | — | | 196 | 5 | 0 | 199 | 0 | 0 | 26 | 15 | 0 | 26 | 10 | 0 |
| 24 | 72 | 12 | 6 | 72 | 5 | 0 | 83 | 10 | 0 | 84 | 10 | 0 | 84 | 10 | 0 | 74 | 10 | 0 | 75 | 15 | 0 | 196 | 15 | 0 | 199 | 0 | 0 | 26 | 17 | 6 | 26 | 10 | 0 |
| 27 | 72 | 12 | 6 | 72 | 0 | 0 | 84 | 0 | 0 | 84 | 10 | 0 | 84 | 10 | 0 | | — | | | — | | 196 | 2 | 6 | 199 | 0 | 0 | 26 | 17 | 6 | 26 | 10 | 0 |
| 28 | 72 | 5 | 0 | 71 | 15 | 0 | 84 | 0 | 0 | 84 | 7 | 6 | 84 | 7 | 6 | 74 | 0 | 0 | 75 | 5 | 0 | 196 | 0 | 0 | 198 | 15 | 0 | 26 | 17 | 6 | 26 | 8 | 9 |
| 29 | 72 | 10 | 0 | 71 | 17 | 6 | 84 | 0 | 0 | 84 | 7 | 6 | 84 | 7 | 6 | | — | | | — | | 196 | 15 | 0 | 199 | 2 | 6 | 26 | 17 | 6 | 26 | 7 | 6 |
| 30 | 73 | 7 | 6 | 72 | 7 | 6 | 83 | 10 | 0 | 84 | 10 | 6 | 84 | 10 | 0 | | — | | | — | | 196 | 10 | 0 | 199 | 0 | 0 | 26 | 17 | 6 | 26 | 7 | 6 |
| 31 | 73 | 12 | 6 | 73 | 0 | 0 | 83 | 10 | 0 | 84 | 10 | 0 | 84 | 10 | 0 | 75 | 0 | 0 | 76 | 5 | 0 | 196 | 5 | 0 | 199 | 0 | 0 | 26 | 16 | 3 | 26 | 7 | 6 |
| June | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 73 | 5 | 0 | 72 | 15 | 0 | 84 | 0 | 0 | 84 | 10 | 0 | 84 | 10 | 0 | | — | | | — | | 198 | 12 | 6 | 201 | 7 | 6 | 26 | 10 | 0 | 26 | 7 | 6 |
| 4 | 73 | 15 | 0 | 73 | 8 | 9 | 84 | 5 | 0 | 84 | 15 | 0 | 84 | 15 | 0 | 75 | 15 | 0 | 77 | 0 | 0 | 198 | 0 | 0 | 200 | 15 | 0 | 26 | 10 | 0 | 26 | 7 | 6 |
| 5 | 74 | 0 | 0 | 73 | 12 | 6 | 84 | 5 | 0 | 84 | 15 | 0 | 84 | 15 | 0 | | — | | | — | | 197 | 5 | 0 | 200 | 5 | 0 | 26 | 8 | 9 | 26 | 5 | 0 |
| 6 | 74 | 8 | 9 | 74 | 2 | 6 | 84 | 5 | 0 | 84 | 15 | 0 | 84 | 15 | 0 | | — | | | — | | 198 | 10 | 0 | 201 | 12 | 6 | 26 | 5 | 0 | 26 | 2 | 6 |
| 7 | 75 | 0 | 0 | 74 | 11 | 3 | 84 | 5 | 0 | 84 | 15 | 0 | 84 | 15 | 0 | 76 | 15 | 0 | 78 | 0 | 0 | 199 | 15 | 0 | 202 | 12 | 6 | 26 | 8 | 9 | 26 | 5 | 0 |
| 10 | 75 | 17 | 6 | 75 | 5 | 0 | 84 | 5 | 0 | 84 | 15 | 0 | 84 | 15 | 0 | | — | | | — | | 202 | 0 | 0 | 205 | 0 | 0 | 26 | 7 | 6 | 26 | 2 | 6 |

| | LEAD. | | | | | | | | | SILVER. | | GOLD | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Soft Foreign. | | | | | | English. | | | Cash. | Forward. | | |
| | Near. | | | Forward. | | | | | | | | | |
| | £ | s. | d. | £ | s. | d. | £ | s. | d. | d. | d. | s. | d. | |
| 24 | 5 | 0 | 24 | 1 | 3 | 25 | 10 | 0 | $25\frac{3}{8}$ | $25\frac{3}{8}$ | 84 | $11\frac{1}{2}$ | May 10 |
| 24 | 2 | 6 | 24 | 0 | 0 | 25 | 10 | 0 | $25\frac{3}{16}$ | $25\frac{3}{8}$ | 84 | $11\frac{1}{2}$ | 13 |
| 23 | 18 | 9 | 23 | 18 | 9 | 25 | 5 | 0 | $25\frac{3}{16}$ | $25\frac{5}{16}$ | 84 | $10\frac{5}{8}$ | 14 |
| 23 | 13 | 9 | 23 | 11 | 3 | 25 | 5 | 0 | $25\frac{5}{16}$ | $25\frac{1}{2}$ | 84 | 11 | 15 |
| 23 | 16 | 3 | 23 | 13 | 9 | 25 | 5 | 0 | $25\frac{3}{16}$ | $25\frac{3}{16}$ | 84 | $11\frac{1}{2}$ | 16 |
| 23 | 16 | 3 | 23 | 15 | 0 | 25 | 5 | 0 | $25\frac{1}{4}$ | $25\frac{1}{4}$ | 84 | $11\frac{1}{2}$ | 17 |
| 23 | 15 | 0 | 23 | 12 | 6 | 25 | 5 | 0 | $25\frac{1}{8}$ | $25\frac{1}{4}$ | 84 | $11\frac{1}{2}$ | 21 |
| 23 | 12 | 6 | 23 | 10 | 0 | 25 | 0 | 0 | $25\frac{1}{16}$ | $25\frac{1}{16}$ | 84 | $11\frac{3}{8}$ | 22 |
| 23 | 12 | 6 | 23 | 7 | 6 | 25 | 0 | 0 | $24\frac{15}{16}$ | $24\frac{15}{16}$ | 84 | $11\frac{1}{2}$ | 23 |
| 23 | 12 | 6 | 23 | 7 | 6 | 25 | 0 | 0 | $24\frac{15}{16}$ | $24\frac{15}{16}$ | 84 | $11\frac{1}{2}$ | 24 |
| 23 | 15 | 0 | 23 | 10 | 0 | 25 | 0 | 0 | $24\frac{7}{8}$ | $24\frac{7}{8}$ | 84 | $11\frac{1}{2}$ | 27 |
| 23 | 13 | 9 | 23 | 7 | 6 | 25 | 0 | 0 | $24\frac{15}{16}$ | $24\frac{13}{16}$ | 84 | 11 | 28 |
| 23 | 12 | 6 | 23 | 8 | 9 | 25 | 0 | 0 | $24\frac{3}{8}$ | $24\frac{3}{8}$ | 84 | $11\frac{1}{2}$ | 29 |
| 23 | 11 | 3 | 23 | 10 | 0 | 25 | 0 | 0 | $24\frac{3}{8}$ | $24\frac{13}{16}$ | 84 | $11\frac{1}{2}$ | 30 |
| 23 | 11 | 3 | 23 | 10 | 0 | 25 | 0 | 0 | $24\frac{9}{16}$ | $24\frac{3}{8}$ | 84 | $11\frac{1}{2}$ | 31 |
| | | | | | | | | | | | | | June |
| 23 | 10 | 0 | 23 | 10 | 0 | 25 | 0 | 0 | $24\frac{3}{16}$ | $24\frac{1}{2}$ | 84 | $11\frac{1}{2}$ | 3 |
| 23 | 13 | 9 | 23 | 13 | 9 | 25 | 0 | 0 | 24 | $24\frac{3}{16}$ | 84 | 11 | 4 |
| 23 | 15 | 0 | 23 | 13 | 9 | 25 | 0 | 0 | 24 | $24\frac{1}{16}$ | 84 | $11\frac{1}{2}$ | 5 |
| 23 | 15 | 0 | 23 | 15 | 0 | 25 | 0 | 0 | 24 | $24\frac{1}{16}$ | 84 | $11\frac{1}{2}$ | 6 |
| 23 | 12 | 6 | 23 | 12 | 6 | 25 | 0 | 0 | 24 | $24\frac{1}{16}$ | 84 | $11\frac{1}{2}$ | 7 |
| 23 | 11 | 3 | 23 | 11 | 3 | 25 | 0 | 0 | $24\frac{5}{16}$ | $24\frac{5}{16}$ | 84 | $11\frac{1}{2}$ | 10 |

Cobalt Metal.—There has been a fair demand and the official price is maintained at 10s. per lb.

Cobalt Oxides.—The position remains unaltered, with black quoted at 8s. per lb. and grey at 8s. 10d. per lb.

Platinum.—Conditions have been rather colourless and dull. The value of refined platinum is steady at £13 10s. to £13 15s. per oz., though £13 17s. 6d. is quoted officially.

Palladium.—There has not been much buying interest latterly. Buyers continue to bid £7 5s., but sellers are not disposed to offer at less than £8 5s. per oz.

Iridium.—The current value of sponge and powder is about £52 to £55 per oz.

Tellurium.—This is a very quiet market, with the price quite nominal at 12s. 6d. to 15s. per lb.

Selenium.—Prices are unchanged, with high grade black powder quoted at 7s. 8d. to 7s. 9d. per lb.

Manganese Ore.—Fresh demand is very subdued, as users are covered some way ahead. Prices have kept steady at about 1s. 2d. to 1s. $2\frac{1}{2}$d. per unit c.i.f. for best Indian and 1s. $1\frac{1}{2}$d. to 1s. $1\frac{3}{4}$d. for washed Caucasian.

Aluminium.—Prices have remained steady at £95 per ton for ingots and bars.

Sulphate of Copper.—Prices have eased further slightly to £29 to £29 10s. per ton.

Nickel.—There has been a good business passing, with the price steady at £175 per ton.

Chrome Ore.—Business has been moderate. Rhodesian has eased somewhat to £4 to £4 6s. per ton c.i.f. whilst Indian and New Caledonian vary from £4 to £4 15s. per ton c.i.f. according to quality.

Quicksilver.—The market has been quiet, with spot material steady at £22 2s. 6d. to £22 5s. per bottle.

Tungsten Ore.—The market is characterized by a shortage of material for near shipment, but very little business has been passing. Buyers seem prepared to pay about 32s. or a little more for June/July shipment.

Molybdenum Ore.—Some fair sales have taken place and the quotation has hardened to 40s. per unit c.i.f.

Graphite.—Conditions remain steady, with good 85 to 90% raw Madagascar flake priced around £27 to £29 per ton, c.i.f., and with 90% Ceylon lumps offering around £25 to £26 per ton c.i.f.

Silver.—May proved a singularly quiet and uninteresting month in the silver market. Although during the first half of the month prices did not alter much, being $25\frac{5}{16}$d. both on the 1st and 15th, during the latter half India and China showed a tendency to sell, and with practically no support forthcoming from any direction quotations dropped, and on May 31 spot bars stood at $24\frac{9}{16}$d.

# STATISTICS

## PRODUCTION OF GOLD IN THE TRANSVAAL.

| | Rand. | Elsewhere. | Total. |
|---|---|---|---|
| | Oz. | Oz. | Oz. |
| May, 1928 | 849,155 | 37,031 | 886,186 |
| June | 825,143 | 37,220 | 862,363 |
| July | 828,482 | 38,729 | 867,211 |
| August | 854,172 | 37,691 | 891,863 |
| September | 819,341 | 38,390 | 857,731 |
| October | 858,945 | 38,775 | 897,720 |
| November | 832,461 | 40,023 | 872,484 |
| December | 821,582 | 38,179 | 859,761 |
| January, 1929 | 840,344 | 36,108 | 876,452 |
| February | 778,559 | 36,725 | 815,284 |
| March | 830,829 | 35,700 | 866,529 |
| April | 836,474 | 35,649 | 872,123 |
| May | 858,991 | 38,607 | 897,598 |

## TRANSVAAL GOLD OUTPUTS.

| | April. | | May. | |
|---|---|---|---|---|
| | Treated Tons. | Yield Oz. | Treated Tons. | Yield Oz. |
| Brakpan | 89,000 | £143,556 | 92,500 | £152,301 |
| City Deep | 95,000 | 25,848 | 98,000 | 27,268 |
| Cons. Main Reef | 58,500 | 22,343 | 59,100 | 21,968 |
| Crown Mines | 206,000 | 69,459 | 223,000 | 72,749 |
| D'rb'n Roodepoort Deep | 40,300 | 14,023 | 41,300 | 14,050 |
| East Rand P.M. | 143,000 | 38,196 | 145,500 | 39,098 |
| Ferreira Deep | 23,600 | 4,278 | 21,000 | 4,400 |
| Geduld | 83,000 | 26,074 | 85,000 | 26,736 |
| Geldenhuis Deep | 62,600 | 14,523 | 65,500 | 15,023 |
| Glynn's Lydenburg | 6,600 | 2,175 | 6,500 | 2,215 |
| Government G.M. Areas | 202,000 | £385,240 | 210,000 | £399,021 |
| Kleinfontein | 51,700 | 10,958 | 52,300 | 11,688 |
| Langlaagte Estate | 81,000 | £110,922 | 85,000 | £114,422 |
| Luipaard's Vlei | 22,800 | 5,723 | 23,500 | 5,941 |
| Meyer and Charlton | 16,800 | £20,039 | 16,300 | £19,225 |
| Modderfontein New | 146,000 | 72,856 | 152,000 | 74,248 |
| Modderfontein B | 69,000 | 25,487 | 71,500 | 25,520 |
| Modderfontein Deep | 44,600 | 23,346 | 45,900 | 24,180 |
| Modderfontein East | 67,000 | 20,546 | 70,000 | 21,304 |
| New State Areas | 79,000 | £138,555 | 81,000 | £142,216 |
| Nourse | 62,300 | 18 255 | 65,000 | 18,632 |
| Randfontein | 205,000 | £211,918 | 216,000 | £213,707 |
| Robinson Deep | 79,300 | 21,670 | 79,000 | 22,108 |
| Rose Deep | 57,500 | 11,997 | 59,000 | 12,248 |
| Simmer and Jack | 73,000 | 18,192 | 75,900 | 18,962 |
| Springs | 70,000 | £142,907 | 72,000 | £145,468 |
| Sub Nigel | 22,800 | 19,937 | 24,800 | 21,772 |
| Transvaal G.M. Estates | 14,620 | 4,686 | 15,110 | 15,127 |
| Van Ryn | 39,000 | £38,452 | 39,000 | £37,383 |
| Van Ryn Deep | 65,000 | £105,514 | 67,000 | £108,699 |
| Village Deep | 58,500 | 15,078 | 59,500 | 15,760 |
| West Rand Consolidated | 83,800 | £91,659 | 90,000 | £93,828 |
| West Springs | 62,600 | £78,254 | 65,100 | £80,833 |
| Witw'tersr'nd (Knights) | 52,500 | £47,081 | 55,000 | £48,648 |
| Witwatersrand Deep | 46,000 | 10,377 | 45,305 | 13,626 |
| Wolhuter | 27,000 | 6,051 | 22,100 | 5,241 |

## 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. | £ |
| March, 1928 | 2,552,100 | 27 11 | 19 9 | 8 2 | 1,039,078 |
| April | 2,381,800 | 28 2 | 20 0 | 8 2 | 971,128 |
| May | 2,571,900 | 28 0 | 19 7 | 8 5 | 1,084,465 |
| June | 2,500,100 | 28 2 | 19 10 | 8 4 | 1,038,851 |
| July | 2,528,600 | 27 11 | 19 8 | 8 3 | 1,048,432 |
| August | 2,580,700 | 27 11 | 19 7 | 8 4 | 1,079,152 |
| September | 2,485,700 | 27 11 | 19 7 | 8 4 | 1,040,368 |
| October | 2,612,500 | 27 9 | 19 5 | 8 4 | 1,092,162 |
| November | 2,539,700 | 27 9 | 19 7 | 8 2 | 1,041,713 |
| December | 2,505,500 | 27 10 | 19 8 | 8 2 | 1,024,654 |
| January, 1929 | 2,627,320 | 28 1 | 19 9 | 8 4 | 1,095,070 |
| February | 2,403,720 | 28 6 | 20 3 | 8 3 | 990,942 |
| March | 2,581,600 | 28 3 | 20 0 | 8 3 | 1,062,331 |
| April | — | — | — | — | 1,068,103 |

## NATIVES EMPLOYED IN THE TRANSVAAL MINES.

| | Gold Mines. | Coal Mines. | Diamond Mines. | Total. |
|---|---|---|---|---|
| May 31, 1928 | 198,461 | 16,943 | 5,742 | 222,172 |
| June 30 | 197,186 | 16,870 | 5,650 | 222,340 |
| July 31 | 194,584 | 16,695 | 5,189 | 220,345 |
| August 31 | 194,788 | 16,553 | 4,839 | 218,578 |
| September 30 | 194,936 | 16,724 | 4,535 | 215,843 |
| October 31 | 193,147 | 16,767 | 4,807 | 215,362 |
| November 30 | 190,970 | 16,803 | 4,889 | 216,628 |
| December 31 | 187,970 | 16,059 | 4,444 | 208,473 |
| January 31, 1929 | 192,526 | 15,845 | 50,56 | 213,427 |
| February 28 | 196,150 | 15,940 | 5,635 | 217,725 |
| March 30 | 197,646 | 16,065 | 5,787 | 219,498 |
| April 30 | 197,412 | 15,900 | 5,554 | 218,866 |
| May 31 | 195,733 | 15,852 | 5,473 | 217,058 |

## PRODUCTION OF GOLD IN RHODESIA.

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

## RHODESIAN GOLD OUTPUTS.

| | April. | | May. | |
|---|---|---|---|---|
| | Tons. | Oz. | Tons. | Oz. |
| Cam and Motor | 24,400 | 12,332 | 24,600 | 12,506 |
| Globe and Phœnix | 6,096 | 4,888 | — | — |
| Lonely Reef | 5,000 | 4,100 | 5,100 | 4,063 |
| Rezende | 6,400 | 2,950 | 6,400 | 2,913 |
| Shamva | 46,000 | £21,427 | 47,000 | £24,283 |
| Sherwood Starr | 4,800 | £8,537 | 4,800 | £8,515 |

## WEST AFRICAN GOLD OUTPUTS.

| | April | | May. | |
|---|---|---|---|---|
| | Tons. | Oz. | Tons. | Oz. |
| Ashanti Goldfields | 9,206 | 10,256 | 9,324 | 10,367 |
| Taquah and Abosso | 8,000 | £13,360 | 7,435 | £12,734 |

## AUSTRALIAN GOLD OUTPUTS BY STATES.

| | Western Australia. | Victoria. | Queensland. | New South Wales |
|---|---|---|---|---|
| | Oz. | Oz. | Oz. | Oz. |
| May, 1928 | 29,264 | 2,990 | 321 | 397 |
| June | 39,449 | 3,932 | 498 | 487 |
| July | 29,399 | 3,208 | 772 | 154 |
| August | 37,991 | 2,637 | 690 | 3,447 |
| September | 32,397 | 3,366 | 644 | 364 |
| October | 36,565 | 2,632 | 820 | 256 |
| November | 31,466 | 3,111 | 865 | 550 |
| December | 36,097 | — | 493 | 208 |
| January, 1929 | 27,384 | — | 260 | 445 |
| February | 28,177 | — | 117 | 474 |
| March | 25,848 | — | 816 | — |
| April | 39,166 | — | — | — |
| May | 28,026 | — | — | — |

## AUSTRALASIAN GOLD OUTPUTS.

| | April. | | May. | |
|---|---|---|---|---|
| | Tons | Value £ | Tons | Value £ |
| Associated G.M. (W.A.) | 4,657 | 9,448 | 5,151 | 9,902 |
| Blackwater (N.Z.) | 3,233 | 5,515 | 3,350 | 5,455 |
| Boulder Persev'ce (W.A.) | 6,196 | 14,342 | 6,329 | 13,685 |
| Grt. Boulder Pro. (W.A.) | 9,300 | 25,657 | — | — |
| Lake View & Star (W.A.) | 8,685 | 14,530 | — | — |
| Sons of Gwalia (W.A.) | 13,760 | 10,961 | 14,358 | 12,152 |
| South Kalgurli (W.A.) | 8,719 | 16,557 | 9,090 | 17,142 |
| Waihi (N.Z.) | 16 455 | { 4,852* 34,993† | — | — |

* Oz. gold. † Oz. silver.

## GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

| | April. | | May. | |
|---|---|---|---|---|
| | Tons Ore | Total Oz. | Tons Ore | Total Oz. |
| Balaghat | 4,650 | 3,049 | 4,850 | 3,015 |
| Champion Reef | 7,820 | 4,721 | 8,475 | 5,124 |
| Mysore | 18,277 | 8,273 | 18,490 | 8,370 |
| Nundydroog | 11,005 | 6,666 | 10,528 | 6,646 |
| Ooregum | 14,000 | 7,378 | 14,000 | 7,294 |

## MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

| | April. | | May. | |
|---|---|---|---|---|
| | Tons | Value £ | Tons | Value £ |
| Chosen Synd. (Korea) | 7,970 | 12,543 | — | — |
| Frontino& Bolivia (C'lbia) | 1,710 | 4,207 | 1,650 | 5,073 |
| Lena (Siberia) | — | 31,748 | — | — |
| Lydenburg Plat. (Trans.) | 3,500 | 616*p* | 3,580 | 791*p* |
| Marmajito (Colombia) | 406 | 5,225 | 640 | 4,058 |
| Mexican Corp. Fresnillo | 81,600 | 135,943*d* | — | — |
| Onverwacht Platinum | 2,364 | 400*p* | 2,514 | 400*p* |
| Oriental Cons. (Korea) | 21,723 | 87,758*d* | — | — |
| St. John del Rey (Brazil) | — | 41,500 | — | 36,600 |
| Santa Gertrudis (Mexico) | 54,013 | 140,210*d* | — | — |

*d* dollars. *p* Oz. platinoids.

## PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

| | | | |
|---|---|---|---|
| July, 1928 | 5,488 | January, 1929 | 5,840 |
| August | 5,499 | February | 4,896 |
| September | 5,071 | March | 5,236 |
| October | 5,161 | April | 5,433 |
| November | 5,483 | May | 5,405 |
| December | 5,249 | June | — |

## OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

| | Mar. | April | May |
|---|---|---|---|
| Ampang | 14 | 21 | 16 |
| Batu Caves | — | 32 | 48 |
| Changkat | 60 | 53 | 54 |
| Chenderiang | 29 | 35 | 28½ |
| Gopeng | 80½ | 83½ | 83 |
| Idris Hydraulic | 41¾ | 38¾ | 41¾ |
| Ipoh | 51 | 42½ | 35½ |
| Jelapang | 26½ | 23 | 33 |
| Kamunting | 93 | 81 | 102 |
| Kent (F.M.S.) | 57 | 58 | 54 |
| Kepong | 25 | 28 | 25 |
| Kinta | 27 | 30 | 28½ |
| Kinta Kellas | 41½ | 59½ | 25½ |
| Kramat Pulai | 20½ | 19¼ | 18¾ |
| Kuala Kampar | 90 | 115 | 115 |
| Kundang | 33 | 35 | 37 |
| Lahat | 18½ | 17¾ | 17¾ |
| Larut Tinfields | 85 | 84½ | 80 |
| Malaya Consolidated | 54¾ | 73½ | 83 |
| Malayan Tin | 160¾ | 133 | 131 |
| Meru | 16¼ | 16 | 14¾ |
| Pahang | 222½ | 226¾ | 220 |
| Pengkalen | 65½ | 77½ | 74½ |
| Petaling | 238 | 226 | 220 |
| Rahman | 53½ | 59½ | 71½ |
| Rambutan | 12 | 12 | 10½ |
| Rantau | 50 | 44 | 26 |
| Rawang | 75 | 70 | 70 |
| Renong | 48½ | 50 | 37 |
| Selayang | 22 | 26½ | 27 |
| Southern Malayan | 113 | 125 | 154¾ |
| Southern Perak | 66¾ | 86¼ | 91½ |
| Southern Tronoh | — | — | 18 |
| Sungei Besi | 46 | 43 | 46 |
| Sungei Kinta | 31 | 20 | 26 |
| Sungei Way | 62½ | 89½ | 89½ |
| Taiping | 48 | 53 | 47 |
| Tanjong | 24 | 24½ | 30 |
| Teja Malaya | 16 | 12 | 17½ |
| Tekka | 50½ | 43 | 45 |
| Tekka-Taiping | 54 | 54 | 48 |
| Temoh | 22 | 35 | 34½ |
| Tronoh | 114 | 96 | 106 |

## OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

| | March. | April. | May |
|---|---|---|---|
| Amari | 5½ | 6 | — |
| Anglo-Nigerian | 57 | 55 | 56 |
| Associated Tin Mines | 244 | 250 | 250 |
| Baba River | 3½ | 3¼ | 4 |
| Batura Monguna | 4 | 2 | 2½ |
| Bisichi | 58 | 61 | 69 |
| Daffo | 5 | 4 | 5 |
| Ex-Lands | 50 | 50 | 50 |
| Filani | 1½ | 1½ | 1½ |
| Jantar | 25 | 35 | 43 |
| Jos | 19¾ | 18¼ | 22¼ |
| Juga Valley | 17½ | 9 | 12 |
| Junction | 14 | 6 | 8 |
| Kaduna | 28¼ | 27¼ | — |
| Kaduna Prospectors | 17 | 19 | — |
| Kassa | 16 | 17 | 17 |
| Lower Bisichi | 5 | 5½ | 5 |
| Mongu | 30 | 35 | 35 |
| Naraguta | 12½ | 11½ | — |
| Naraguta Durumi | 9 | 14 | — |
| Naraguta Extended | 9 | 9 | 10 |
| Naraguta Karama | 16½ | 19½ | — |
| Naraguta Korot | 15 | 15 | — |
| Nigerian Base Metals | 47 | 49 | 50 |
| Nigerian Consolidated | 20 | 20 | 20 |
| N.N. Bauchi | 150 | 160 | 160 |
| Offin River | 6¼ | 6 | 8 |
| Ribon Valley | 17 | 14 | 14½ |
| Ropp | 72 | 74 | 80 |
| Rukuba | 4 | 4 | 4 |
| South Bukeru | 15 | 14½ | 14 |
| Tin Fields | 7¾ | 6 | 5 |
| Tin Properties | 26 | 19 | 15 |
| United Tin Areas | 5½ | 4½ | 12½ |
| Yarde Kerri | 15 | 15 | 10 |

## OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

| | March | April | May |
|---|---|---|---|
| Anglo-Burma (Burma) | 6 | 3 | — |
| Aramayo Mines (Bolivia) | 329 | 415 | 425 |
| Bangrin (Siam) | 52½ | 66½ | 65½ |
| Berenguela (Bolivia) | 32 | 27 | 45 |
| C'nsolidated Tin Mines (Burma) | 91* | 81* | 72* |
| Eastern Siam (Siam) | 4½ | — | — |
| East Pool (Cornwall) | 84½ | 84 | — |
| Fabulosa (Bolivia) | 154 | 145 | 128 |
| Geevor (Cornwall) | 73 | 70 | 70 |
| Jantar (Cornwall) | 19 | 19 | — |
| Kagera (Uganda) | 25 | 25 | 23 |
| Polhigey (Cornwall) | — | 20 | 31 |
| San Finx (Spain) | 36* | 40½* | — |
| Siamese Tin (Siam) | 139½ | 120½ | 131½ |
| South Crofty (Cornwall) | 66 | 65 | 65½ |
| Tavoy Tin (Burma) | 55 | 54 | 51 |
| Theindaw (Burma) | — | 3½ | 3½ |
| Tongkah Harbour (Siam) | 110 | 64 | 95 |
| Toyo (Japan) | 11 | — | — |
| Wheal Kitty (Cornwall) | 51 | 50 | 50 |

* Tin and Wolfram.

## COPPER, LEAD, AND ZINC OUTPUTS.

| | | April | May |
|---|---|---|---|
| Broken Hill Prop. | Tons lead conc. | 1,646 | — |
| Broken Hill South | Tons lead conc. | 5,764 | 4,359 |
| | Tons zinc conc. | 4,593 | 3,954 |
| Burma Corporation | Tons refined lead | 6,554 | 6,567 |
| | Oz. refined silver | 625,327 | 623,222 |
| Bwana M'Kubwa | Tons copper oxide | 687 | 354 |
| Electrolytic Zinc | Tons zinc | 3,920 | 3,982 |
| Indian Copper | Tons copper | 135 | — |
| Messina | Tons copper | 545 | 582 |
| Mount Lyell | Tons concentrates | 2,633 | 2,628 |
| Namaqua | Tons copper | 199 | — |
| North Broken Hill | Tons lead conc. | 7,560 | — |
| | Tons zinc conc. | 5,700 | — |
| Poderosa | Tons copper ore | 1,030 | 1,040 |
| Rhodesia Broken Hill | Tons lead | 210 | 145 |
| | Tons slab zinc | 835 | 985 |
| San Francisco Mexico | Tons lead conc. | 3,220 | 3,056 |
| | Tons zinc conc. | 3,800 | 4,036 |
| Sulphide Corporation | Tons lead conc. | 1,806 | 1,955 |
| | Tons zinc conc. | 2,770 | 3,055 |
| Tetiube | Tons lead conc. | 495 | — |
| | Tons zinc conc. | 1,328 | — |
| Union Minière | Tons copper | 11,700 | — |
| Zinc Corporation | Tons lead conc. | 5,514 | — |
| | Tons zinc conc. | 4,155 | — |

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

| | | March. | April. |
|---|---|---|---|
| Iron Ore | Tons | 462,368 | 466,645 |
| Manganese Ore | Tons | 19,720 | 26,442 |
| Iron and Steel | Tons | 182,107 | 261,932 |
| Copper and Iron Pyrites | Tons | 25,466 | 7,305 |
| Copper Ore, Matte, and Prec. | Tons | 152 | 4,218 |
| Copper Metal | Tons | 14,541 | 13,514 |
| Tin Concentrate | Tons | 4,986 | 8,135 |
| Tin Metal | Tons | 1,261 | 1,249 |
| Lead Pig and Sheet | Tons | 21,579 | 25,415 |
| Zinc (Spelter) | Tons | 9,964 | 17,261 |
| Zinc Sheets, etc. | Tons | 2,005 | 1,681 |
| Aluminium | Tons | 1,844 | 1,396 |
| Quicksilver | Lb. | 19,224 | 27,781 |
| Zinc Oxide | Tons | 837 | 932 |
| White Lead | Cwt. | 14,721 | 14,238 |
| Red and Orange Lead | Cwt. | 3,449 | 2,545 |
| Barytes, ground | Cwt. | 44,442 | 117,657 |
| Asbestos | Tons | 1,666 | 2,286 |
| Boron Minerals | Tons | 493 | 1,266 |
| Borax | Cwt. | 12,317 | 29,700 |
| Basic Slag | Tons | 3,006 | 8,275 |
| Superphosphates | Tons | 26,984 | 29,912 |
| Phosphate of Lime | Tons | 28,197 | 29,973 |
| Mica | Tons | 264 | 182 |
| Sulphur | Tons | 3,089 | 10,667 |
| Nitrate of Soda | Cwt. | 416,539 | 145,893 |
| Potash Salts | Cwt. | 407,418 | 584,308 |
| Petroleum: Crude | Gallons | 51,192,683 | 23,868,489 |
| Lamp Oil | Gallons | 26,998,354 | 31,789,070 |
| Motor Spirit | Gallons | 84,508,95- | 64,189,036 |
| Lubricating Oil | Gallons | 7,594,24- | 8,542,667 |
| Gas Oil | Gallons | 11,615,85- | 5,300,465 |
| Fuel Oil | Gallons | 35,538,79- | 46,965,001 |
| Asphalt and Bitumen | Tons | 12,362 | 17,795 |
| Paraffin Wax | Cwt. | 115,719 | 129,225 |
| Turpentine | Cwt. | 10,078 | 15,203 |

## OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

| | March. | April. | May. |
|---|---|---|---|
| Anglo-Ecuadorian | 13,968 | 13,204 | 13,683 |
| Apex Trinidad | 37,210 | 35,820 | 37,060 |
| Attock | 6,457 | 5,241 | 4,688 |
| British Burmah | 5,440 | 5,223 | — |
| British Controlled | 32,795 | 31,520 | — |
| Kern Mex. | 916 | 789 | 809 |
| Kern River (Cal.) | 1,183 | 3,827 | 4,377 |
| Kern Romana | 3,213 | 2,707 | 2,637 |
| Kern Trinidad | 3,610 | 3,086 | 3,644 |
| Lobitos | 27,629 | 26,899 | 27,362 |
| Phœnix | 41,007 | 34,048 | 36,029 |
| St. Helen's Petroleum | 7,762 | 5,198 | 22,627 |
| Steaua Romana | 63,100 | 61,850 | 68,940 |
| Tampico | — | — | 2,877 |
| Trinidad Leaseholds | 32,300 | 32,500 | 32,100 |
| Venezuelan Consolidated | 2,143 | 2,157 | 1,864 |

## QUOTATIONS OF OIL COMPANIES SHARES.

Denomination of Shares £1 unless otherwise noted.

| | May 8, 1929 | June 7, 1929 |
|---|---|---|
| | £ s. d. | £ s. d. |
| Anglo-American | 3 2 6 | 3 2 6 |
| Anglo-Ecuadorian | 1 2 0 | 1 1 10½ |
| Anglo-Egyptian B | 3 0 0 | 2 15 0 |
| Anglo-Persian 1st Pref. | 1 7 0 | 1 7 0 |
| " " Ord. | 4 10 0 | 4 10 0 |
| Apex Trinidad (5s.) | 1 10 0 | 1 11 3 |
| Attock | 2 19 0 | 3 0 0 |
| British Burmah (8s.) | 7 0 | 7 0 |
| British Controlled ($5) | 5 0 | 6 6 |
| Burmah Oil | 4 6 3 | 4 9 6 |
| Kern River, Cal. (10s.) | 7 9 | 8 0 |
| Lobitos, Peru | 2 4 6 | 2 3 9 |
| Mexican Eagle, Ord. (4 pesos) | 14 0 | 17 0 |
| " " 8% Pref. (4 pesos) | 13 0 | 16 6 |
| Phœnix, Roumania | 12 9 | 13 0 |
| Royal Dutch (100 fl.) | 32 16 3 | 33 17 6 |
| Shell Transport, Ord. | 4 17 0 | 4 18 0 |
| " " 5% Pref. (£10) | 10 0 0 | 10 0 0 |
| Steaua Romana | 12 0 | 11 9 |
| Trinidad Leaseholds | 4 14 0 | 4 9 6 |
| United British of Trinidad (6s. 8d.) | 10 0 | 10 0 |
| V.O.C. Holding | 4 4 0 | 3 16 3 |

## PRICES OF CHEMICALS. June 7.

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

| | | £ s. d. |
|---|---|---|
| Acetic Acid, 40% | per cwt. | 16 6 |
| " 80% | " | 1 16 0 |
| " Glacial | per ton | 66 0 0 |
| Alum | " | 8 10 0 |
| Alumina, Sulphate, 17 to 18% | " | 6 15 0 |
| Ammonia, Anhydrous | per lb. | 10 |
| " 0·880 solution | per ton | 15 10 0 |
| " Carbonate | " | 27 10 0 |
| " Nitrate | " | 24 0 0 |
| " Phosphate | " | 40 0 0 |
| " Sulphate, 20·6% N. | " | 10 13 0 |
| Antimony, Tartar Emetic | per lb. | 10½ |
| " Sulphide, Golden | " | 7 |
| Arsenic, White | per ton | 16 0 0 |
| Barium Carbonate, 94% | " | 5 10 0 |
| " Chlorate | per lb. | 4 |
| " Chloride | per ton | 11 0 0 |
| " Sulphate, 94% | " | 6 0 0 |
| Benzol, standard motor | per gal. | 1 11½ |
| Bleaching Powder, 35% Cl. | per ton | 7 0 0 |
| " Liquor, 7% | " | 3 5 0 |
| Borax | " | 20 0 0 |
| Boric Acid | " | 30 0 0 |
| Calcium Chloride | " | 4 12 6 |
| Carbolic Acid, crude 60% | per gal | 1 11½ |
| " crystallized, 40° | per lb. | 6½ |
| Carbon Disulphide | per ton | 24 0 0 |
| Citric Acid | per lb. | 2 1½ |
| Copper Sulphate | per ton | 27 15 0 |
| Cyanide of Sodium, 100% KCN | per lb. | 7 |
| Hydrofluoric Acid | " | 6 |
| Iodine | per oz. | 1 0 |
| Iron, Nitrate | per ton | 6 10 0 |
| " Sulphate | " | 1 17 6 |
| Lead, Acetate, white | " | 40 0 0 |
| " Nitrate | " | 34 0 0 |
| " Oxide, Litharge | " | 37 10 0 |
| " White | " | 40 0 0 |
| Lime, Acetate, brown | " | 8 0 0 |
| " " grey, 80% | " | 16 10 0 |
| Magnesite, Calcined | " | 9 0 0 |
| Magnesium, Chloride | " | 6 15 0 |
| " Sulphate | " | 3 2 6 |
| Methylated Spirit 64° Industrial | per gal. | 1 5 |
| Nitric Acid, 80° Tw. | per ton | 21 0 0 |
| Oxalic Acid | per lb. | 3 |
| Phosphoric Acid | per ton | 29 15 0 |
| Potassium Bichromate | per lb. | 4½ |
| " Carbonate | per ton | 26 2 6 |
| " Chlorate | per lb. | 3 |
| " Chloride 80% | per ton | 9 0 0 |
| " Hydrate (Caustic) 90% | " | 33 5 0 |
| " Nitrate, refined | " | 20 10 0 |
| " Permanganate | per lb. | 5 |
| " Prussiate, Yellow | " | 6½ |
| " " Red | " | 1 9 |
| " Sulphate, 90% | per ton | 11 5 0 |
| Sodium Acetate | per ton | 21 0 0 |
| " Arsenate, 45% | " | 26 0 0 |
| " Bicarbonate | " | 10 10 0 |
| " Bichromate | per lb. | 3¾ |
| " Carbonate (Soda Ash) | per ton | 6 0 0 |
| " " (Crystals) | " | 5 5 0 |
| " Chlorate | per lb. | 2¾ |
| " Hydrate, 76% | per ton | 14 10 0 |
| " Hyposulphite | " | 9 0 0 |
| " Nitrate, 96% | " | 10 12 0 |
| " Phosphate | " | 11 10 0 |
| " Prussiate | per lb. | 4¾ |
| " Silicate | per ton | 9 10 0 |
| " Sulphate (Salt-cake) | " | 2 10 0 |
| " " (Glauber's Salt) | " | 2 5 0 |
| " Sulphide | " | 9 0 0 |
| Sulphur, Roll | " | 10 0 0 |
| " Flowers | " | 11 10 0 |
| Sulphuric Acid, 168° | " | 6 5 0 |
| " " free from Arsenic, 144° | " | 4 0 0 |
| Superphosphate of Lime, 35% | " | 2 15 0 |
| Tartaric Acid | per lb. | 1 4½ |
| Turpentine | per cwt. | 2 4 0 |
| Tin Crystals | per lb. | 1 6½ |
| Titanous Chloride | " | 10 |
| Zinc Chloride | per ton | 12 0 0 |
| Zinc Dust | " | 32 0 0 |
| Zinc Oxide | " | 42 0 0 |
| Zinc Sulphate | " | 9 0 0 |

# SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

| GOLD AND SILVER: | May 8, 1929. £ s. d. | June 7, 1929. £ s. d. |
|---|---|---|
| **SOUTH AFRICA:** | | |
| Brakpan | 4 7 6 | 4 7 6 |
| City Deep | 11 3 | 10 6 |
| Consolidated Main Reef | 16 9 | 16 6 |
| Crown Mines (10s.) | 3 3 0 | 3 4 6 |
| Daggafontein | 1 1 0 | 1 1 3 |
| Durban Roodepoort Deep | 8 6 | 10 0 |
| East Geduld | 1 18 9 | 1 17 0 |
| East Rand Proprietary (10s.) | 10 0 | 10 6 |
| Ferreira Deep | 5 9 | 6 0 |
| Geduld | 3 8 0 | 3 10 6 |
| Geldenhuis Deep | 4 6 | 4 6 |
| Glynn's Lydenburg | 5 0 | 5 0 |
| Government Gold Mining Areas (5s.) | 1 19 0 | 2 1 3 |
| Kleinfontein | 2 6 | 2 6 |
| Langlaagte Estate | 1 1 3 | 1 1 0 |
| Luipaards Vlei (4s.) | 4 3 | 4 0 |
| Meyer & Charlton | 10 0 | 10 0 |
| Modderfontein New (10s.) | 5 3 9 | 5 7 6 |
| Modderfontein B (5s.) | 15 0 | 16 6 |
| Modderfontein Deep (5s.) | 1 10 0 | 1 11 3 |
| Modderfontein East | 1 5 9 | 1 8 9 |
| New State Areas | 1 13 0 | 1 13 0 |
| Nourse | 8 6 | 8 9 |
| Randfontein | 6 0 | 6 3 |
| Robinson Deep A (1s.) | 13 9 | 15 0 |
| " " B | 9 6 | 9 6 |
| Rose Deep | 5 3 | 5 0 |
| Simmer & Jack (2s. 6d.) | 3 0 | 3 3 |
| Springs | 3 1 3 | 3 6 3 |
| Sub Nigel (10s.) | 1 19 0 | 1 16 3 |
| Transvaal Gold Mining Estates | 8 3 | 8 6 |
| Van Ryn | 9 0 | 9 0 |
| Van Ryn Deep | 1 19 0 | 2 0 0 |
| Village Deep | 4 0 | 4 0 |
| West Rand Consolidated (10s.) | 8 0 | 8 0 |
| West Springs | 18 6 | 18 3 |
| Witwatersrand (Knight's) | 7 0 | 7 0 |
| Witwatersrand Deep | 4 6 | 4 6 |
| Wolhuter | 1 0 | 1 0 |
| **RHODESIA:** | | |
| Cam and Motor | 1 18 0 | 1 16 3 |
| Gaika | 7 0 | 6 0 |
| Globe and Phœnix (5s.) | 9 9 | 11 6 |
| Lonely Reef | 1 1 3 | 1 5 0 |
| Rezende | 16 9 | 17 6 |
| Shamva | 7 0 | 5 6 |
| Sherwood Starr | 8 9 | 10 6 |
| **GOLD COAST:** | | |
| Ashanti (4s.) | 1 4 0 | 1 4 0 |
| Taquah and Abosso (5s.) | 2 9 | 2 3 |
| **AUSTRALASIA:** | | |
| Associated Gold Mines (4s.), W.A. | 1 0 | 1 0 |
| Blackwater, N.Z. | 2 6 | 2 6 |
| Boulder Perseverance (1s.), W.A. | 9 | 9 |
| Great Boulder Proprietary (2s.), W.A | 2 6 | 2 6 |
| Lake View and Star (4s.), W.A. | 12 9 | 13 9 |
| Sons of Gwalia, W.A. | 2 9 | 2 9 |
| South Kalgurli (10s.), W.A. | 16 9 | 16 0 |
| Waihi (5s.), N.Z. | 13 6 | 13 6 |
| Waihi Grand Junction, N.Z. | 1 0 | 1 0 |
| Wiluna Gold, W.A. | 1 2 0 | 1 2 0 |
| **INDIA:** | | |
| Balaghat (10s.) | 5 3 | 5 3 |
| Champion Reef (10s.) | 8 9 | 8 7 |
| Mysore (10s.) | 14 0 | 13 6 |
| Nundydroog (10s.) | 16 0 | 15 6 |
| Ooregum (10s.) | 11 0 | 10 6 |
| **AMERICA:** | | |
| Camp Bird (2s.), Colorado | 2 6 | 2 6 |
| Chosen (Korea) | 1 0 0 | 1 1 0 |
| Frontino and Bolivia, Colombia | 8 9 | 8 9 |
| Keeley Silver ($1.00), Ontario | 2 0 | 2 0 |
| Mexican Corporation, Mexico | 14 6 | 11 3 |
| Mexico Mines of El Oro, Mexico | 4 0 | 7 0 |
| Oroville Dredging, Colombia (4s.) | 2 0 | 1 9 |
| Panama Corporation | 15 6 | 19 0 |
| St. John del Rey, Brazil | 19 0 | 17 6 |
| Santa Gertrudis, Mexico | 11 3 | 10 3 |
| Selukwe (2s. 6d.), British Columbia | 5 9 | 5 9 |
| Vipond ($1), Ontario | 4 9 | 3 9 |
| **RUSSIA:** | | |
| Lena Goldfields | 4 3 | 4 6 |

| DIAMONDS: | May 8, 1929. £ s. d. | June 7, 1929. £ s. d. |
|---|---|---|
| Consol. African Selection Trust (5s.) | 1 8 9 | 1 10 0 |
| Consolidated of S.W.A. | 1 3 6 | 1 5 6 |
| De Beers Deferred (£2 10s.) | 13 11 0 | 13 10 0 |
| Jagersfontein | 2 10 6 | 2 9 6 |
| Premier Preferred (5s.) | 5 17 6 | 5 16 3 |
| **COPPER:** | | |
| Arizona Copper (5s.) Arizona | 2 2 0 | 2 2 0 |
| Bwana M'Kubwa (5s.) Rhodesia | 18 3 | 19 3 |
| Esperanza Copper, Spain | 19 0 | 19 6 |
| Messina (5s.), Transvaal | 19 3 | 18 3 |
| Mount Lyell, Tasmania | 2 3 0 | 2 1 6 |
| Namaqua (£2), Cape Province | 1 10 0 | 1 3 9 |
| N'Changa, Rhodesia | 3 11 6 | 4 5 0 |
| Rio Tinto (£5), Spain | 57 0 0 | 57 0 0 |
| Roan Antelope (5s.), Rhodesia | 2 7 6 | 1 15 6 |
| Tanganyika, Congo and Rhodesia | 3 1 6 | 3 0 0 |
| **LEAD-ZINC:** | | |
| Broken Hill Proprietary N.S.W. | 1 7 6 | 1 5 9 |
| Broken Hill North, N.S.W. | 5 11 0 | 5 11 3 |
| Broken Hill South, N.S.W. | 3 8 6 | 3 6 3 |
| Burma Corporation (10 rupees) | 17 3 | 18 9 |
| Electrolytic Zinc Pref., Tasmania | 1 16 6 | 1 16 6 |
| Mount Isa, Queensland | 2 7 0 | 2 5 0 |
| Rhodesia Broken Hill (5s.) | 3 9 | 4 0 |
| Russo-Asiatic Consd. (2s. 6d.) | 3 9 | 3 9 |
| San Francisco (10s.), Mexico | 1 17 6 | 1 17 6 |
| Sulphide Corporation (15s.), N.S.W. | 19 0 | 18 6 |
| Tetiuhe (5s.), Siberia | 4 0 | 4 6 |
| Zinc Corporation (10s.), N.S.W. | 2 11 6 | 2 11 6 |
| **TIN:** | | |
| Aramayo Mines (25 fr.), Bolivia | 3 0 0 | 3 0 0 |
| Associated Tin (5s.), Nigeria | 9 9 | 10 0 |
| Bangrin, Siam | 1 13 9 | 1 16 3 |
| Bisichi (10s.), Nigeria | 9 3 | 9 0 |
| Briseis, Tasmania | 3 6 | 3 6 |
| Chenderiang, Malay | 8 6 | 8 9 |
| Dolcoath (10s.), Cornwall | 9 | 9 |
| East Pool (5s.), Cornwall | 1 6 | 1 6 |
| Ex-Lands Nigeria (2s.), Nigeria | 2 6 | 2 6 |
| Fabulosa ($1.00), Bolivia | 9 | 9 |
| Geevor (10s.), Cornwall | 7 6 | 8 0 |
| Gopeng, Malaya | 2 3 9 | 2 5 0 |
| Idris (5s.), Malaya | 14 9 | 15 6 |
| Ipoh Dredging (16s.), Malay | 1 7 0 | 1 7 0 |
| Kamunting (5s.), Malay | 15 0 | 15 6 |
| Kinta, Malay | 11 0 | 11 6 |
| Lahat, Malay | 14 0 | 14 0 |
| Malayan Tin Dredging (5s.), Malay | 1 6 0 | 1 6 6 |
| Mongu (10s.), Nigeria | 10 0 | 9 9 |
| Naraguta, Nigeria | 1 2 6 | 17 6 |
| Nigerian Base Metals (5s.) | 4 9 | 4 6 |
| N.N. Bauchi, Nigeria (10s.) | 1 2 9 | 1 1 6 |
| Pahang Consolidated (5s.), Malay | 10 0 | 9 9 |
| Pengkalen (5s.), Malay | 19 3 | 19 0 |
| Petaling (2s. 4d.) | 12 9 | 13 0 |
| Renong Dredging, Malay | 1 8 9 | 1 10 0 |
| Ropp (4s.), Nigeria | 8 0 | 8 0 |
| Siamese Tin (5s.), Siam | 15 0 | 15 3 |
| South Crofty (5s.), Cornwall | 4 3 | 4 6 |
| Southern Malayan | 13 6 | 14 9 |
| Southern Perak, Malay | 2 7 0 | 2 11 10 |
| Southern Tronoh (5s.) | 11 0 | 11 3 |
| Sungei Besi (5s.), Malay | 13 6 | 14 0 |
| Tavoy (4s.), Burma | 12 3 | 12 0 |
| Tekka, Malay | 19 0 | 1 0 0 |
| Tekka Taiping, Malay | 1 0 6 | 1 0 9 |
| Toyo (10s.), Japan | 11 0 | 11 6 |
| Tronoh (5s.), Malay | 1 0 6 | 1 1 0 |
| **FINANCE, ETC.:** | | |
| Anglo-American Corporation | 2 1 0 | 2 4 6 |
| Anglo-French Exploration | 1 3 6 | 1 2 9 |
| Anglo-Oriental (5s.) | 19 3 | 18 9 |
| British South Africa (15s.) | 1 16 6 | 2 2 3 |
| Central Mining (£8) | 18 12 6 | 19 0 0 |
| Chemical & Metallurgical Corp. (2s.) | 4 0 | 4 0 |
| Consolidated Gold Fields | 2 14 6 | 2 17 0 |
| Consolidated Mines Selection (10s.) | 16 9 | 18 6 |
| General Mining and Finance | 18 3 | 19 6 |
| Gold Fields Rhodesian (10s.) | 10 6 | 10 6 |
| Johannesburg Consolidated | 2 6 6 | 2 7 6 |
| London Tin Syndicate | 3 6 3 | 3 9 0 |
| Minerals Separation | 5 13 6 | 7 10 0 |
| National Mining (8s.) | 4 0 | 3 6 |
| Rand Mines (5s.) | 3 3 0 | 3 3 0 |
| Rhodesian Congo Border | 5 17 6 | 10 0 0 |
| Southern Rhodesia Base Metals | 11 6 | 13 9 |
| South-West Africa | 16 0 | 16 0 |
| Tin Selection Trust | 1 3 9 | 1 7 6 |
| Union Corporation (12s. 6d.) | 4 8 0 | 4 7 6 |

# THE MINING DIGEST

## A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

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## KIRKLAND LAKE GOLD AREA

In the MAGAZINE for February and March, 1921, was reproduced an abstract from the report of A. G. Burrows and P. E. Hopkins for the Ontario Government Department of Mines and in May, 1926, another abstract appeared of an article by J. B. Tyrrell and R. E. Hore in *Mining and Metallurgy*. We reproduce here extracts from the report of E. W. Todd which comprises the 37th Annual Report of the Ontario Department of Mines, being Vol. xxxvii, Part II, 1928.

In his introduction the author holds the view that the prospect of success being met with in depths considerably greater than already reached can be definitely predicted while new producers are still coming in and intense exploration is taking place in the outlying parts of the area. Dealing with the general geology of the district, he alludes to the synclinal structure which is marked by the sedimentary formations and represents a line of weakness in the earth's crust, extending from the Matachewan area eastward through Kirkland Lake to the Quebec boundary, a distance of roughly 75 miles. At intervals among this belt discoveries of gold ore have been made. At Kirkland Lake the sedimentary band is about 2 miles wide and strikes E. 30° N.

In Lebel township to the east the general strike of the series approaches more nearly an east-west direction, whilst still further east in Gauthier township the band extends in a direction E. 30° S. This change in structure appears to be related to a large boss of granite and syenite which invades the south part of the Lebel township and this intrusive mass appears to have played a very important part in certain structures relating to the ore deposits. Speaking of the nature of the sediments, the author refers to the colour of the tuff which varies between dark-grey and red, various shades of the latter predominating on surface, a fact which has led to the adoption of useless terms in describing them such as " red sediments " and " red sandstone ". This colourization is particularly prominent on the surface in intrusive masses and over shear zones. In mine workings and in diamond-drill cores, where oxidation has not penetrated, grey tints are more common than red, although the rock usually has a mottled appearance, on close examination, owing to the presence of reddish greys. This characteristic mottling shows also on fresh fractures of the grey phases exposed on the surface.

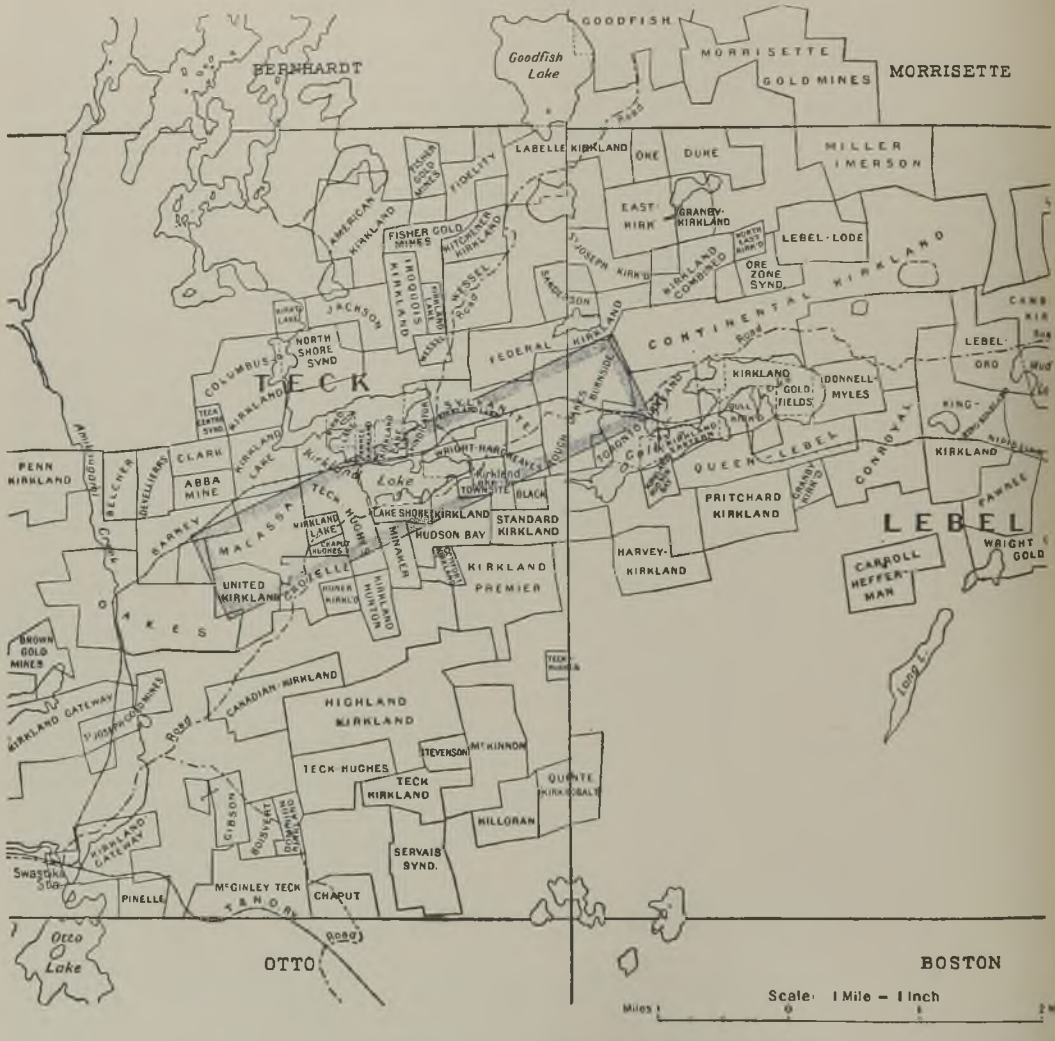
Although the geological structure in the Kirkland Lake area is somewhat complex, a study of the rocks, on the surface and underground reveals a fairly clear picture of the major features and of many of the details as well. Very few areas contain as interesting an assembly of structural phenomena as those found in the Kirkland Lake and very seldom are the facilities for observing them as good. There is an abundance of outcrops over most of the region and underground development, which has reached a maximum depth of about 3,000 feet, is obviously of great help in adding to the knowledge of the structures. Summarizing the more important geological veins leading up to and following the formation of the orebodies, the author reads as follows :—Pressure associated with the invasion of a batholith of Algoman granite causes the folding of the Timiskamian series and the Keewatin on a general east-west line and thus produces the synclinal structure of Kirkland Lake. Syenitic types, porphyry, and diabase were injected along lines of weakness developed roughly parallel to the folds. The series of overthrust faults resulted from release of continued pressure. Deep-seated mineral solutions began to circulate through some of the fractures and, in the case of the " main break " of Kirkland Lake, faulting and mineral deposition continued contemporaneously for a long time. A series of north-south tension faults which appear to post date the end of the period of ore deposition appears to be the last expression of movement. Finally, erosion existant for a very long time and still continuing has removed the upper parts of the folds. The folding of the Timiskamian zone was not accompanied by excessive shearing except along the margins of the belt. Dealing further with the intrusion of syenitic rocks he shows evidence that all intrusions came in subsequently to the folding, and extensive surface maps and a great number of vertical sections which accompany the report should be referred to by the reader anxious to obtain more detailed information. Regarding the main break there are several productive veins in the faulted zone, but the best ore is associated with a north fault, on which the displacement appears to be much greater than on the others, particularly in the central and western part of the area.

On the subject of the relation of veins to faults the author says that the production veins lie along the planes of the faults and that these cut indiscriminately across all of the important rock formations. He thinks that it is quite apparent that their function is very important in that they provide openings in the rocks without which vein solutions could not have penetrated in sufficient quantity to form commercial orebodies.

As a rule the veins are strongest where the movements on the faults are large and have caused much brecciation of the wall rock, thus allowing mineral-bearing solutions to enter with greater ease and in larger quantity than in the case of fractures resulting from minor movements. There are, nevertheless, many subsidiary fractures particularly towards the east end of the area in which commercial orebodies are found but here there is a certain inconsistency in continuity of ore content. The synclinal structure marked by the Timiskamian series in Lebel

and Gauthier townships lies adjacent to the large boss of granite situated in south Lebel and Boston townships, which probably produced in the earlier stages of its advance other faults similar to those found in Teck township and associated there with the ores. Evidence of mineralization is abundant in the eastern section, as indicated by the presence of the many small gold-bearing veins and by others which have been shown by recent work to have commercial possibilities.

syenite and lamprophyre, red syenite, porphyry, and the diabase dykes. The chief function of the porphyry appears to have been connected with the formation of favourable structure leading to a more deep-seated source of ore-bearing solutions. Ore shoots are found in all of the rocks traversed by the veins, so that there seems to be no distinct genetic relation between the ores and any particular type of exposed rock. However, the character of the fissuring which was the principal controlling




Map showing outlines of Properties Kirkland Lake Area. Shaded

On the subject of the general characteristics of the veins he concludes that they consist of sheared and brecciated rocks partially replaced by secondary minerals such as sericite and chlorite. Irregular masses of quartz fill openings through the crushed rock in the veins and the gold accompanied by the tellurides and sulphides occur in streaks and minute fractures in the masses of secondary minerals. Faults which provided openings for later deposition of the ore traverse the tuff, conglomerate, basic

factor in the vein formation, is quite evidently dependent upon the physical nature of the enclosing rocks, since it is found that the vein structures are wider and more continuous in some formations than in others.

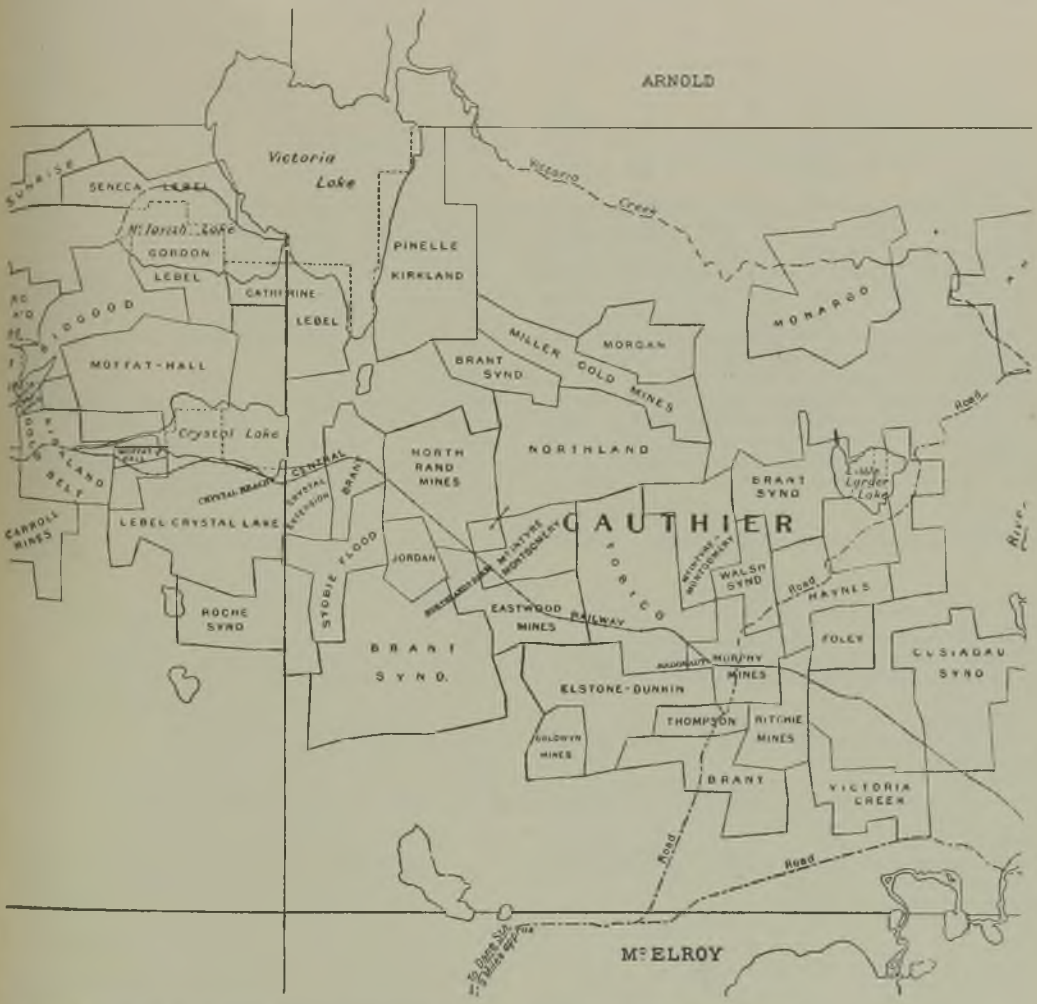
Considerable space is devoted in the report to a description of the nature of the ores. This section is profusely illustrated with photographs of polished hand specimens and microscope sections together with many tables of analyses. Continuing, the author

deals with the persistence of favourable vein structure in greater depth and holds the view that there is a strong assurance that structure favourable for ore deposition, as regards pre-mineralization faulting, will continue to depths below the economic limit of mining operations but this assurance does not apply with the same force in the eastern part of the main vein series.

The report goes on to deal with the operating properties and the accompanying map serves to illustrate this region well. In this part of the report the detailed geology of the separate producing areas is dealt with, that dealing with the Lebel township being particularly interesting.

In a general way the formation and structure occurring in Teck township continue eastward through Lebel. The Timiskamian belt, which has a width of about 10,000 feet, in the middle of Teck township, increases in breadth to about 13,000 feet in the middle of Lebel. The belt describes a sweeping curve around the north side of a mass of granite and syenite. The proximity of this large body of igneous rock is no doubt responsible for the greater amount of schistosity noticeable in Lebel township.

The Timiskamian series contains, besides conglomerate, greywacké, and tuff, an interesting assemblage of lava flows. These lavas are different from all types of rock seen elsewhere by the author, They are exposed in volume on the Continental. Bidgood, Conroyal, Pawnee, Kirkland Gold Belt,




PORTION REFERS TO LARGE SCALE GEOLOGICAL MAPS ACCOMPANYING THE REPORT.

and other properties. The most common type is the reddish fine-grained trachyte showing small crystals of hornblende, which are represented by pits on the weathered surface. Throughout this rock there are irregular patches and streaks showing pronounced spherulitic structure. At the Conroyal property and other places in the vicinity, changes in texture across individual flows may be observed. The tops in many instances show an amygdaloidal phase, which passes gradually downward into a

porphyritic type in which the phenocrysts were originally feldspar.

The syenite exposed on the Continental, Bidgood, and other properties in the vicinity is similar to the rock occurring in the western part of the Kirkland Lake camp. It has the habit of grading into the basic lamprophyric type.

The porphyry is somewhat different from the type found in Teck township. It is coarser in grain and when fresh is somewhat darker in appearance, although it possesses a considerable proportion of quartz, a feature not in common with the type found at Kirkland Lake. This phase of the porphyry is first observed near the west side of the Continental mine and it extends eastward across the township in the form of dykes and irregular masses.

The system of north-south faults found in Teck township continues across Lebel. Faults of this type have been located on the east side of the Tough-Oakes, on the Continental, and on the Bidgood properties.

Gold-bearing veins occur in abundance across the full width of the synclinal belt marked by the Timiskamian sediments and flows, but up to the present little has been accomplished in correlating the breaks from one property to another. Many of the veins are too small to be of economic importance; others are formed along strong faults which must extend for considerable distances. It is reasonable to think that persistent effort expended on the stronger of these vein fractures will result in the development of orebodies of commercial importance.

The veins in Lebel township are characterized by a type of mineralization somewhat different from that of the productive veins of Kirkland Lake. Tellurides are of rare occurrence, and pyrite is present in much greater amount; chalcopyrite is probably more common in the veins of the eastern section. The values are associated with finely crystallized pyrite in quartz stringers as a rule; in some instances they appear to be associated with galena.

Dealing with the area belonging to the Continental Kirkland Mines, the report points out that the surface showing at the shaft consisted of a north-south break, in which low assays were obtained over a length of 100 feet. This vein carries pyrite, chalcopyrite, galena, and specular hematite. It dips about 50° W. and was encountered on the 150-foot level in a cross-cut extending 150 feet west from the shaft. In another part of this property there are indications on the surface of an east-west break of considerable size.

The rocks exposed on the property consist of sediments, trachyte, syenite, lamprophyre, and porphyry, which are regionally altered and sheared in contrast to the rather well preserved outcrops found around Kirkland Lake.

From a cross-cut north of the No. 2 shaft at the 500 ft. level the break, indicated at the surface by trenching, shows as a very strong fault marked by a foot or more of gouge and much crushing of the wall rock, which consists principally of trachyte and tuff, in the region of the shaft. The fault dips about 65° N.

The report concludes with a short section describing the mining methods which are being employed in this field. It may be added that the value of the whole is greatly enhanced by a considerable number of maps both geological and topographical and vertical sections.

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## FILLING STOPES WITH MILL TAILINGS

In *Engineering and Mining Journal* for March 2, George L. Richert describes the method of filling stopes with mill tailing as adopted in the Matahambre Mine, Cuba.

Minas de Matahambre is situated on the north coast of Cuba, in the province of Pinar del Rio, approximately 150 miles west of Havana. The mine, which is the only producer of copper in Cuba, has been worked by various operators for the last fifteen years. In 1921 the property became affiliated with the American Metal Company, Ltd., and it has been operated by that company since that time. The orebodies in the Matahambre mine occur as large irregular pipes, usually of lenticular cross-section, of primary chalcopyrite locally associated with quartz and pyrite. The main mineralized zone trends N. 30° E. and dips 42 to 45° north-west. The country rock is a uniform series of alternating shale and quartzite beds. The mine, operated by one vertical shaft of three compartments, is producing 30,000 tons of ore per month. Its levels are spaced 100 to 135 ft. apart, and the ore is mined by the flat-back cut-and-fill system. Stopes are silled out 13 ft. above the levels. The hanging wall is usually of shale and weak, whereas the footwall is of quartzite and gives no trouble. Cuts are from 8 to 12 ft. high, and stopes are filled as soon as possible after a cut has been taken. Filling stopes with classified mill tailing in place of "glory-holed" surface waste was started in the latter part of 1925. With the exception of a few short periods soon after the system was installed, the practice has been in continuous operation since that time. The classified mill tailing which is put into the mine is known locally as "sand fill," and all operations and apparatus connected with "sand filling" are part of the sand-fill system.

Placing of tailing in the mine as fill consists essentially of the following operations, each of which will be described separately:—

(1) Pumping mill tailings through a 6-in. iron pipe from the mill to a Dorr bowl classifier.
(2) Removing slimes at the classifier, adding water, and discharging "sand" into the pipe for distribution in the mine.
(3) Running "sand" through the pipe or hose from the surface to the stopes.
(4) Wrapping the cribbed ore passes and manways in the stopes with burlap.

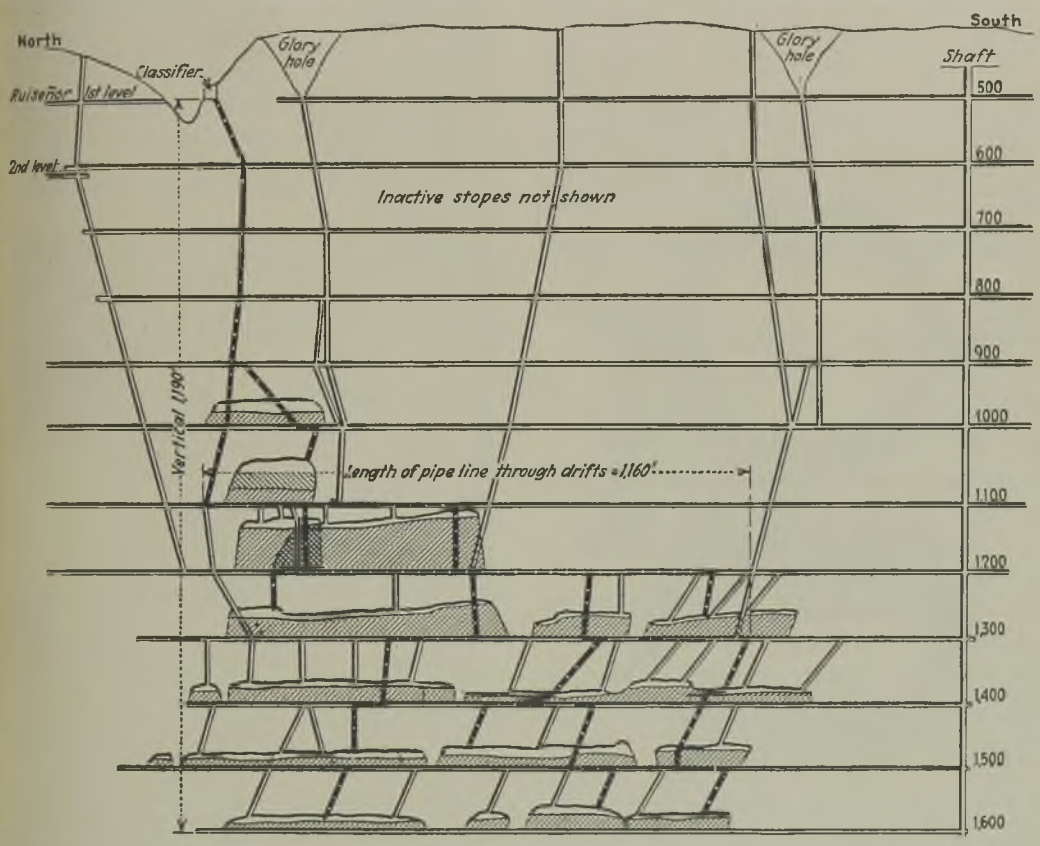
(1) Roughly 80% of the mill feed is tailing, but this percentage varies with the ratio of concentration. Although all the mill tailing is available for classification and stope filling, only 50 to 80% is sent to the bowl classifier. A sample screen analysis of the tailing as discharged from the mill is given in Table I. Screen analysis of the tailing varies from day to day as the amounts of quartzite and shale in the mill feed vary. Mill tailing, averaging 30% solids by weight, is discharged to a 6-in., model C, Wilfley centrifugal sand-pump operating at 950 r.p.m. The pump is driven by a 50-h.p.

belt-connected G.E. induction motor (220 volts, 3-phase, 60 cycles). The tailings are pumped through a 6-in. pipe a distance of 850 ft. against a head of 45 ft.

Desliming the Tailing.—(2) From the pump line the tailing is discharged into the bowl classifier (Type D.S.D.B., 6 ft. by 26 ft. 8 in. by 16 ft. bowl). Of the total tailing pumped to the classifier an average of 48% of the solids is discharged into the mine fill pipe and 52%, as slime overflow, is sent to the pond. These percentages vary, the amount entering the mine running as high as 65% and at times as low as 30%. This fluctuation is also due to changes in the amount of shale and quartzite in the ore milled. Table II shows an average screen analysis of the classifier discharge, which, averaging 80% solids by weight, is discharged at the rate of 15·6 tons per hour of classifier operation. To it is added a maximum of 18 gal. of water per minute. This water is added by means of a ½-in. spray pipe with 32 openings and discharging directly over the mine fill pipe. This gives a total of 1,830 gal. of water per hour, including the water in the classifier discharge, which goes with 12·5 tons of sand per hour into the mine. In addition, after the classifier has been shut down, water is run into the fill pipe to flush it out and keep the sand from settling in the curves and flat stretches.

Sand-fill data for September, 1928, are given in Table III.

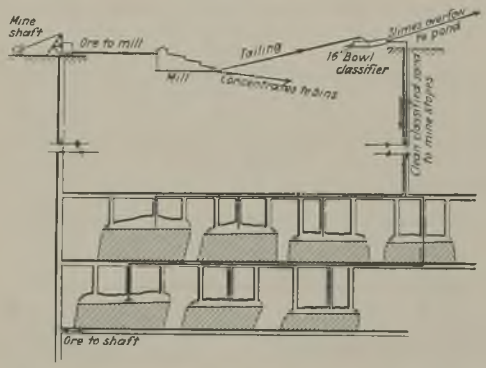
(3) To date, the running of sand fill through pipe or hose from the classifier on the surface to the stopes in the mine has passed through three experimental stages and will soon be on the fourth, and it is hoped the best and last stage. During the first stage the mill tailing was put through a small cone classifier and the sand run by gravity through a 4-in. iron pipe into the mine. This was not satisfactory, as the sand plugged up in the 4-in. pipe, owing to lack of velocity. Much time was spent finding the plugged pipe and cleaning it out after it was found. In the second experimental stage, after a 16-ft. bowl classifier had replaced the cone classifier, an ordinary 2-in. iron pipe was used to run the sand into the mine. This pipe carried the sand satisfactorily, but was good for the passage of only a thousand tons, or less, at the bends in the line where the wear was the greatest. It was replaced by 2-in. extra heavy pipe with plain ends, the lengths of which were joined together with Dresser couplings. This heavier pipe lasted much longer than the other, but filling costs were still high because of the extra labour necessary to change the pipe and to clean up "spills" when the pipe wore through. However, even with high fill costs, use of the sand was profitable to the mine because




Longitudinal section of Matahambre Mine showing sand-fill system. The heavy line shows the distribution pipe-line.

of the amount of fill available, the ease of handling in stopes, and also because the fill did not spread and because a comparatively short time was required to fill a stope. In the third stage, special four-ply rubber hose, having a rubber lining ¼-in. thick and an inside diameter of 2 in., was used from the surface, through the raises, to the 1,100 ft. level. This hose was an improvement over the iron pipe, as it carried 25,000 to 30,000 tons of fill before failing. However, it kinked at the bends so that it was necessary to place a split pipe sleeve, bent to the desired curve, at all curves in the line. The couplings consist of a rubber-lined nipple, inserted in the ends of each piece of hose with a Victaulic coupling for each length. The rubber hose failed first just behind the coupling. This was probably caused by the offset in the inner lining between the hose and the nipple. This offset retarded the flow of the sand and built up a high pressure at this point. To remedy this fault and lengthen the life of the hose, a six-ply rubber hose having a ¼-in. lining and a 2-in. inside diameter was installed. This has three heavy iron clamps

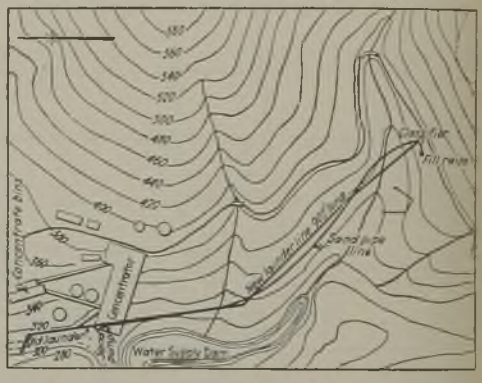
*Diagrammatic sketch showing the Matahambre system of filling stopes*




where the hose fits over the nipple in place of the two lighter iron clamps used on the four-ply hose. Life of the hose is unknown. At the time the 2-in. iron pipe was changed to 2-in. extra-heavy iron pipe, 50 ft. of 3 in. iron pipe, rubber lined, was put into the line for a trial. This pipe had ¼-in. walls and a ¼-in. rubber lining, the inside diameter thus being 2½-in. This section of pipe was examined whenever opportunity afforded. After it had been in service over one year, and had handled around 80,000 tons of fill, a piece was brought to the surface for better examination. A close inspection revealed no apparent wear on the rubber lining. The iron pipe had rusted on the outside, but not enough to weaken it. Sections of the pipe are 10 ft. in length and are joined by means of rubber-faced flanged couplings. The rubber on the face of the couplings allows the line of the pipe to be changed about 20° without bending the pipe. This is accomplished by tightening the flange bolts on one side more than those on the other. While on the surface, a piece of this rubber-lined pipe was bent cold 90°. The centre of the bend was cut, and an examination showed that the rubber did not wrinkle or come loose from the pipe. This will permit bending the pipe to any desired curve. Two thousand feet of this pipe has been ordered to replace the rubber hose now in service.

To date, 95% of all trouble experienced with pipe and hose has been in the raises between the classifiers and the 1,100 level. This is caused by the high velocity of the fill in this line and by the curves and bends made necessary in passing from one raise to another and bringing the pipe out on a level. At present there is about 7,000 ft. of sand-fill hose and pipe in the mine. The 2,000 ft. of rubber-lined pipe will be installed as a main line from the surface through the raises to the 1,100 level and along the latter. The rubber hose and extra-heavy iron pipe now in service will be used in the branch line from the main line to the stopes.

Wrapping Ore-Passes and Manways with Burlap.—(4) As all ore-passes and manways into the stopes are built up of 6-in. round cribbing with a 4-in. tongue, it is necessary to wrap the cribbed ore-pass or manway with 10-oz. burlap to prevent the sand washing out. This method worked satisfactorily until the stope had been filled to a height of 60 or 70 ft. above the level. As most of the water from each filling settles directly to the




Surface map showing the sand-fill line between concentrator and classifier.

first sill door and then seeps out between the cribbing to the drift below, the burlap on the lower part of the manways and ore-passes rotted out after the stope had been filled a number of times. To eliminate the spills caused by the burlap giving way it was decided to line the inside of all stope ore-passes and manways with 2-in. plank. This was necessary to protect the cribbing in the ore-passes, regardless of the sand fill, as some trouble had been experienced with the cribbing cutting out before the stope had been taken up to the level above. Burlap is also used in some stopes along the fractured shale hanging wall. Whether or not the use of burlap along the hanging wall is profitable or does any real good is doubtful.

Tonnage and Costs.—From January 1, 1928, to October 1, 1928, a total of 63,354 tons of classified mill tailings was put into the mine for stope filling. The average cost was 35·3 c. per ton of sand fill, divided as follows: Labour, 15·6 c.; power, 1·1 c.; supplies, 18·6 c.—a total of 35·3 c. The labour cost includes all labour connected with sand filling, pumping the classifier, and also the two men on each shift engaged in changing or placing pipe and handling the discharge in stopes, together with the labour required to clean up spills.

TABLE I.—Screen Analysis of Tailing as Discharged from Mill.

| | Mesh. | Direct, % | Cumulative, % |
|---|---|---|---|
| Plus | 48 | 20 | 20 |
| Plus | 65 | 10 | 30 |
| Plus | 100 | 8 | 38 |
| Plus | 200 | 11 | 49 |
| Minus | 200 | 51 | 51 |
| | | 100 | 100 |

TABLE II.—Average Screen Analysis of Classifier Discharge.

| | Mesh. | Direct, % | Cumulative, % |
|---|---|---|---|
| Plus | 48 | 40 | 40 |
| Plus | 65 | 20 | 60 |
| Plus | 100 | 22·5 | 82·5 |
| Plus | 200 | 9·5 | 92·0 |
| Minus | 200 | 8·0 | 8·0 |
| | | 100·0 | 100·0 |

The cost of supplies is divided as follows :—

| | |
|---|---|
| Pipe | 11·0 c. per ton of fill placed. |
| Miscellaneous | 2·2 c. per ton of fill placed. |
| Burlap | 5·4 c. per ton of fill placed. |

TABLE III.—Sand-Fill Data for September, 1928.

| | |
|---|---|
| Total tons of mill tailings | 24,018 |
| Per cent of total to classifier | 55·5 |
| Total tons to classifier | 13,400 |
| Per cent of total tailing into classifier discharged as mine fill | 46·5 |
| Total tons of sand to mine | 6,240 |
| Tons of solids, including classifier overflow and tailings pumped direct to the tailing pond | 17,778 |
| Per cent of total mill tail placed in the mine as fill | 26 |

Individual item, costs not including installation, are :—

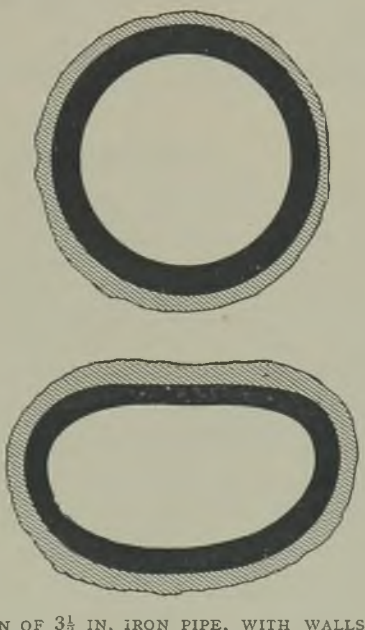
10-oz. burlap: 11½ c. per yd. 3 ft. wide 30 yd. rls.
Extra heavy pipe: 30 c. per ft. 10 ft. lengths.
4-ply special 2 in. rubber hose: $1·60 per ft. 40 ft. lengths.
4-ply special 2 in. rubber hose: $1·68 per ft. 40 ft. lengths.
Rubber-lined pipe, 3 in. inside diameter: $3·00 per ft. 10 ft. lengths.

With the installation of 2,000 ft. of the 3-in. rubber-lined pipe, a sample of which has apparently shown no wear of the lining after being in use one year, and on the basis of a conservative estimate of its life of service at one and one-half years, the amount of fill placed in the mine for this period remaining the same as in the past, the cost of pipe for handling an estimated 126,526 tons of fill in one and one-half years would be 0·0475 c. per ton. The labour cost with the 3-in. pipe in operation should be cut at least in half. With an estimated additional cost of 1¼ c. per ton for replacing feeder pipe lines into the stopes, the total cost for pipe should be around 6 c. per ton of sand placed in the mine.

In the near future it will be possible to run a raise from the mine connecting with the surface at the bottom of the mill. The classifier will then be moved to the mill, the sand pump eliminated, and all the sand fill handled by gravity. As the larger part of the miscellaneous cost of 2·2 c. per ton is made up of sand-pump costs, the miscellaneous cost should be cut to ½ c. per ton. This arrangement with the sand pump eliminated should also cut the power cost from 1·1 c. per ton to 0·5 c. per ton. With the 3-in. rubber-lined pipe in place and the classifier at the mill as planned, estimated sand-fill costs would be approximately as follows :—

| | Cents. | Supplies. | Cents. |
|---|---|---|---|
| Labour | 7·8 | Pipe | 6·0 |
| Power | 0·5 | Miscellaneous | 0·5 |
| Supplies | 11·9 | Burlap | 5·4 |
| | 20·2 | | 11·9 |

In general, several interesting facts have been determined. It has been found that 100 ft. of head in the sand-fill pipe will force the sand 400 ft. along a drift. The use of threaded or plain unlined flanged couplings on pipe has not proved satisfactory. Large stopes can be filled in any desired part, ends or centre, by building small sand dams



SECTION OF 3½ IN. IRON PIPE, WITH WALLS ¼ IN. THICK AND HAVING A ¼ IN. RUBBER LINING. The inside diameter is 2½ in. This pipe has handled about 85,000 tons of sand fill and has been in service more than one year with no appreciable sign of wear on the rubber lining. The bent piece is a section cut from the centre of a 90-deg. turn put into the pipe after it was taken out of the mine, showing that bending does not loosen or distort the rubber lining. The pipe is apparently less than ¼ in. thick in photograph, owing to rusting from the outside.

with shovels and placing the discharge pipe behind the dams. With the use of classified tailings, from which the slime has been removed, it is found that in 24 hours practically all the water has settled out and passed into the drift below. The sand fill enters all cracks and fissures along both walls, forming a better pillar than could be obtained with the use of rock fill.

Use of sand fill has cut down the number of fill

raises necessary in the larger stopes. Previously it was necessary to have one every 80 ft. With the sand fill, one every 200 to 300 ft. is ample as the sand can be piped to any part of the stope.

In 1924, before any mill tailing had been put into the mine as fill, 112,805 tons of surface fill was placed in the mine at a cost of 55 c. per ton of fill. The present cost of 35·3 c. shows a saving of 19·7 c. per ton of fill.

Before installing the sand fill system, production from the mine was limited by the amount of surface fill available. As the mine became deeper, the use of surface fill necessitated long crosscuts on each level to the fill raises. It was also necessary to tram all the surface fill from the central raises to branch raises or to the stope being filled. During the rainy season the fill became sticky and was extremely hard to handle. The surface fill then had to be spread in the stopes, usually by hand, as scrappers were unsatisfactory when the fill was wet. Use of mill tailing as fill has eliminated all the difficulties.

Conclusion.—Classified mill tailings for stope filling instead of glory-hole surface waste has proved a success at Minas de Matahambre. The outstanding advantages of the classified mill tailings, or sand fill, over surface waste filling are :—(1) Ease of handling : There is no mucking, no tramming, no spreading of fill in stopes, and no change in handling conditions regardless of surface weather conditions.

(2) Sand fill is available for a stope in one part of the mine and for one in another part of the mine the same day, if desired. A change in pipe connections from one branch line to another is all that is required.

(3) Fewer fill raises from stopes to the levels are needed with sand fill, as it can be piped to any part of a stope.

(4) Sand fill forms a hard, even floor in the stopes, making for less dilution of the ore with waste.

From January 1, 1928, to October 1, 1928, a total of 63,354 tons of classified mill tailing has been put into the mine for stope filling. The average cost was 35·3 c. per ton of sand fill.

With the installation of 3-in. rubber-lined pipe to replace the rubber hose now in service, and the moving of the classifier to the mill as planned, estimated fill costs per ton of sand will be 20·2 c. Mine production is no longer limited or held up by the lack of available stope filling, for, within certain limits, the more ore mined, the more tailings are available for stope filling.

## POSTMASBURG MANGANESE DEPOSITS.

In the Magazine for May, 1927, abstracts from a paper by A. L. Hall read before the Geological Society of South Africa, including his map, were given. The discovery of important manganese deposits along the Gamagara ridge, extending from four and a half miles W.N.W. of Postmasburg for about 38 miles in a northerly direction has attracted considerable attention to that part of the Cape Province. The exploratory activity which followed resulted in further discoveries of manganese in the neighbouring Klipfontein hills. The nature, occurrences, and probable extent of the orebodies have become the subject of much inquiry and debate. It soon became evident that there is a striking diversity of opinion as far as the form and origin of the manganese deposits are concerned, and as to whether there is sufficient high-grade ore for profitable mining. It was desirable, therefore, to acquire more information on the subject, and for this reason the Director of the Geological Survey of the Union of South Africa deputed Dr. L. T. Nel to make a detailed survey of the orebodies and the surrounding geological formation.

The following is abstracted from his report :—

Dealing with the stratigraphy he makes the general statement that the geological formations exposed within the area surveyed are dominantly of sedimentary origin, but include a group of extrusive lavas, some dolerite dykes, and also a few kimberlite pipes. Plutonic rocks are not present. Recent accumulations of surface limestone and red sand, with occasional gravel patches cover wide stretches of ground and conceal the underlying formations. All the rocks are non-fossiliferous, and, with the exception of certain dolerite dykes, the kimberlite pipes, and superficial deposits, are probably of pre-Cambrian age. They are given in stratigraphical order in the table below.

After dealing at length with the general geology of the area and the structural geology he proceeds to a detailed examination of the manganese deposits themselves, which occur (*a*) along the Gamagara ridge, (*b*) in a series of detached hills comprising the Klipfontein ridge, and (*c*) on some of the prominent solitary kopjes or low rises which are outliers of the rocks building the main ridges. Of these occurrences the last mentioned are only small irregular patches of ore, far apart, and of little economic importance. The most important deposits are those of the Gamagara and Klipfontein hills ; in other words, the deposits occur chiefly within two belts of country roughly parallel to one another and conveniently referred to as the Western or Gamagara and the Eastern or Klipfontein belts.

The ore deposits of one belt differ from those of the other in shape and dimensions and in the nature of some of the associated rocks, but wherever manganese is found it is always close to, and in places may even rest directly on, the dolomitic limestones of the Campbell Rand Series. This fact may lead one to suspect that there is some connection between the manganese and limestones, and also that the former may be present at other localities in the neighbourhood where the top of the Campbell Rand Series is exposed. There is no indication, however, of the ore along the base of the comparatively undisturbed Lower Griquatown beds forming the low hills to the east of the Klipfontein ridge, nor is manganese known to occur along the same horizon in the adjoining areas. On the other hand the manganese of the Gamagara ridge is associated with the basal members of the Gamagara Series, so that the base of the Matsap group, with which the Gamagara beds are correlated, might also have offered conditions similarly favourable for the deposition of the ore, but again there is no sign of ore along the eastern flanks of the Langebergen where the Matsap Series rests unconformably on the Upper Griquatown beds.

In the Western belt the manganese deposits, following the unconformable contact between the Gamagara Series and the Campbell Rand Series,

| Formations. | Series. | Thickness. | Rock Types. | Igneous Intrusions. |
|---|---|---|---|---|
| Superficial Deposits. | — | — | Calcareous tufa, sand, gravel. | — |
| — | — | — | — | Kimberlites, Karroo dolerites. |
| Waterberg System (?) | Gamagara* | From a few feet up to about 1,200 feet. | Quartzites, shales, flagstones, conglomerates and breccia. | — |
| | | Unconformity. | | |
| — | — | — | — | Diabases or dolerites. |
| Transvaal System. | Upper Griquatown. | ± 2,500 ft. | Banded ironstones, jaspers, lava, quartzite, limestone. | — |
| | Ongeluk Volcanics. | ± 3,600 ft. | Basic lavas in part amygdaloid, red jaspers. | — |
| | Lower Griquatown. | ± 3,000 ft. | Banded ironstones, jaspers, shales, flagstones, quartzite, limestones, tillite, and Blinkklip breccia. | — |
| | Campbell Rand. | ± 5,000 ft. | Dolomite, limestone, cherts, and shales. | — |

* Formerly known as Lower Matsap.

crop out generally along the eastern slopes of the ridge; now and again they are right on the top, but on Beeshoek No. M.81 and Doornfontein No. M.82, where the ridge gradually sinks down to the general level of the surrounding country the ore is seen on the western slopes or on the level ground. The slopes of the ridge are often also thickly strewn with manganese rubble which has rolled down from the outcrops higher up. Much of this manganese rubble is rich ore. With the partial denudation of the Gamagara beds extensive masses of ore were laid bare which are distributed over slopes, the inclination of which conforms to the westerly dip of the Gamagara Series. Excellent illustrations of this phenomenon are frequently afforded along the Gamagara ridge so that large quantities of manganese ore are available on the surface of the ground. A few outliers of manganese ore capping solitary dolomite kopjes near the main ridge indicate a former extension of the ore sheet to the east.

The impression generally gained at first is that the manganese ore is in the form of a bed or of sheet-like bodies of sedimentary origin conforming to the dip and strike of the overlying members of the Gamagara Series, yet, on closer examination, they seem to be tabular or irregularly shaped orebodies that do not coincide with the bedding but deviate from the directions of dip and strike to cut across various horizons of the enclosing sediments. The manganese ore then, although it seems to conform in a general way to the bedding of the enclosing sediments, is not confined to a single horizon in the lowermost zone of the Gamagara Series. Moreover, it is quite possible for two or more orebodies to be present in the rock sequence between the dolomitic limestones and the Gamagara quartzites.

The true average thickness of the manganese deposit is very difficult to determine owing to its folded or broken character, the uneven floor on which it lies, and, where not covered by sediments, the possibility of its having been partly denuded away. On those wide dip slopes chiefly occupied by the manganese, as at Gloucester No. 13 and Bishop No. 51, the ore sheet is mostly very thin, the irregularities of the dolomitic limestone floor protruding through every now and again. In between these ridges or bulges there are depressions filled with a sequence of rocks that occasionally may extend from the manganese ore below right up to the shale group. The manganese layer itself is subject to appreciable changes in thickness when followed from place to place and sudden variations within short distances may even take place. In some of the Beeshoek and Doornfontein prospect workings the ore may be three feet or less thick, yet in the Calvert of Lace's Goat cuttings situated on these farms, masses are exposed in places fully twenty feet or more thick. On Gloucester, the orebody laid open in some pits appears to be at least twelve feet thick; on the southern boundary of Bishop No. 51 it is about seven feet, while on King No. 47 and Bruce No. 38 occurrences hardly exceeding four feet in thickness were noticed.

While the persistence of manganese ore over many miles and the enormous tonnages available in a deposit which behaves much like that of an interbedded sheet, are characteristic of the western belt, in the eastern belt, on the other hand a regular orebody, extending unbroken along the length of the Klipfontein hills, does not exist. Instead, scattered orebodies occur at irregular intervals. In the western belt the manganese underlies, or is intercalated with, the basal member of the Gamagara Series, but in the Klipfontein area it is at or near the contact of the chert breccia with the overlying Blinkklip breccia; i.e. it is either in the chert breccia or in the lowermost part of the Blinkklip breccia. Thus in the two belts the ore is found in rocks of widely different ages, which cannot be reconciled with the former existence of an extensive interbedded ore sheet. Moreover, the survey of the Klipfontein hills has clearly shown that the notion of a continuous ore sheet, affected by local disturbances and dissected by weathering agents, does not agree with the observed mode of occurrence of the orebodies.

In the Klipfontein area and also on the northernmost part of the Gamagara belt, the ore is mostly present in a chert breccia. This, especially near the contact with Blinkklip breccia, tends to form round or hummocky outcrops with a black polished appearance on the weathered surface, caused by a thin veneer of either manganese or iron oxide. They then bear a close resemblance to outcrops of manganese ore, even when approached to within a few yards, so that without close observation, these black siliceous rocks are readily mistaken for the ore. Their more or less constant presence along or near the base of the Blinkklip breccia could easily lead to the erroneous impression of an ore band that extends right through the hills, especially where this breccia forms a more or less persistent krantz round the tops of the hills (e.g. Thaakwaneng No. 14).

If the distribution of the manganese ore is examined carefully, the fact is revealed that it occurs as disconnected masses varying greatly in size and shape, and scattered at irregular intervals through the chert breccia or the adjacent parts of the Blinkklip breccia. There may be flat or tabular shaped bodies in some localities, elsewhere again pits have disclosed funnel, chimney or irregularly shaped masses. The tabular type of ore body is generally found at or near the surface of the ground inclined at the same angle as the hill slope, filling former rock fissures and crevices, or intercalated with the ferruginous breccia or less broken red shaly rock of the Blinkklip breccia formation, in which case it tends to conform to the dip of the surrounding rocks if this has not been entirely obliterated by local disturbances. The flat-shaped bodies vary considerably in thickness and are apt to dwindle away altogether in a comparatively short distance. The greater number of the manganese ore occurrences within the eastern belt are either irregular or funnel-shaped masses. Many of the deepest pits in this tract were sunk on the outcrops of such orebodies, and some, though twenty and more feet deep, have not passed through the ore.

The deposits of the Eastern belt, like those of the Western belt, also show distinct and exactly similar signs of disturbance. Detached ore-blocks embedded in a dark, reddish or chocolate coloured gravelly sub-soil, are also found here. Such occurrences give the impression that the ore was originally formed at the outcrops of rocks either as lateritic blankets, or by the orebodies, instead of being abruptly cut off at the surface, spreading or bending over the adjacent rocks. In the course of time the rocks underneath were gradually removed, so that, as a result of settling down to lower and lower levels, the flat bodies of the more resistant manganese ore become broken into angular blocks and smaller fragments. Besides the breaking up of the ore deposits in this manner they have also been subjected in some localities to irregular folding, puckering, and shattering in conjunction with the surrounding rocks. Such disturbances were most probably produced by the settling and caving in of overlying strata into solution channels. Thus while ore of high grade is found in the Eastern as well as in the Western belt, there are in the mode of occurrence and distribution of the ore deposits several important differences, which may be summarized as follows :—

(1) The manganese deposit of the Western belt tends to form continuous outcrops extending for many hundreds, even thousands of yards, whereas in the Eastern belt, detached orebodies occur at irregular intervals.

(2) The above difference is borne out by the fact that while in the Western belt the form of the ore deposit at the surface is, in general, like that of a sheet, the Eastern belt is largely characterized by vertical, highly irregular orebodies with relatively small lateral extent.

(3) In the Western belt, therefore, the available tonnage is clearly very much larger than in the Eastern belt.

(4) In the Western belt manganese ore is associated with a sequence of rocks different from that in the Eastern belt, i.e. in the two belts the ore is found in rocks of widely different ages.

(5) Consequently the manganese deposits of the two belts are not circumdenuded outliers of a former ore-sheet of regional extent.

*The Nature and Quality of the Manganese Ores.*— The manganese ore of the Postmasburg region takes the form of two or more of the oxides of manganese. There are two principal varieties, one massive or non-crystalline, and the other crystalline. These may occur separately but generally are intimately associated with one another in various degrees of admixture without any sharp line of separation. Occasionally the ore has a banded appearance due to alternations of the bright crystalline and duller massive varieties. In both the Western and Eastern belts variations in the grade of ore occur not only along the strike, but also across the deposits, while layers of high-grade manganese may alternate with layers of manganiferous iron ore. Fortunately the general tendency of iron and manganese to separate again revealed itself during the period of deposition of these ores, so that many an orebody remains uniform in composition over appreciable distances while sharp lines of demarcation and abrupt transitions between manganese and iron ores may frequently be seen. Even where the passage between the two is gradual the middle portion of the manganiferous deposit often constitutes rich ore. Large quantities of excellent grade ore, which remains uniform in composition for some distance, may thus be readily separated from inferior matter that is too high in iron. On the manganese fields the quality of the ore depends largely on the content of iron.

which, in fact, is the most harmful ingredient on the ores of the district, but, as already pointed out, it can largely be avoided by selective mining and sorting. There are mixtures of manganese and iron oxides in all propositions, the percentage of iron increasing as that of the manganese decreases. The ores range from massive bodies of practically pure hematite on the one hand to rich thoroughly ferrograde ore on the other, with less than 0·4% iron. When they do not occur in separate masses, with sharply defined contacts, the one passes imperceptibly into the other, and the two may sometimes be so intimately mingled that it is impossible to tell whether one is dealing with a mechanical mixture or a chemical combination. In this range of manganiferous iron and ferruginous manganese ores other constituents occur in negligible amounts. Should a demand for the more ferruginous (non-ferrograde) type of ore, with less than 40% manganese, be created, then that of the Postmasburg area will prove a most valuable asset in the direct manufacture of manganiferous pig iron, because of the enormous supplies available practically free from harmful ingredients; as this is associated with higher grade manganese ore, the two could easily be worked in conjunction. The information available is insufficient to determine with any degree of accuracy the average manganese and iron contents in the ore over the whole length of the Western belt.

Judging from the extensive outcrops of manganese ore and the evidence afforded by many prospecting pits and trenches, the available tonnage of manganese ore is enormous and must run into many million tons. According to the analyses of numerous samples collected in the fields it seems that the greater part of the deposits is made up of ore in which the manganese content ranges more or less between 40 and 50%, but in addition to this there are large reserves, the tonnage of which runs probably into seven or eight figures, of high grade ore carrying more than 50% metallic manganese. As regards the iron content, trade specifications require that iron should not exceed 7% in the case of ferrograde ores. In this area large supplies are available conforming to this requirement, in

Analyses of Various Grades of Ore.

| | I. | II. | III. | IV. | V. |
|---|---|---|---|---|---|
| Manganese dioxide | 22·45 | 31·6 | 42·7 | 51·2 | 42·9 |
| Manganous oxide | 9·9 | 3·75 | 6·5 | 9·55 | 32·35 |
| Ferric oxide | 55·85 | 49·45 | 38·7 | 21·45 | 6·1 |
| Alumina | 5·3 | 4·9 | 1·25 | 6·45 | 5·75 |
| Barium oxide | 1·75 | 0·08 | 6·28 | 2·05 | 2·85 |
| Calcium oxide | 0·3 | 0·65 | 0·55 | 0·55 | 1·45 |
| Silica | 1·5 | 4·8 | 1·4 | 1·1 | 4·65 |
| Sodium oxide | 0·2 | 0·2 | 0·3 | 1·5 | 0·25 |
| Potassium oxide | 0·15 | 0·8 | 1·9 | 2·1 | 0·04 |
| Sulphur | 0·04 | 0·05 | 0·05 | 0·09 | 0·19 |
| Phosphoric oxide | 0·15 | 0·2 | 0·1 | 0·15 | 0·1 |
| Moisture | 0·6 | 1·4 | 0·4 | 0·9 | 0·4 |
| Water of constitution | 2·0 | 2·6 | 0·95 | 2·85 | 2·65 |
| | 100·19 | 100·48 | 101·08 | 99·94 | 100·08 |
| Metallic manganese | 21·85 | 22·87 | 32·02 | 39·75 | 52·16 |
| Metallic iron | 39·06 | 34·59 | 27·07 | 15·00 | 4·27 |
| Phosphorus | 0·07 | 0·09 | 0·04 | 0·07 | 0·04 |
| Specific Gravity | 4·64 | 4·09 | 4·43 | 4·19 | —— |

Magnesium Oxide.—All of the samples contain strong traces of magnesium oxide.
Carbon Dioxide.—All of the samples contain carbon dioxide; the amounts vary from 0·04 to 0·09% in the samples.
Chromic Oxide.—Sample No. V contains 0·06% of chromic oxide. No chromium was found in any of the other samples.
Titanium Oxide.—Traces of titania were found in all samples.
Arsenic Oxide.—Traces of arsenic were found in Sample No. IV. No arsenic was found in any of the other samples.
Lead, Nickel, and Cobalt could not be identified in any of the samples. Analyst: H. G. Weall, F.I.C., Government Chemical Laboratories, Johannesburg.
I. Shaly type of manganese ore from the northern part of King No. 47.
II. Ferruginous breccia partly replaced by manganese oxide. From dump of trench on southern part of Beeshoek No. M. 81.
III. Shaly type of manganese ore, from western slopes of ridge on northern part of Beeshoek No. M. 81.
IV. Manganese ore showing shaly cleavage, from S.E. corner of Bishop No. 51.
V. Manganese ore containing some reddish manganese diaspore, from a trench on the southern part of Paling No. M. 87.

fact the iron content in some instances was found to be less than 1%. If, on the other hand, the average iron content of the ore could be taken over the whole extent of the field then it would be found to exceed the 7% limit. However, the chances are that the iron content can easily be reduced by selective mining and careful sorting.

*Summary and Conclusions.*—The manganese deposits occur in two distinct tracts of country coinciding with the trend of the Gamagara and Klipfontein ranges, and known respectively as the Western and Eastern belts.

Minor occurrences of ore are also found on some prominent lone kopjes or low rises which are outliers of the rock forming the main ridge, but these are of little economic importance.

In the Western belt the ore, found over a distance of about 38 miles, is generally associated with the basal members of the Gamagara Series, whereas in the Eastern belt it occurs over a shorter distance and is either in the Blinkklip breccia or in the underlying chert breccia, but usually close to the contact between the two formations.

The ore deposits of the Western belt are more extensive and continuous (except from Macarthy No. 50 northwards), than those of the Eastern belt, so that the tonnage available in the Western belt is naturally very great.

Ferrograde ore has been found in the Eastern belt, but the deposits of this tract occur in irregular detached masses that can hardly be expected to provide tonnages on a scale comparable to that indicated in the Western belt.

There are two principal varieties of ore, the one massive or non-crystalline and agreeing in composition and properties with psilomelane, the other crystalline and corresponding in certain respects to braunite.

Generally the two varieties are intimately associated with one another in various degrees of admixture; they also occur in conjunction with ferruginous manganese and manganiferous iron (hematitic) ores.

The tonnage of manganese ore available is enormous, even if the inferior grades be excluded. Apparently the greater bulk of this is made up of ore in which the manganese content ranges between 40 and 50%; there are also large reserves of very high-grade ore carrying more than 50% metallic manganese.

The quality of the ore depends largely on the content of iron as it is practically free from other harmful ingredients.

Over the entire fields the average iron content would probably exceed 7%; it is not likely, however, that it will be more than 14%. At the same time it has been proved that there are extensive deposits yielding ferrograde ore with less than 7% iron.

What has already been done on the fields shows that rich or ferrograde ore can be readily sorted in practice from ore of inferior grade so that there should be no difficulty in maintaining an output of a high-grade product.

The ore possesses superior physical properties which prevent any crumbling or production of fines during mining operations, ensure very little loss in transit, and reduce loss from flue dust to a minimum. The ore is also eminently suitable for storage as there is no apparent tendency for it to disintegrate.

Among the few minerals occasionally found in the ore, there are an unusual claret or rose-coloured manganese-diaspore and a delicate rose-coloured soda-rich mica, representing probably a new species of the mica group.

The manganese ore deposits are considered to have been formed by metasomatic replacement.

While is is not clear where the manganese came from, the evidence is strongly in favour of its having been leached from the Campbell Rand limestones and reprecipitated as the oxide in the situations where it is now found.

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## ANALYSIS OF CHROME ORES

In *Industrial and Engineering Chemistry* for April 15, J. B. Cunningham and T. R. McNeill describe methods for the determination of chromium, iron, silica, alumina, lime and magnesia. The following is an abstract from that description:—

*Determination of Chromium.*—Chromium can be determined more quickly and more accurately on a separate portion of the sample than on the same portion used for determining the other constituents. One (1·0000) gram. of the 100-mesh ore, which has been dried for 2 hours at 105–110° C., is weighed, preferably from a weighing bottle, transferred to a 30-c.c. Armco iron crucible, and fused over a gas flame with about 8 grms. of dry sodium peroxide. The fusion should be made by revolving the crucible around the outer edge of the flame of a laboratory burner until the contents have melted down quietly; the temperature is then increased to a medium red heat for 3 to 5 minutes and a rotary motion is given to the fused material to prevent spraying. Suitable iron crucibles, containing only a trace of chromium, must be used.

When the crucible has partly cooled, and while tightly covered, it is tapped on an iron plate to loosen the fusion in a solid cake. This is transferred to a 600-c.c. covered beaker and treated with 200 c.c. of warm water. The crucible is also rinsed with water. The solution is treated with 60 c.c. of sulphuric acid (1 : 1) and 5 c.c. of nitric acid (sp. gr. 1·42) and is then boiled for several minutes until all iron scale from the crucible has dissolved. From 20 to 25 c.c. of a 0·5% solution of silver nitrate, 1 or 2 drops of strong potassium permanganate (25 grms. per litre) and 3 to 5 grms. of ammonium persulphate (to oxidize the chromium completely) are added and the liquid is then boiled for 5 minutes. Twenty c.c. of a 10% solution of sodium chloride are introduced and the solution is boiled for 5 to 10 minutes after the permanganate or any manganese dioxide has completely disappeared, to make sure that all chlorine has been expelled. The solution is cooled to room temperature, treated with 3 c.c. of phosphoric acid (syrup, sp. gr. 1·725), and an excess of 5 c.c. of 0·1 *N* ferrous ammonium sulphate solution is added from a 100-c.c. burette. This will cause the reduction of the chromium to the trivalent state, as shown by the following equation:—

$2H_2CrO_4 + 6FeSO_4 + 6H_2SO_4 = Cr_2(SO_4)_3 + 3Fe_2(SO_4)_3 + 8H_2O$.

The burette reading is noted and 0·1 *N* potassium permanganate solution is run in with vigorous stirring to the first faint permanent darkening of the clear green colour.

The excess of ferrous ammonium sulphate naturally is oxidized to ferric sulphate; wherefore, subtraction of the volume of 0·1 *N* potassium permanganate used from the volume of 0·1 *N* ferrous ammonium sulphate taken gives the volume of 0·1 *N* ferrous ammonium sulphate required to reduce the chromic acid. The ferrous ammonium sulphate solution is prepared by dissolving 39·2 grms. of the salt in 1 litre of water (1 c.c. = 0·001733 gram. chromium) and it is standardized against 0·1 *N* potassium permanganate; this standardization must be made every day the solution is used, as this gradually grows weaker as a result of oxidation. The 0·1 *N* potassium permanganate is standardized against pure sodium oxalate.

*Determination of Iron and Alumina.*—One-half (0·5000) gram. of the sample, which has been ground to an impalpable powder in an agate mortar and dried for 2 hours at 105–110° C., is weighed preferably from a weighing bottle, and treated in a 300-c.c. covered casserole with 50 c.c. of sulphuric acid (1 : 4) and 5 c.c. of perchloric acid (sp. gr. 1·54). The liquid is heated gently until fumes of sulphur trioxide are freely evolved. This treatment should result in a complete decomposition of the ore except some chrome ores which contain quartz.

An alternate method of decomposition is to fuse a 0·5000-gram. sample of the dry agate-ground ore with a mixture of 5 grms. of sodium carbonate and 2 grms. of powdered fused borax ($Na_2B_4O_7$) in a covered 50-c.c. platinum crucible. The fusion must be maintained at a temperature of approximately 1100° C. for 20 minutes, while a rotary motion is given to the crucible from time to time to stir up any unattacked particles of ore on the sides or bottom. When cool, the melt is dissolved in 50 c.c. of hydrochloric acid (1 : 4) contained in a 300-c.c. covered casserole. Forty cubic centimetres of sulphuric acid (1 : 1) are added and the solution is concentrated to a volume of 40 to 45 c.c.; 25 c.c. of methanol and 10 c.c. of hydrochloric acid (sp. gr. 1·19) are added, and the evaporation is continued slowly until fumes of sulphur trioxide are given off. The methanol causes the volatilization of boron which, unless removed, might cause erratic results.

After partial cooling, about 150 c.c. of water and several c.c. of sulphurous acid are added to reduce chromium to the trivalent state, and the solution is boiled for several minutes until all salts have dissolved. The gelatinous silica is then filtered on a 9-cm. paper and washed thoroughly with hot water. The silica is ignited in platinum, first at a dull red heat until the carbon has burned and finally at 1100° C. for 10 minutes. The crucible and silica are cooled in a desiccator, weighed, and treated with 1 drop of sulphuric acid and 1 to 2 c.c. of hydrofluoric acid (48%), and the solution is evaporated to dryness. The crucible is again ignited for a few minutes at 1100° C., cooled, and weighed. The loss in weight multiplied by 200 gives the percentage of $SiO_2$ in the sample. The small residue which usually remains is fused with about 0·5 gram. of potassium pyrosulphate, then dissolved in a few c.c. of dilute hydrochloric acid and added to the filtrate from the silica.

The solution is treated with 1 c.c. of nitric acid (sp. gr. 1·42) and boiled several minutes to oxidize the iron to the ferric state. Five grams. of ammonium chloride and a considerable quantity of ashless paper pulp are introduced, and the solution is rendered very faintly ammoniacal by the addition of dilute, filtered ammonium hydroxide (1 : 4). The solution is heated to boiling for 1 or 2 minutes (no longer), the precipitate is allowed to settle, and is then filtered and washed ten or twelve times with a hot 2% solution of ammonium chloride. The precipitate is rinsed from the filter back into the beaker with a jet of warm water, dissolved in 75 c.c. of hydrochloric acid (1 : 4), and the solution diluted to 200 c.c. A second ammonia separation is made in a similar manner, the precipitates being filtered on the same paper. The two filtrates are combined and reserved for the determination of lime and magnesia.

The hydroxide precipitate is dissolved in 60 c.c. of hot sulphuric acid (1 : 4) and the solution made up to a volume of 150 c.c. Some ashless paper pulp is added, the liquid is cooled to about 20° C., and the iron and titanium are precipitated by the addition (dropwise and with constant stirring) of a freshly prepared, cold, 6% solution of cupferron [ammonium nitrosophenylhydroxylamine, $C_6H_5(NO)ONH_4$] in slight excess. An excess is known to be present when a drop of the precipitant forms a white precipitate which goes quickly into solution.

The precipitate is filtered on an 11-cm. paper with the aid of gentle suction, washed thoroughly with cold 10% sulphuric acid, and ignited at a low temperature in a porcelain or silica crucible. The resulting oxides are treated in a 150-c.c. beaker with 10 c.c. of hydrochloric acid (sp. gr. 1·19) and heated until the iron oxide has all dissolved. Iron is determined in this solution by the Zimmerman-Reinhardt method. If the determination of titanium is desired, the ignited oxides are fused with potassium pyrosulphate, the melt dissolved in sulphuric acid (1 : 4), and the titanium determined colorimetrically. The iron is then determined in this solution by one of the approved methods.

The filtrate from the cupferron precipitate, which contains all of the aluminium and chromium, is concentrated to a volume of 40 to 50 c.c.; 100 c.c. of nitric acid (sp. gr. 1·42) are added, and the evaporation is continued slowly until the volume has again been reduced to 60–75 c.c. Potassium chlorate is next added, a few crystals at a time, to the slowly boiling solution until its colour changes from green to clear reddish yellow, indicating that the excess cupferron has been completely oxidized and the chromium converted to the hexavalent state. The solution is then diluted with 300 c.c. of cold water, approximately 5 grams. of ammonium chloride and some ashless paper pulp are introduced, and the aluminum is precipitated by the addition of ammonium hydroxide (1 : 4) in very faint excess. The liquid is boiled for 1 or 2 minutes (no longer) and the precipitate, after having been allowed to settle, is filtered and washed ten or twelve times with hot 2% ammonium chloride solution. The aluminium hydroxide is dissolved in 50 c.c. of hot hydrochloric acid (1 : 1) and the precipitation with ammonia and filtration repeated as previously described. The precipitate and filter paper are placed in a weighed, covered platinum crucible and ignited first at a low heat and finally to constant weight at 1100° C. The increase in weight represents the amount of $Al_2O_3$ present

in the ore plus a very small amount of $Cr_2O_3$ and all of the $P_2O_5$ in the ore.

The phosphorus content of the chrome ores usually encountered is so low that the error introduced by its inclusion with the alumina is negligible, except when the highest accuracy is desired. To make correction for chromium, the oxides are fused with 6 to 8 grms. of sodium carbonate, the fusion is dissolved in water and filtered, and chromium is determined colorimetrically by comparison with a standard solution of potassium chromate prepared by dissolving 1·867 grms. of anhydrous potassium chromate in 1 litre of water (1 c.c. = 0·0005 gram. Cr). The chromium found, calculated to $Cr_2O_3$, is deducted from the weight of the impure alumina, and the remainder is calculated to percentage of $Al_2O_3$ in the ore. If desired, phosphorus may be determined in the solution after the estimation of chromium, calculated to $P_2O_5$, and deducted from the alumina.

*Determination of Lime and Magnesia.*—The combined ammoniacal filtrates from the iron and aluminium hydroxide precipitates are made slightly acid with hydrochloric acid, evaporated to a volume of approximately 150 c.c., and cooled to 15° C. Twenty c.c. of a 10% solution of diammonium phosphate are added and ammonium hydroxide (sp. gr. 0·90) is then slowly introduced, drop by drop, with vigorous stirring until the solution is ammoniacal and a crystalline precipitate appears. Fifteen c.c. of ammonia (sp. gr. 0·90) are added, the liquid is stirred thoroughly and finally chilled by surrounding the beaker with crushed ice. After standing for several hours with frequent stirring, or preferably overnight if allowed to stand at room temperature, the solution is filtered on a 9-cm. blue ribbon paper, and the precipitate is washed three or four times by decantation with cold 2·5% ammonia water. Twenty-five c.c. of hydrochloric acid (1 : 1) are poured through the filter, the filtrate being collected in the original beaker containing the bulk of the precipitate, and the filter is washed thoroughly with 5% hydrochloric acid. The solution is diluted with cold water to a volume of 150 c.c., 3 c.c. of a 10% solution of diammonium phosphate are added, and the precipitation is repeated as previously described. The precipitate is allowed to stand for 2 hours surrounded by crushed ice, filtered, washed ten or twelve times with cold 2·5% ammonia water, and ignited in a weighed platinum crucible, first at a dull red heat until the carbon has been burned, and finally to constant weight at 1000–1050° C.

The pyrophosphate precipitate thus obtained—which will contain all the lime, magnesia, any manganese present, and small amounts of silica—is dissolved in 20 c.c. of hot dilute (1 : 4) hydrochloric acid, the solution is filtered on a 7-cm. paper to remove silica, and the filter is washed well with hot water. The paper and silica are ignited and the silica determination is completed in the usual manner. The weight of silica found is deducted from the weight of the magnesium pyrophosphate obtained as previously described.

Ten c.c. of sulphuric acid (1 : 1) are added to the filtrate from the silica and the solution is evaporated to fumes of sulphur trioxide. Five c.c. of water and enough absolute alcohol to constitute 90 to 95% of the total volume are added, and the solution is stirred vigorously for several minutes. After the calcium sulphate precipitate has settled for 2 or 3 hours, preferably overnight, it is filtered on a 9-cm. blue ribbon paper and the paper and precipitate are washed free from phosphoric acid with 80% alcohol. The calcium sulphate is dissolved in 25 c.c. of hot 10% hydrochloric acid and the solution is heated to boiling. One-tenth grm. of oxalic acid is added and the lime is precipitated by the slow addition, with vigorous stirring, of dilute ammonia (1 : 3) in slight excess, the determination being completed in the usual manner. The weight of calcium oxide found is calculated to tricalcium phosphate ($Ca_3(PO_4)_2$) by multiplication by 1·8447, and this amount is deducted from the weight of the magnesium pyrophosphate obtained as previously described.

The alcoholic filtrate from the calcium sulphate is evaporated until strong fumes of sulphur trioxide are evolved and all organic matter is destroyed. After the solution has cooled, the residue is dissolved in 25 c.c. of nitric acid (sp. gr. 1·135) and finished for manganese by the bismuthate method. Any manganese found is calculated to manganese pyrophosphate ($Mn_2P_2O_7$), (factor 2·5847), and this is deducted from the weight of magnesium pyrophosphate. The weight of $Mg_2P_2O_7$ is multiplied by 0·3621 and by 200 to obtain the percentage of MgO in the sample.

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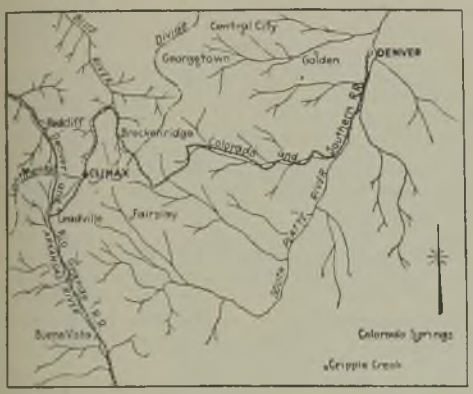
**Climax Molybdenum Mine, Colorado.**—*Engineering and Mining Journal* for March 9 contains a paper by W. J. Coulter, describing the Climax molybdenum mine, Colorado. The author points out that it is one of the world's great mines and that in *Mineral Resources of the United States*, 1918, published under the auspices of the U.S. Geological Survey, it was referred to as follows: "So far as it is already explored, the deposit at Climax can probably supply 100,000 tons (200,000,000 lb.) of elemental molybdenum." Diamond drilling and development work since the publication of that statement have fully borne this out, and a tonnage appoximating some of the porphyry copper deposits may be developed ultimately. The area at present developed for mining contains over 4,000,000 tons of ore, but several times this tonnage has been indicated by diamond drilling, which is carried on continuously and is still far within the zone of mineralization. However, owing to the large developed tonnage, no very active diamond-drilling campaign is carried on. One diamond drill is kept working continuously, with the result that the definite reserves proved every year are many times the tonnage mined. Mining from areas developed by diamond drilling has proved the reliability of the drilling results. The present production results in 3,000,000 lb. of metallic molybdenum per annum. With the large blocked-out tonnage and the reserves indicated by drilling, the mine is in a position to take care of any possible increased demand for the metal.

The molybdenite occurs remarkably evenly disseminated through an area of silicified Pre-Cambrian granite. It is not associated with aplite or pegmatite, nor in veins, W. Lindgren being to this extent in error in his last edition of "Mineral Deposits," p. 861, under the heading "Mineral Deposits of the Pegmatite Dykes." The main mass of the granite shows little, if any, alteration,

but in the vicinity of the ore deposition the alteration to a highly siliceous rock has been intense. The altered area is intensely brecciated and fractured, and it is believed that, following this, the interstices were filled with siliceous and mineral-bearing solutions. Few dykes have been encountered in mining, but these dykes, of quartz porphyry, are definitely pre-mineral. The dykes are much altered and the mineralization of them has been slight. Several minor faults occur, but with the exception of one major fault, the displacements have been negligible. In the major fault the ore has been found on the other side, but the direction and extent of the throw have not been determined.

A mineralized area approximately 2,000 ft. square has been partly developed by mine workings and diamond drilling, which has so far proved the deposit to be continuous. Part of the original




CENTRAL COLORADO, SHOWING LOCATION OF CLIMAX.

orebody was removed by glaciation, this largely accounting for a variation in the thickness of commercial ore between 100 and 450 ft. Recent diamond drilling shows that the ore zone is dipping to the north-west. The orebody is not bounded by definite walls, so mining operations are limited by assay values. The uniformity of the assays is remarkable, a consistent average of about 0·9 per cent molybdenum sulphide ($MoS_2$) being maintained. A small amount of pyrite, about 1%, is also present. In general, silicification is more complete below the commercial ore zone, whereas above it, unreplaced felspar is more evident as a rock constituent. Except where the orebody outcrops, and in the region of the major fault, the presence of the oxide ($MoO_3$) is sparingly in evidence. Where oxidation has occurred in the upper horizon, there is no evidence of molybdenum enrichment below. The molybdenite occurs throughout the orebody in two characteristic forms: As comparatively coarse plates or veinlets along fracture planes, and as mineral so finely disseminated through the quartz gangue that a blue tinge is imparted to the quartz, the mineral only being recognized as molybdenite by use of the microscope.

In the succeeding issue of the same journal the author describes the crushing and concentration of the ore.

## SHORT NOTICES

**Mexico's Lead-Silver Manto Deposits.**—In *Engineering and Mining Journal*, March 30, A. R. Fletcher describes the lead-silver manto deposits of Mexico and discusses their origin.

**Flotation of Bauxite.**—In U.S. Bureau of Mines *Bulletin* 2,906, B. W. Gandrud and F. D. De-Vaney report on preliminary examination of low-grade bauxite with particular reference to flotation.

**The Cambridge Pendulum Apparatus.**—In the *Geographical Journal*, April, 1929, Sir G. Lenox-Conyngham describes the Cambridge Pendulum Apparatus and points out that it is sometimes desirable to check the results of torsion balance surveys by pendulum observations at intervals.

**Oilfields of Burma.**—In a paper read before the Institution of Petroleum Technologists on April 9, L. Dudley Stamp described the actual producing oilfields of Burma.

**Air Conditioning in Deep Mines.**—In *Technical Publication* No. 206 of the American Institute of Mining and Metallurgical Engineers, R. W. Waterfill describes a method of cooling the air near the working face in deep mines by means of a humidifying and dehumidifying apparatus situated in the mine in close proximity to the section it is desired to cool.

**Dust Recovery.**—In *Industrial and Engineering Chemistry* for May, E. P. Partridge gives a resumé of present methods of dust recovery in industrial undertakings.

**Road Transport.**—In *The South African Engineer* for March, A. J. T. Crosby discusses the economics of road transport in South Africa.

**Tin Deposits of Alaska.**—In *Engineering and Mining Journal* for April 13, E. N. Patty describes the known tin deposits of Alaska from which it would appear that there is little ground for hope that the territory will ever be an important producer.

**Fine Mica from Kaolin.**—In *Engineering and Mining Journal* for April 20, S. T. Henry describes the method of reclaiming fine mica from kaolin used by the Harris Clay Company at Spruce Pine, N.C.

**Manganese in Queensland.**—In *Queensland Government Mining Journal* for March 15, C. C. Morton describes the Amanoor manganese deposits of the Mary River Valley.

**Alluvial Tin Mining in Siam.**—In *Chemical Engineering and Mining Review* for March 5, F. A. Roberg describes alluvial tin mining operations in Siam.

**François Cementation in America.**—In *Engineering and Mining Journal* for April 27, J. S. Crawhall describes the application of the François cementation process to the mine-water problem in America.

**Removing Vertical Pillars.**—In *Engineering and Mining Journal* for April 20, W. I. Nelson describes a method of removing vertical pillars by diamond drill methods.

**Copper-Ore Leaching in Arizona.**—In *Engineering and Mining Journal* for April 20, R. Gahl describes the development of copper ore leaching in Arizona.

**Burma Gems.**—In *Engineering and Mining Journal* for May 4, A. B. Calhoun describes the ruby, jade, and amber mining industries of Burma.

**The Kigugwe Copper Deposit of Tanganyika.**—In *Short Paper No.* 3 of the Geological Survey of

Tanganyika, G. M. Stockley describes the Kigugwe Copper Deposit.

**Alleghany Gold Deposits.**—In *Technical Publication No.* 211 of the American Institute of Mining and Metallurgical Engineers, H. G. Ferguson and R. W. Gannett describe the gold-quartz veins of the Alleghany District, California.

**Low-Temperature Distillation in Manchuria.**—In *The Engineer* of May 3, in the course of an article dealing with the iron, coal and oil enterprises of South Manchuria, W. F. Collins describes a low-temperature distillation plant which has been erected at the Fushun Colliery near Mukden to treat 4,000 tons of oil-shale per day.

**South African Iron and Steel Industry.**—In *Journal of the Royal Society of Arts* for March 29 appears a paper read before the Society by H. J. van der Byl on the iron and steel industry of South Africa.

**Canadian Department of Mines.**—In *Canadian Mining and Metallurgical Bulletin* for April, L. L. Bolton describes how the Department of Mines of Canada serves the public.

## 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.*

**34,836 of 1927 (308,637).** T. Hill and British Copper Manufacturers, Ltd., Landore, Wales. Improvements in or relating to tilting furnaces for melting metals.

**1,217 of 1928 (309,621).** M. Buchner, Hannover-Kleefeld, Germany. A process of producing alumina from clay and other aluminiferous minerals.

**1,475 of 1928 (309,848).** H. H. Alexander, New Jersey. A process for the melting and refining of copper.

**1,730 of 1928 (309,940).** W. G. Perkins, London. A process for the treatment of complex copper ores.

**2,028 of 1928 (310,089).** A. Holmberg, Stockholm. Improvements in sintering apparatus.

**4,239 of 1928 (309,269).** S. I. Levy and G. W. Gray, London. A process for the recovery of the metals and also of the sulphur, from the copper-rich material obtained as the result of the process specified in Patent No. 4,213 of 1928 (307,188) which was mentioned in The Magazine last month.

**4,941 of 1928 (285,462) and 4,942 of 1928 (285,463).** Hüttenwerke Templehof A. Meyer, Berlin-Tempelhof, Germany. Processes for working down residues, containing tin and at least two of the metals antimony, lead and copper.

**10,301 of 1928 (309,307).** E. A. Ashcroft, Ashburton. A process for treating tin-containing materials, consisting of heating them in the presence of ammonium chloride, and separating the volatile and/or soluble chlorides of the metals from the gangue matter by volatilization or by lixiviation or both, the ammonia produced in the reaction being utilized to recover the metals as oxides, hydrates, carbonates, or sulphides.

**22,706 of 1928 (310,252).** F. L. Duffield, London. A process for recovering zinc, lead, and such other volatalizable metals as bismuth, antimony, arsenic, and mercury from their natural raw ores with or without prior roasting or mechanical or other means of concentration or elimination of sulphur, by adopting the principle and apparatus of Patent No. 26,812 of 1927 (304,174) which was mentioned in The Magazine for March, 1929.

**28,002 of 1928 (306,445).** Cayzer Tin Smelting Company (Proprietary), Ltd., Johannesburg. A process for producing tin, which consists in introducing a mixture of ore or concentrate and excess of reducing carbonaceous material on to a bed of sponge iron formed on the furnace hearth. Magnetite or hematite is fed with the tin to form the sponge iron bed.

## 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.

**Kirkland Lake Gold Area.** Annual Report of the Ontario Department of Mines, Vol. xxxvii, part 2, 1928. Paper covers, 176 pages, illustrated. Toronto: Mines Department.

**Annual Report on the Mines, Province of Nova Scotia, 1928.** Paper covers, 515 pages, illustrated. Halifax, N.S.: Department of Public Works and Mines.

**Preliminary Report on the Mineral Production of Canada for 1928.** Paper covers, 36 pages. Ottawa: Department of Trade and Commerce.

**Preliminary Report on the Mineral Production of Ontario for 1928.** Paper covers, 32 pages. Ontario: Department of Mines.

**Preliminary Statement on the Mineral Production of Quebec for 1928.** Paper covers, 10 pages. Quebec: Bureau of Mines.

**The Testing of Explosives for Use in Fiery Coal Mines.** Safety in Mines Research Board Paper No. 51. Paper Covers, octavo, 50 pages. London: H.M. Stationery Office. A new test is described, while emphasis is laid on the importance of stemming.

**Geological Survey of Nyasaland: Annual Report for 1928.** Paper covers, quarto, 22 pages. Zomba: Geological Survey Department.

**Regulations and Orders relating to Mines, 1928 Edition:** including orders up to January 1, 1929. Paper covers, octavo, 184 pages. Price 1s. London: H.M. Stationery Office.

**Bulletin of the Imperial Institute, Vol. XXVII, No. 1, 1929.** Paper covers, octavo, 146 pages. Price 3s. 6d. London: John Murray.

**The Ventilation of Mines: Generation of the Air Current.** By H. Briggs, D.Sc., Ph.D. Cloth, octavo, 136 pages, with 79 illustrations. Price 7s. 6d. London: Methuen and Co.

**Geological Survey of Southern Rhodesia: Annual Report for 1928.** Paper covers, quarto, 18 pages. Salisbury: Geological Survey Office.

**Ontario Department of Mines, Annual Report for 1927. Vol. XXXVII, Part I.** Octavo, paper covers, 215 pages, illustrated. Toronto: Department of Mines.

**Electricity Applied to Mining.** By H. Cotton, M.Sc. Cloth octavo, 625 pages, illustrated. Price 35s. London: Sir Isaac Pitman and Sons, Ltd.

# COMPANY REPORTS

**Zinc Corporation.**—Although for 1928 operations at the mine were on a larger scale, 274,371 tons of ore being treated, as compared with 263,202 tons for 1927, the profit at £205,867 was £69,747 lower, due to the fall in metal prices. The dividends for the year were the same as for 1927, absorbing £228,905. Development work yielded satisfactory results, there being an increase in the tonnage of the ore reserves on the lead lode, which at the end of last year were estimated at 2,666,800 tons, as compared with 2,626,707 tons at the end of 1927. The reserves on the zinc lode were estimated at 245,969 tons, the ore having lower lead content and higher zinc than the lead lode. The report states that further improvements have been made in metal recoveries and that working costs again show a satisfactory reduction.

**Tekka-Taiping.**—The report for the year to October 31, 1928, states that the number of cu. yds. treated was 1,741,855, the output from No. 1 dredge being 225½ tons and from No. 2 dredge 338½ tons, a total of 564 tons, or 95 tons below the output for the previous year. The total revenue was £77,101 and the working profit £42,822. The profit for the year was £38,848, after writing off £7,000 for depreciation on machinery and plant, from which dividends totalling 2s. per share were paid, amounting to £39,998. During the year contracts were placed for the material for No. 3 dredge, which has a design capacity of 120,000 cu. yd. per month, with which good progress is being made.

**Pengkalen, Ltd.**—For the year ended September 30, 1928, the output from No. 1 dredge was 360½ tons and that from No. 2 dredge, the erection of which was only completed in September, 7·80 tons, the number of cu. yds. treated being 806,730. The total revenue was £108,294 and the working profit £61,715. The profit, after providing £14,653 for depreciation of machinery and plant, was £46,265 and dividends at the rate of 35% on the preferred ordinary shares and 25% on the ordinary shares absorbed £47,000. The report states that during the coming year the No. 2 dredge will cross the Kinta river in order to reach the main northern section of the property.

**Sungei Kinta Tin Dredging.**—The report for 1928 states that the output was 300¾ tons. The dredge started actual work in January, 1928, the only available site for launching being in poor ground. The results of the first six months' working were, therefore, poor, only 110¾ tons being recovered during that period, the balance of the year's output being obtained during the second half of the year, which witnessed a general improvement. The net profit, after charging depreciation, etc., was £11,787. In his report the general manager expresses the view that the returns for the current year will be much better than those for 1928.

**Kramat Pulai.**—The report for 1928 states that 489,000 cu. yd. were treated for 182½ tons of tin ore, as compared with 219 tons for 1927, the proceeds of the ore sold amounting to £22,814, equal to £131 0s. 10d. per ton, as against £172 14s. 5d. per ton for 1927. The net profit for the year, after writing off depreciation, amounted to £12,203, from which dividends totalling 2s. 6d. per share absorbed £12,500.

**Mongu (Nigeria) Tin Mines.**—The report for 1928 states that the output amounted to 465 tons, as against 480 tons for 1927 and 516 tons for 1926. Of the 1928 output only 59 tons were from dredging, due to the dredge having to traverse poor ground in order to take up a new position. Good ground is now being worked and the manager estimates that a recovery of at least 100 tons will be secured by the dredge for the current year. The reserves at the end of 1928 were estimated at 3,258 tons, as against 3,732 tons at the close of the previous year. The net profit last year was £8,323, of which the dividend of 5% absorbed £6,000, the gross price realized for tin concentrate averaging £175 8s. 6d. per ton, as compared with £204 8s. 9d. for 1927.

**Patiño Mines and Enterprises.**—The fifth annual report covering 1928 states that the output of fine tin was 17,089 long tons, as compared with 12,156 tons for 1927 and 9,697 for 1926. The total profit was £1,195,227, of which £1,102,506 was from operation of mines and the balance from operation of railway. For the year dividends have absorbed £828,189. The reserves in the mine at the end of last year, excluding dumps, were 51,426 metric tons of fine tin, comparing with 58,346 tons at the end of 1927. The report states that the directors have been authorized by the stockholders to acquire the tin smelting plant of Williams, Harvey, and Co., Ltd., of Bootle, but that it was not possible for various reasons to close negotiations during 1928.

**Mining Corporation of Canada.**—The report for 1928 states that the total production of silver was 1,313,958 oz., as against 2,119,771 oz. for 1927, the reduction being due to the decline in the content of mill-ore and the exhaustion of high grade reserves in the South Lorrain. The estimated reserves in the Cobalt Mines at the end of 1928 were 25,000 tons, containing 600,000 oz., as against 25,000 tons containing 700,000 oz. at the end of 1927. Since the close of the financial year the corporation has acquired 700,000 shares of Base Metals Mining Corporation, Ltd., and also 80% of the issued share capital of the Mincor Exploration and Development Co., Ltd., which owns 230 claims in the Sudbury district. For 1928 £85,277 was disbursed in dividends, the same as for 1927.

**Poderosa Mining.**—The net receipts for 1928 from sales of ore, etc., were £166,436 and, after providing for mining, management, etc., there was a balance of £81,352. Deducting depreciation and the debit brought forward from 1927, there remained a credit balance of £19,648, from which a dividend of 1s. per share absorbed £11,600. For the year 12,515 tons of copper ore were shipped to the smelters, as compared with 9,023 tons for 1927. It is estimated that the probable reserves total 21,500 tons of shipping ore assaying 21% copper.

**Oriental Consolidated Mining.**—For 1928 the tonnage milled aggregated 238,820, against 244,830 for 1927. Operating conditions were affected during the first part of the year by shortage of water for the hydro-electric plants. The net total yield amounted to $972,796, the working profit being $427,942. The loss for the year, after deducting reserves, was $47,812. The estimated ore reserves at the end of 1928 were 393,000 tons, having a gross value of $1,864,461. The general manager in his report states that operating expenses for 1929 should show a decrease, provided water power and general conditions continue favourable.

## DIVIDENDS DECLARED

**Eastern Smelting.**—Pref. Ord. and Ord., 1s., less tax, payable June 21.
**Hampden Cloncurry.**—6d., payable May 31 (final liquidation distribution).
**Kent Tin Dredging.**—1¼d., less tax, payable June 24.
**Kinta Kellas Tin.**—1s., less tax, payable May 27.
**Kinta Tin Mines.**—6d., payable June 28.
**Kuala Kampar Tinfields.**—4d., less tax, payable May 31.
**Lonely Reef.**—2s., less tax, payable July 31.
**Malayan Tin Dredging.**—6d., less tax, payable June 7.
**Mining Corporation of Canada.**—12½c., less tax, payable June 13.
**Mongu.**—6d., less tax, payable June 15.
**Mount Lyell.**—1s. 3d., less tax, payable June 24.
**Namaqua Copper.**—2s. 6d.
**North Broken Hill.**—2s. 6d., less tax, payable June 28.
**Patino Mines.**—4s., payable June 28.
**Poderosa.**—1s., less tax.
**Rand Nucleus Gold Mining.**—1s. 8d. (first liquidation distribution).
**Seremban.**—1½d., less tax, payable June 8.
**Siamese Tin.**—6d., less tax, payable May 31.
**Southern Malayan Tin.**—3d., less tax, payable June 5.
**Southern Perak Dredging.**—1s., less tax, payable June 6.
**Tanjong Tin Dredging.**—6d., payable June 28.
**Tekka.**—10½d., less tax, payable June 3.

## NEW COMPANIES REGISTERED

**Anglo-Western Mining Syndicate, Ltd.**—Capital: £15,750 in 15,000 £1 "A" and 15,000 1s. "B" shares. Objects: To acquire an option for the period up to June 10, 1930, to purchase, free of incumbrances, certain mineral claims in the Kootenay District, British Columbia, known as Alpha, Alpha No. 2, Alpha Fraction, Omega and Omega No. 2, etc. Offices: Carlton House, 11d, Regent Street, S.W. 1.

**British Radium Production Trust, Ltd.**—Registered June 6. Capital: £1,000, in 5s. shares. Objects: To search for uranium ore, pitchblende and other radium-bearing minerals. Secretary: J. J. B. Cross, 92, Regent Street, W. 1.

**Gwyn Mines, Ltd.**—Registered May 8. Capital: £10,000 in 20,000 5s. "A" and 100,000 1s. "B" shares. Objects: To search for and prepare for market gold, lead, zinc, and other metals, etc. Offices: Finsbury House, Bloomfield Street, E.C.

**International Pulverizing and Grinding Machines (Parent) Corporation, Ltd.**—Registered May 10. Capital: £50,000, in 1s. shares. Objects: To acquire the business of a manufacturer of and dealer in milling, pulverizing, and grinding machines carried on by P. Legrand, to adopt an agreement with Alliance Contracts, Ltd., etc. Directors: Hon. M. Brownlow Parker (director English China Clays, Ltd.), Sir George Thurston, K.B.E., G. W. Wells (director Fullbrook, Bell, and Co., Ltd., Slough); P. Legrand (director Antwerp Oil Wharves, Ltd.). Office: 73, Basinghall Street, E.C. 2.

**Lotex Syndicate, Ltd.**—Capital: £100,000. Objects: Distillers of carbonaceous materials at a low temperature, etc.

**Lovering China Clays, Ltd.**—Registered May 3. Capital: £400,000 in £1 shares. Objects: To acquire the business carried on at St. Austell, Cornwall, as John Lovering and Co.; to adopt an agreement with the Rt. Hon. Lord Forres, A. B. Williamson, J. Lawson, H. C. R. Williamson, the Hon. S. K. G. Williamson, D. Mathieson, J. A. Henderson, and F. J. Milne, carrying on business as Balfour, Williamson, and Co., and to carry on the business of china clay producers, merchants, and exporters, etc. Directors: A. B. Williamson and J. Lawson, both of 7, Gracechurch Street, E.C. 3. Office: 145, Dashwood House, Old Broad Street, E.C. 3.

**Manganese Corporation (1929), Ltd.**—Particulars filed May 15 pursuant to Section 274 of Companies (Consolidation) Act. Company incorporated in Union of South Africa in 1929. Capital: £1,000,000, in £1 shares. Objects: To adopt agreement dated Feb. 14 with Union Manganese Mines and Minerals (S.A.), Ltd., and British Swiss International Corporation, Ltd., to acquire, take cession and assignment from the last-named company of an agreement dated Feb. 22, between the Minister of Railways and Harbours of the Union of South Africa (representing the Government of the Union) of the one part and the said British Swiss International Corporation, Ltd., of the other part, whereby under the first agreement the company is to purchase certain freehold lands and mineral leases and rights, and under the second agreement is to secure the construction of a line of railway to transport manganese ore and other products to the present nearest railhead, to carry on the business of prospectors, explorers, etc. Registered office in the Transvaal. British address: 22, Queen Anne's Gate, S.W. C. R. Cran, of 3, Devonshire Square, E.C., authorized to accept service of process and notices on behalf of company. Of the directors five are to be nominees of British Swiss International Corporation, Ltd., and three of Union Manganese Mines and Minerals (S.A.), Ltd. Directors: G. A. Clark, A.M.I.C.E., T. Breslin, A.M.I.C.E., H. L. Burnie, A.R.S.M., and E. F. Jones, all of Johannesburg.

**Mining Trust, Ltd.**—Capital: £100, in £1 shares. The directors may increase the capital by the creation of new shares, provided that the capital shall not be increased beyond six millions without the sanction of a general meeting. Objects: To adopt agreements (1) with the Mining Trust, Ltd. (registered July 21, 1919), and J. P. B. Webster, the liquidator, for the acquisition of the whole of the undertaking and assets of that company, (2) with Russo-Asiatic Consolidated, Ltd., and the said J. P. B. Webster, the liquidator, for the acquisition of the whole of the undertaking of that company, except its Russian undertaking, and (3) with Leslie Urquhart, etc. Offices: Adelaide House, King William Street, E.C. 4.

**Rhodesia - Katanga Co., Ltd.**—Capital: £1,500,000, in £1 shares. Objects: To acquire the undertaking and assets of the Rhodesia-Katanga Junction Railway and Mineral Company, etc. Directors: General Sir Francis R. Wingate, Mr. Charles F. Rowsell, Mr. John Scott, Sir Robert Williams, Col. Francis Bere Follett, Major the Hon. Charles White, Mr. Sheffield Neave, and Mr. James G. Watson.

**Southern Asbestos Mines.**—Registered May 27. Capital: £200,000, in £1 shares. Objects: To acquire mine workings and grounds, carry on the business of a mining, smelting and refining company, etc.