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EDITORIAL

REGRET is expressed for inconvenience occasioned to any of our readers by the errors in the Rand outputs table in the July issue of the MAGAZINE, due to a slip on the part of our printers.

ANNOUNCEMENTS to the effect that the summer meeting of the Institution of Mechanical Engineers was to be held in Canada and the United States have already been issued and the outline programme for the visit is now available. The party is expected to arrive in Quebec on August 27 and to sail from New York on September 9, the time spent on the American continent promising to be fully occupied by an interesting programme.

ON July 26 last a conference was held at the Mines Department at which the condition of the coal-mining industry in this country was reviewed, particularly with the object of examining the present position as regards the utilization of coal and its products. Proposals were put forward for consideration which had in view making more readily available to industry the scientific results obtained in the course of Government research.

THE joint autumn meeting of the Iron and Steel Institute and the Institute of Metals will be held from September 12 to September 15 in the rooms of the Institution of Civil Engineers, Great George Street, and of the Institution of Mechanical Engineers, Storey's Gate. On the first day Dr. H. J. Gough will deliver the annual Autumn Lecture of the Institute of Metals, the following two days being devoted mainly to the discussion of papers. For the afternoon of September 14 a choice of visits to certain places of technical interest has been arranged, while the whole of the last day is given over to an inspection of the new Ford works, at Dagenham.

Transporting Dredges by Air.

As mentioned last month, a special general meeting of the Institution was held on July 2 in the lecture hall of the Institution of Electrical Engineers for the purpose of hearing a paper by Mr. Charles A. Banks on the "Air Transportation of Gold Dredges in New Guinea," advantage having been taken of the author's presence in this country on a short visit. Interest in the occasion was considerably enhanced by reason of the fact that it was known beforehand that the paper was to be illustrated by a cinematograph film showing the progress of the work and as a consequence there was a very good attendance of members and their friends. While the author must have been gratified at the number assembled and the reception accorded to his paper, there is no doubt that his audience profited considerably by his description of pioneer work in the maintenance of communication with a distant mining property by aeroplane.

The author was introduced to the meeting by the newly-elected president of the Institution, Dr. Sydney Smith, who in a few words commented on the novel work which formed the subject-matter of the paper. This is quoted extensively elsewhere in this issue, but it will be as well to outline here the problem and the solution contained in this somewhat unique engineering achievement. As the title indicates, Mr. Banks gives an account of the transport of dredge parts to an alluvial area in the interior of New Guinea. The property in question had been developed on the Bulolo River and by the end of 1929 the dredgeable ground, stretching for four and a half miles along the river-bed, had been proved to contain approximately 40,000,000 cubic yards of gold-bearing gravel estimated to contain an average recoverable content of 50 cents per cubic yard. In order to equip the property an operating company —Bulolo Gold Dredging, Ltd.—was formed in 1930 and this was faced with the problem of transporting material for the erection of two all-steel bucket dredges, each of 10 cubic feet bucket capacity, and for the building of a hydro-electric plant across many miles of mountainous, densely-wooded, tropical country. A survey for road construction was carried out and this showed that it would be necessary to build a road over 90 miles in length, that it would take approximately from a year to a year and a half to build it, and that the cost of this undertaking would be approximately a million dollars, while it was quite impossible to forecast what would be the cost of upkeep of such a road. During the testing of the ground the engineers in charge had maintained contact with the coast through the offices of a local air-transport service and, after long consideration, it was decided by the operating company to abandon the idea of constructing a road and to carry all parts to the property by aeroplane. This decided upon, it was calculated that the total weight of machinery to be transported amounted to 2,400 short tons and that in order not to delay construction it would be

necessary to arrange for the delivery of 200 tons per month. The transport company used the Government aerodrome at Lae, a port on the east coast of New Guinea, which was lengthened for the purpose, while at the same time a suitable aerodrome was constructed at Bulolo. The aircraft used were Junker low-wing, all-metal monoplanes, this type obviating the construction of hangars at Bulolo, while being particularly suitable for heavy freighting, since they could be crane-loaded through a hatch directly on to the cabin floor. These aeroplanes proved eminently successful, 2,500 short tons of supplies being safely transported to the property without a single accident, the monthly tonnage carried being built up from 35 tons in April, 1931, to 350 tons when conditions were more thoroughly understood. The company has since acquired additional ground estimated to contain a further 60,000,000 cubic yards of dredgeable gravels and the air transport of material for the erection of two further dredges is now under way, so that the method may be regarded as a proved success. As to costs, the author estimates that, as against the construction of a road, air transport has saved the company a sum approximating to $450,000, while in addition at least one year has been saved in time, an important consideration when profits are locked up in the company's area, especially as it has been calculated that the interest on these earlier profits alone would be equal to the entire cost of the aeroplanes and the transport of the plant to Bulolo.

In reviewing work such as that described by Mr. Banks, it must be recognized that those responsible have to a certain extent broken new ground. Air transport of supplies for mining ventures is nothing new, for many otherwise inaccessible properties have been opened up in Canada and other places by means of the aeroplane. A densely-wooded tropical country like New Guinea, however, can hardly be considered as suitable for air transport, especially in view of its mountainous character, and the courage of Mr. Banks and his colleagues, who visualized and carried through the project, is deserving of admiration. That they had their own doubts is very evident, the author himself confessing that the work had proved much easier than had been expected. The difficulties of the project were admirably revealed by the film used to illustrate the paper and if these were more apparent than real it cannot be denied that these pioneers were deserving of their good fortune. At the conclusion of the meeting a tribute to the author was paid by Mr. J. A. Agnew, who felt, as had the president in his introduction, that many enterprises, long considered inaccessible, might well be brought within measurable distance of successful development now that the practicability of air transport in difficult conditions had been proved.

Metalliferous Mining in Britain

If we except the obvious potentialities of Cornwall, Cumberland, Lincolnshire, and certain other well-known localities, it would seem that metal mining in this country is at the present time largely a matter of retrospect. Lode outcrops down to water-level at least have in most cases been worked out by successive generations of miners, generally in a spasmodic manner, and bad times have meant the cessation of operations owing to the fact that the work was on a small scale, that the properties were in the hands of many owners, or that the profits accumulated during prosperous periods were returned to the "Adventurers" providing the working capital, no provision being made for a reserve to enable the mine to be kept in good trim against the return of better conditions. In addition, the capital originally available was often inadequate for exploitation on anything approaching modern lines. Many other disadvantageous conditions affecting the mining industry in this country might be quoted, and reference to some of them is made elsewhere in this issue, in the course of a short history of Derbyshire mining, contributed by Mr. Leslie B. Williams, manager of the Mill Close mine. Nevertheless, in times of depression it has always been suggested that certain schemes might be undertaken that would not only provide employment for miners thrown out of work by the low price of metals, but at the same time be to the eventual advantage of the State. During the past few years schemes of this character have been proposed in various districts and, with the object of co-ordinating the work and of reporting on the various measures outlined, the late Labour Government referred the whole question to the Advisory Committee for the Metalliferous Mining and Quarrying Industry, the terms of reference being "To inquire into the possibilities of developing or of reviving the working of metalliferous and

associated deposits in Great Britain." The work of the committee was retarded to some extent by the protracted illness and death of two of its members, but their report [1] is now available. While the findings of the committee are not unanimous, certain members considering the whole tone of the report too optimistic, they are worthy of examination.

The main body of the report is divided into two parts, the first dealing with iron-ore and ironstone mining and quarrying and the second with non-ferrous and associated minerals. Under the first of these sections it is pointed out that large bodies of iron-ore have been developed in Northamptonshire, Lincolnshire, and Oxfordshire and it is felt that an effort should be made to increase the demand for British pig-iron, especially in view of the amalgamations now being considered in various parts of the country. It will be recalled that such a development, noteworthy as an attempt to bring producer and consumer together, was recently recorded in the MAGAZINE. Meanwhile, it is felt that the railway rates for iron-ore are too high and that, especially in the case of West Coast hæmatite, some reduction would be of great benefit. The lack of water in parts of Northamptonshire and Lincolnshire is also noted and it is recommended that concerted action should be taken to conserve and utilize their supplies. In addition, it is suggested that more use could be made of canals, in view of the fact that ore-barges in Germany can carry up to 300 tons, the usual load in this country being from 25 to 30 tons. As regards non-ferrous metals, several noteworthy recommendations are made in the report, among them being the suggestion that the Mines Department should undertake the compilation of comprehensive plans of the adits in the Mining Division of Cornwall and elsewhere. Proposals for a drainage scheme for the Camborne-Redruth area have been carefully examined and approved in principle, but it was unanimously concluded that the scheme would be of much greater benefit to the industry if the projected tunnel could be made large enough for haulage in the case of the southern mines, as well as drainage for the whole area. It is urged, too, that the southern mines should be worked as a group. It should be noted here that certain members of the committee are opposed to the provision of State funds for the carrying out of this suggestion, although the majority favour it. For the solution of several other problems—such as the improvement of recoveries from tin ores and the beneficiation of British fluorspar and barytes—State-aided research is suggested. Throughout the report there is evidence that the committee is whole-heartedly in agreement with the view that for the reduction of costs and unification of control amalgamations of small properties are necessary in mineralized areas, if successful mining is to be rehabilitated in them, the multiplicity of owners of mineral rights being a retarding influence of such weight. Suggestions for new legislation and the advertisement of certain favourable features of existing laws which do not seem to be generally known are also made, the whole of the recommendations so far reviewed being concerned with known mineral properties. The testing of potentially important areas, however, has not been forgotten and besides a specific recommendation for a geophysical survey of the Leadhills and Wanlockhead areas the committee is of the opinion that the facilities at the disposal of the Geological Survey should be increased so as to enable it to undertake geophysical surveys in any part of the country.

Examining the many recommendations of the committee, that for surveying potential resources will doubtless be regarded as of chief importance and the only justifiable use of State funds would seem to be in the testing of selected areas and in aiding research on ore-dressing problems peculiar to this country. The co-ordination of the results of geological surveys, geophysical investigations, and tests with the diamond drill should offer convincing testimony as to whether the chances are or are not in favour of any important drainage or development scheme being a success, and this should be undertaken before such a scheme receives support from public funds. It is difficult not to take exception, together with the minority of the committee members, to the unduly optimistic tone of the report. Like them we feel inclined to think that possibilities rather than facts have swayed the majority and we would prefer the expenditure of public money on the systematic testing of mineralized areas and

[1] Report by the Advisory Committee for the Metalliferous Mining and Quarrying Industry, 1932. Price 6d. London: H.M. Stationery Office.

on ore-dressing research. After all, once an area is considered proved and worthy of development the investing public are invariably ready to take an interest in the venture, with equal benefit to the unemployed.

African Native Communities

In the past occasional reference has been made in these columns to Government policy on native affairs and conditions in East Africa, particularly in so far as this has tended to hinder or facilitate the initial development of new territories. The group of East African British colonies has been visited during the past few years by quite a series of commissions, all set up to survey one particular set of problems, and in view of the issue of yet another report—that by the financial commissioner (Lord Moyne)—on certain questions in Kenya the time seems opportune for a return to the subject, particularly as mining activities are now becoming of importance in that colony, perhaps for the first time in its history.

The task of the financial commissioner embraced several questions of importance to Kenya, its chief intention being to define as clearly as possible the economic position of the colony. The main terms of his inquiry were to discover the contributions made to taxation by the different racial communities, to review railway rates and import duties, and to determine the extent to which each community benefited by money expended. Further, Lord Moyne was asked to decide in what degree financial responsibility might be conferred on native councils, while finally he was to consider the general financial and economic situation in the colony. The work of the commissioner has been completed with commendable despatch, and his report is admirably short and clear. While his recommendations may be considered on the whole fair and equitable for all classes in Kenya, it is obvious that the contrast between racial standards of life has made it difficult to assess the measure of financial taxation necessary to determine equality of sacrifice. It is interesting to note the frank opinion of Lord Moyne that in the development of the colony there has been a decided bias towards the conveniences of a civilization in which the native shares little of the direct advantages, although he recognizes that the immense betterment of native conditions achieved during the advance of civilization cannot be measured in terms of money, for, whereas the native formerly lived in constant fear of disease, famine, slavery, or violent death, he now enjoys liberty and security, while being taught gradually to improve his health and standard of life. Compared with the rest of the world, the African native enjoys many of the amenities of civilization in return for a very light contribution to the cost of the services necessary to preserve those amenities, yet Lord Moyne has concluded that natives cannot fairly be expected to make heavier contributions to the revenue and that any present increase in taxation which may be necessary for budgetary purposes will have to be borne by non-natives.

It is generally recognized that the greatest problem in all African countries is to raise the level of native culture and that it was rising, mainly through the results of white settlement, up to the incidence of the present depression, and a rally of prices would, no doubt, lead to a resumption of this progress. Meanwhile certain steps must be taken and the report recommends that as a set-off to the large proportion of expenditure now devoted to research on non-native agricultural problems applied research on questions affecting native agriculture should be initiated, agricultural training schools being attached to research centres on native reserves. In addition there is the welcome suggestion that a native marketing advisory council should be formed, for it is felt that such a step would do much to put a stop to the victimization of native traders by Asiatic storekeepers. A contented native population in Central Africa is of paramount importance for the successful prosecution of exploratory and development work, and it is felt that Lord Moyne has surveyed the varied problems of a mixed community with a just mind. There is, however, a disconcerting whisper of a problem which will, sooner or later, have to be dealt with, for the struggle between the Asiatic and the educated native has already commenced. This may be one of the great political issues East Africa will have to face in the future, when the rising African seeks his rightful place. Meanwhile, it is emphasized that the present financial difficulties in the colony will not solve themselves and steps will have to be taken to broaden the basis of taxation, and, as is the case at home, incomes apparently offer the easiest solution.

REVIEW OF MINING

Introduction.—Judging by the results so far published the Government's War Loan conversion scheme appears to have been eminently successful. Conditions on the New York market have rapidly improved this month, the resultant demand for dollars reacting on sterling, and metal prices have gone up as sterling has gone down.

Transvaal.—The output of gold on the Rand for July was 933,947 oz. and in outside districts 47,213 oz., making a total of 981,160 oz., as compared with 959,011 oz. in June, the July total representing a new monthly record. The number of natives employed on the gold mines at the end of the month totalled 217,525, as compared with 217,077 at the end of June.

A further decline in the total reserves of the New Modderfontein Gold Mining Company, as well as in their value, was recorded at the end of June, when the estimated total was 7,294,700 tons of an average value of 7·5 dwt. over a stoping width of 49·8 in.

The terms under which the Union Government will participate in the profits on the new leases secured by Vogelstruisbult Gold Mining Areas, Ltd., and the Sub Nigel company were issued last month. In the case of the former company the Government's percentage is to be calculated on the formula $y = 12 - \frac{240}{x}$, where x is the ratio of profit to recovery expressed as a percentage and y is the percentage of the net profit payable to the Government, provided that in no case shall the share payable to the Government be less than 3·5%. For the Sub Nigel lease the formula will be $y = 15{\cdot}2 - \frac{152}{x}$, and on this area it is expected that developments will be started in about five months' time.

The report of Daggafontein Mines, Ltd., for the three months ended June 30 last states that satisfactory progress has been made with underground work and organization, the monthly tonnage showing a steady increase. A start is being made on the unwatering of Shaft No. 2.

In order that assets, as they become available, may be distributed to shareholders it has been considered desirable that the Witpoort Gold Areas company should go into voluntary liquidation and an extraordinary meeting is to be held in Johannesburg next month at which resolutions with this in view will be proposed.

A progress report issued by the Rooiberg Minerals Development Co., Ltd., covering the three months to June 30 last states that mining operations on the Nieuwpoort section and the necessary repairs to the mill were commenced towards the end of May, the mill being finally brought into commission on June 18. The plant is said to be running satisfactorily.

South-West Africa.—The report of the Otavi Mines and Railway Company for the year to March 31 last shows that after writing various sums off securities, etc., and including £11,478 brought in from the previous account the company suffered a loss of £94,434, which is carried forward. It is proposed to reduce the capital by £80,000 by cancelling the company's own shares under the German emergency decree of October 6 last. The capital thus becomes £720,000. During the year under review 103,500 tons of ore was mined, deliveries amounting to 32,700 tons with an average content of 13·3% copper, 27·1% lead, and 314 grammes silver per ton, work being restricted to the upper levels of the mine in order to reduce pumping costs. Smelter production was 8,322 tons of copper matte and 2,641 tons of metallic lead, smelting in the large furnaces being discontinued in November last.

Southern Rhodesia.—The output of gold from Southern Rhodesia during June was 48,441 oz., as compared with 46,854 oz. for the previous month and 44,118 oz. for June, 1931. Other outputs for June last were: Silver, 6,678 oz.; coal, 41,927 tons; chrome ore, 748 tons; asbestos, 1,856 tons.

The report of the Rhodesian Corporation for the year ended September 30, 1931, shows a profit of £6,253, after allowing for depreciation, the total sum available being £23,471. Provision for bad debts, etc., reduced the balance carried forward to £15,373. The treatment of 24,035 tons at the Fred mine produced 14,149 oz. of gold, the working profit being £17,486, while the profit at the Turkois mine was £3,073 on the treatment of 15,240 tons of ore.

Developments on the No. 25 level of the Cam and Motor mine were referred to in the June issue of the MAGAZINE and shareholders have since been informed that promising lode material has now been picked up on Nos. 26 and 27 levels.

A meeting of Shamva Mines, Ltd. (in liquidation), was held this month, when shareholders were informed of the course of affairs up to April 3, 1932.

Northern Rhodesia.—A progress report issued by the Rhokana Corporation covers the six months to June 30 last. It will be recalled that the first reverberatory furnace was fired on March 17 last, the first blister being railed on March 21. Up to the end of June 17,072 tons of blister copper had been railed, all of which has been sold. Costs for the last three months of the period under review averaged £25·92 per long ton of copper, this figure excluding debenture interest and depreciation.

During the three months ended June 30 last the output of ore at the Roan Antelope was 252,900 tons, averaging 3·78% copper. At the smelter 11,504 short tons of concentrates was treated, 6,916 short tons of blister being produced. Costs over the period are estimated at £25·666 per long ton of blister, this figure not including depreciation or debenture interest.

Gold Coast.—Although the ore crushed by the Ashanti Goldfields Corporation reached 13,430 short tons during July, 14,605 oz. of gold being recovered, developments on the 21, 23, 24, and 26 levels were poor. This, however, has been the case on previous occasions.

Developments at the Bibiani property have been reported to shareholders this month. No. 4 shaft is being relined from the surface with steel setts and is being equipped for ore haulage against the completion of the treatment plant. In the middle section, between Nos. 1 and 4 shafts, ore is being prepared for stoping.

In a circular to shareholders of Ariston Gold Mines Mr. C. B. Brodigan, joint consulting engineer, gives a brief record of work done up to July 31 last. Results on the 17th level are said to show the continuance downwards of the good values encountered on the 16th level, the shoot being 100 ft. longer. In addition a cross-cut from the 17th level Prestea shaft has struck the West reef, a drive of 30 ft. on the lode showing payable values.

Nigeria.—During the year to February 29 last the Nigerian Electricity Supply Corporation made a profit of £25,227 and, after adding the sum of £16,626 brought in and allowing for income tax, there was an available total of £35,816. Of this amount £4,000 has been placed to reserve, £30,000 written off development expenses, and the balance of £1,816 carried forward. The heightening of the main dam by 5 ft. and the completion of a new reinforced concrete spillway were carried out during the period under review.

Australia.—In a progress report covering the year ended June 30 shareholders of Lake View and Star have been informed that the first section of the new plant, with a capacity of 30,000 tons per month, has been completed. This is to be increased to 40,000 tons per month in view of the strong ore-reserve position. During the year the whole of the indebtedness to the New Consolidated Gold Fields has been paid off, as well as two instalments on the loan guaranteed by the Western Australian Government, leaving the total of loans outstanding at £30,750. Interesting developments on the property have been reported during the past month, especially on No. 4 lode at the 3,320-ft. level in the Chaffers section.

Shareholders of the Wiluna Gold Corporation have been informed, in the return for June, that the Australian company repaid on June 1 the first instalment, amounting to £25,000, of the £300,000 issue of 6% 7-year notes, which had been guaranteed by the Australian Government.

It was reported last month that a new lode had been encountered during development at the South Kalgurli in the neighbourhood of the Morty shaft.

The new plant of the Boulder Perseverance was brought into full operation early this month and the trials are reported to have given satisfaction.

Shareholders of the Golden Horse Shoe (New) have been informed that the proposed reduction of capital to £165,000 by the return of 1s. on each 4s. share has been approved by the Court.

The report of North Kalgurli (1912), Ltd., for 1931 shows that expenditure for the year totalled £19,688, the receipts from the treatment of ore, etc., amounting to £21,718, giving a credit balance of £2,030, after allowing £4,000 for expenditure on surface equipment. The ore reserves at the end of the year were estimated to be 274,800 tons, of which 104,800 tons are in the nature of probable ore. The two most notable developments of the year are considered to be the extension of the high-grade Genevieve shoot on the No. 3 level, which now has a total length of 470 ft., with ore for the full width of the drive in the north face, and the location of a strong body of oxidized ore on the No. 1 level. Underground work has been mainly concentrated on blocking out

ore previously located for a much larger output, while the question of a treatment plant is under consideration.

During 1931 Barrier South, Ltd., made a profit of £172, reducing the debit balance brought in to £7,375. In consequence of the suspension of operations by the Zinc Corporation the company has nothing to report with regard to its leases.

In order to enlarge the scope of operations of the Komata Reefs Gold Mining Company the directors have decided to make an issue of 200,000 reserve (2s.) shares. These are to be offered to shareholders at 2s. 3d.

Malaya.—The accounts of Ulu Klang Tin, Ltd., for the year to March 31 last show a profit of $29,446, which, added to the balance brought in, gave an available total of $52,505. Of this amount $20,000 has been transferred to reserve, while a dividend equal to 2½% absorbs $22,500, leaving $10,005 to be carried forward. During the period under review the dredge treated 701,468 cu. yd. of ground, the production of tin concentrate being 238 tons.

The report of Ipoh Tin Dredging, Ltd., for the year to March 31 last shows that No. 1 dredge at Lahat was closed down for the whole of the period under review, while No. 2 only worked for 6½ months. No. 3 dredge (Ayer Etam) has worked continuously since August, 1931, the grouping of the restriction allowances of the company with those of the Temoh and Sungei Kinta companies permitting of work on this scale. The working of No. 2 dredge resulted in a loss of £5,079, reducing the credit balance brought in to £8,235, which was carried forward. The operating profit of No. 3 dredge was £9,519 and this has been written off the costs of acquiring the Ayer Etam property. The total yardage treated by the two dredges was 1,428,100, the tin recovered amounting to 463 tons.

Siam.—A circular sent to shareholders of Tongkah Harbour Tin last month states that present conditions have so largely affected the company's operations that, in spite of strict economy, the directors have been compelled to make a further call of 1s. per share.

Colombia.—The report of Viborita Gold Mines, Ltd., for 1931 shows that until the new debris tunnel is completed—which, owing to unforeseen difficulties in the driving, is not expected much before April next—it is only possible to continue hydraulicking through the old tunnel by using elevators, which adds considerably to cost and handling difficulties. Work is at present confined to deepening the hydraulic pit to a point where connexion will be made with the new tunnel.

Mexico.—A new discovery by the Santa Gertrudis Company on the Elena South cross-cut was recorded in the last issue of the MAGAZINE. It has since been stated that the drive continued in high-grade ore to 67 metres, from which point it was unpayable to 72 metres. Faulting is suspected and diamond drilling to locate the possible throw is in progress.

Portugal.—The report of the Beralt Tin and Wolfram, Ltd., for 1931 shows a loss for the year of £9,412. Work has been largely confined to preparing the property for production on a larger scale and to the development of the alluvial area at Viseu. Land has been acquired in England, near the Thames, for the erection of plant for the manufacture of ferro-tungsten from wolfram concentrates.

Spain.—Shareholders of San Finx Tin Mines have been informed that efforts to raise further working capital have been unsuccessful and that, in consequence, it will be advisable to place the company in voluntary liquidation.

Yugoslavia.—A progress report issued by Trepca Mines, Ltd., covering the three months to June 30 last, shows that the extensions to the power plant and third section of the mill have now been completed. During the quarter 106,683 tons of ore was milled, the lead concentrates produced amounting to 12,346 tons, assaying 76·20% lead and 26·19 oz. silver per ton, while 17,028 tons of zinc concentrates, assaying 50·42% zinc, was also produced. The estimated working surplus for the period was £21,536 and capital expenditure totalled £22,837.

Consolidated Tin Smelters.—The report of Consolidated Tin Smelters, Ltd., for the year to June 30 last shows a profit of £253,836, which includes a bonus dividend of £50,000 from a subsidiary company. The amount brought in from the previous account was £81,513, giving an available total of £335,349. Of this amount the bonus dividend of £50,000 was placed to capital reserve, an additional £50,000 was also taken for reserve, £65,020 was required for preference dividends, while a dividend of 5% on the ordinary shares absorbed £74,943, leaving a balance of £95,386 to be carried forward.

THE CHAMPION REEF MINE

By H. M. WHITE, M.I.M.M.

A description of the well-known mine on the Kolar goldfield, Southern India.

Occupying an approximately central position in South India, and embracing an area of about 28,000 square miles, is the State of Mysore, the topography of which may be broadly described as a gently undulating plateau at a mean elevation of about 2,800 ft. above sea level.

The oldest rocks of the State, known as the Dharwar schists, from their typical development in the Dharwar district, may be sub-divided into a younger and an older series represented, respectively, by a chloritic and hornblendic facies. The rocks which constitute the bulk of the State, however, are an Archæan complex of granitic gneisses and gneissose granites. The disconnected strips or belts of schist that furnish the present-day exposures of the Dharwar rocks, are always seen to be surrounded by this igneous complex, the oldest member of which (or what appears to be the oldest member), always exhibits intrusive contact with the Dharwars. At a somewhat later date, but nevertheless, still pre-Cambrian, the whole was intersected by a number of dolerite dykes, varying in width up to 100 ft. or more. Some of these dykes constitute a feature of the underground workings.

The Kolar schist belt, which is about 40 miles in length with a width varying up to 3 miles, comprises a series of schists of the lower or hornblendic facies, which doubtless represent the metamorphic product of an original alternation of flows and sills, and it is into this belt that has been intruded the gold-bearing quartz lode, now worked by the mines of the Kolar goldfield. The lode conforms to the planes of schistosity, has a strike almost due north and dips westward with the schist at an angle varying from 60° in the upper portion to nearly vertical in the deeper workings. The width of the lode is variable, but is commonly from 2 to 4 ft. wide. The distribution of gold, however, is not uniform throughout and the economic value of the lode depends upon the location of " shoots," which pitch northward down the plane of the reef.

At present the total length worked along the strike measures a little over 4 miles, and is operated by five companies under the management of Messrs. John Taylor & Sons, London. The Champion Reef Gold Mines of India, Ltd., is one of these companies, and holds under lease from the Mysore Government a block covering an area of some 1095 acres, near the centre of the Kolar goldfield. The inauguration of the Champion Reef company was in 1889, since when the mine has produced 3,913,663 oz. of gold to the total value of £16,826,198, whilst up to the end of 1931 the amount paid in dividends totalled £4,789,966. The length of the property measured along the strike of the lode is 3,500 ft., and the present workings extend to the 76 level, approximately 7,180 ft. below surface. A general view over the surface of the property is shown in Fig. 1.

FIG. 1.—CHAMPION REEF PROPERTY, LOOKING WEST—GIFFORD SHAFT IS IN THE CENTRE.

The climate is pleasant and healthful,

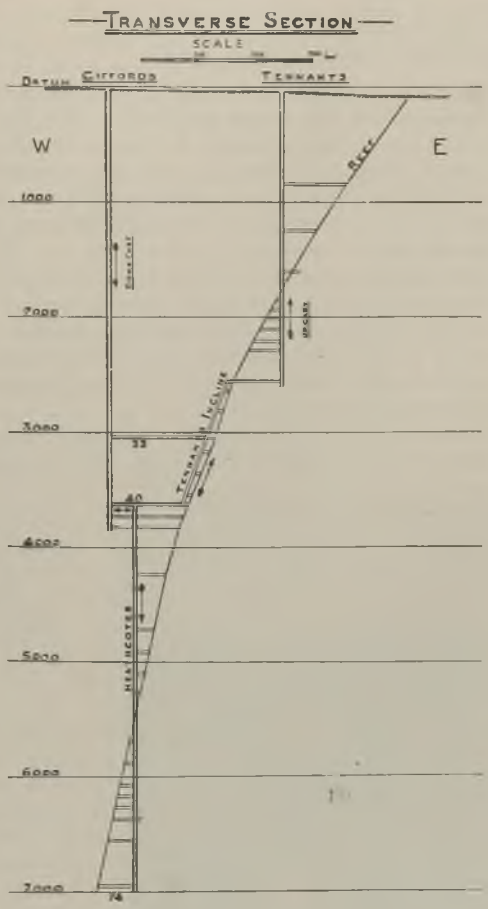


FIG. 2.—TRANSVERSE SECTION OF THE MINE.

the mean daily range for the year averaging 19·8° F. whilst the maximum shade temperature rarely exceeds 100° F. The average annual rainfall taken over a period of twenty-three years is 31 in., the major portion of which occurs during the months of July to December. The nearest city, Bangalore, some 60 miles distant, can be easily reached by road. Ready transport is afforded by some 7 miles of broad-gauge railway from the field to Bowringpet, this latter being the junction with the main Bangalore–Madras line of the Madras & Southern Mahratta Railway.

GENERAL LAY-OUT OF MINE WORKINGS.—The early development of the mine was by incline shafts in the hanging- and foot-wall of the reef. The shafts were rectangular measuring 16 ft. by 6 ft., lined with timber and equipped with double tracks, the skips running on steel rails. Consequent upon extensive stoping, however, the rock pressures became such that portions of these early shafts collapsed, and the cost of their repair and maintenance became prohibitive. The present lay-out of the mine is shown in Fig 2. Tennant's and Gifford's are the main vertical hoisting shafts to surface. The former goes to the 2,800-ft. level, where it is connected by cross-cut to Tennant's incline shaft, this terminating at the 4000-ft. level, at which horizon there is intercommunication with Gifford's shaft which is vertical from surface.

Gifford shaft (Fig. 6) is a brick-lined shaft of 18 ft. internal diameter, equipped with centre-steel byatts and 90 lb. steel rails. Hoisting is by 6-ton skips, whilst men are conveyed in double-deck cages carrying 50 men per trip. Between surface and the No. 40 level this shaft is now the main hoisting way of the mine and deals with the entire output of the deep level workings.

Below the No. 40 level there are three secondary shafts, two of these being incline and the other vertical. At one time these incline shafts served as the main hoisting shafts for the deep levels, but have now been superseded by Heathcote shaft, which, starting at the No. 40 horizon is sunk vertical and communicates direct with the 70th level, where it deals with the output of the deeper workings, concentration being effected by a main haulage of ample dimensions,

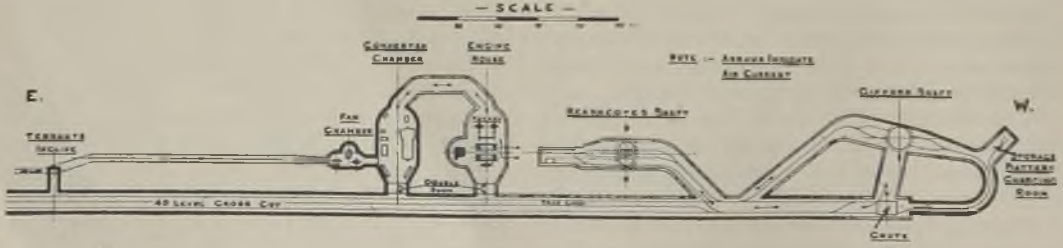


FIG. 3.—LAY-OUT AT THE 40TH LEVEL, CHAMPION REEF MINE.

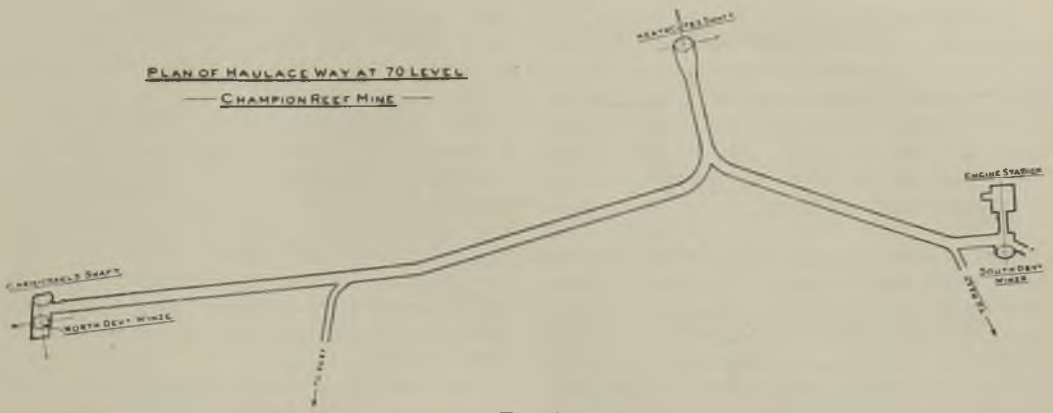


FIG. 4.

driven in the foot-wall of the reef. Figures 3 and 4 give an idea of the lay-out at the 40th and 70th levels.

The shaft, the equipment of which is shown in Fig. 7, is concrete lined and of elliptical section, the axial measurements being 18 ft. 6 in. by 12 ft. 6 in. inside concrete. The runners are of Oregon pine and the dividers are Indian hard wood. Hoisting is by cages and trucks, the former being double decked carrying a total of 60 men, whilst the latter are of 1¼ ton capacity, two such trucks being hoisted per trip.

From the 70th level, which is approximately 6,580 ft. vertically below surface, the North and South development winzes serve the deeper parts of the mine. These winzes, situated respectively in the north and south sections of the mine, are likewise of the vertical, concrete-lined, type with elliptical section of 16 ft. 6 in. by 11 ft. 6 in. and equipped with a double road. Hoisting is by single-deck cages which accommodate one truck each. The North development winze has now reached the 76 level, a vertical depth of 7,180 ft. below surface.

As already noted, Gifford's is the main hoisting shaft from surface to the No. 40 level, below which the greater bulk of ore and materials is transported through Heathcote shaft. It follows therefore that the sinking of this shaft has to be continued without interruptions to the normal hoisting routine. To effect this a reinforced concrete "penthouse" constructed of I section steel girders 12 in. by 6 in., spaced 5 ft. apart laterally and 8 ft. vertically, is placed in the shaft below the last level and when concreting smaller rails are inserted to provide the necessary reinforcement. At either end of this "penthouse," are the sinking, pipe, and ladderway compartments. Sinking is by Climax No. 2 Joburg jackhammers in a tough close-grained hornblende schist, the average depth of all holes drilled being 3 ft. 6 in. Thirty-four holes are drilled to the round, the centre cut method being that adopted and blasting gelatine is used. From the sink the broken rock is hoisted by compressed-air sinking-winch in half-ton buckets to the bottom level, where it is emptied into trucks and further hoisted by the main winder to such level as it may be required for purposes of stope filling.

The shaft is lined in concrete of 2 ft. average thickness, which is placed after sinking a maximum of 20 ft.; but should the walls of the shaft become dangerous, or show signs of bursting, the lining is placed at shorter intervals. The correct elliptical shape of the shaft is assured by the use of steel "formers," 2 ft. in height, made of 1/16 in. plate, riveted to 2 in. angle iron and constructed in portable sections for easy transport and erection. Rail spreaders are used to keep the "former" rigid.

Concrete mixing machines have been tried, but owing to the space required, and their frequent clogging, these machines have been discarded in favour of hand mixing, for which local labour is well suited. The rock from the last blast is left in the sink, and on it the "former" is erected and a mixture of 5 of rock, 3 of sand and 1 of cement, mixed in the sink, is placed in position. At 8 ft. intervals a special "former" is fixed in which are slots to allow of the wooden dividers being placed simultaneously with the lining. The present total depth of this shaft is 3,410 ft. below the 3,670 ft. or No. 40 level, and 7,080 ft. below surface.

The sinking operations of the North and South development winzes are carried out in the same manner as that of Heathcote shaft, differing only in that the rock from the sink is loaded direct into trucks which are lowered into the sink by cage, this being effected by the use of removable runners which are set in position after each blast.

Development - Driving. — Levels are driven at vertical intervals of 100 ft. and as the mine is dry they are not graded. Where the level passes through the ore shoots a concrete lining 8 ft. by 5 ft. inside measurements is inserted. At intervals of 200 ft. in the ore-shoots rectangular winzes 6 ft. by 4 ft., concrete-lined and equipped with bucket road and ladderway are sunk.

lode, but never less than 6 ft. This is then filled with mass concrete, and holes 3 ft. in dia. are left at 20 ft. intervals to permit of passing the filling to stopes below.

The back of the level is then stoped to a height 19 ft. above the rail and the level is arched in concrete the inside dimensions being 8 ft. by 5 ft. ; rails spaced 5 ft. apart with plank lagging form the arching, these being removed later when the concrete has set. Above this arching 6 ft. of concrete is placed and 8 ft. by 4 ft. holes are left in which chutes are fixed, these holes are spaced at 25 ft. centres.

This method of concreting the levels was first tried in 1927, as it was then found that rock pressures were becoming too great for

Fig. 5.—Champion Reef Property, looking North.

For driving, $3\frac{1}{4}$ in. reciprocating drills are used and 41 lb. jackhammers for winze sinking. The machines are all of the dry-drilling type, only a minimum of water being added. The use of water is restricted, so as not to increase the wet-bulb temperature underground. With the reciprocating machines solid steel is used and hollow steel with the jackhammers, sharpening and tempering being by O'Donovan furnaces fitted with pyrometer heat-control. A steel of 0·85% carbon content is employed and drilling is in both the schist and quartz, the former giving an average scleroscope hardness of 94·3 and the latter of 100·4. The average monthly advance in levels is 60 ft. and in winzes 20 ft.

Stoping.—Fig. 8 illustrates the method at present employed, this having been adopted to supersede underhand stoping with the stull or pigstye form of support. The first stage in this rill stoping is the preparation of the level. The bottom of the level is stoped for a depth equal to the width of the

timber support and moreover the frequency of rockbursts compelled the introduction of a more rigid and safer form of support, especially of the levels, to enable them to be kept open whilst the ground was being stoped. The concrete level has done this, and although it crushes with the ground pressure, there has never been a total collapse and choking of the level even in spite of severe rockbursts, and in consequence, this is the form of support now adopted throughout all the new stoping areas.

The waste rock from shaft sinking and other dead work is used in the concrete, and Fig. 9, a photo taken at the 74 level in the south section of the mine, shows the concrete arching in place. The back of the arch forms a bed for the stope filling, so that after stoping the whole of the ground is supported. The stope filling, which is waste rock and old sand tailings, helps to ease the strain on the concrete level support until the hanging-wall eventually compresses, the whole mass coming to rest on it before the fracturing

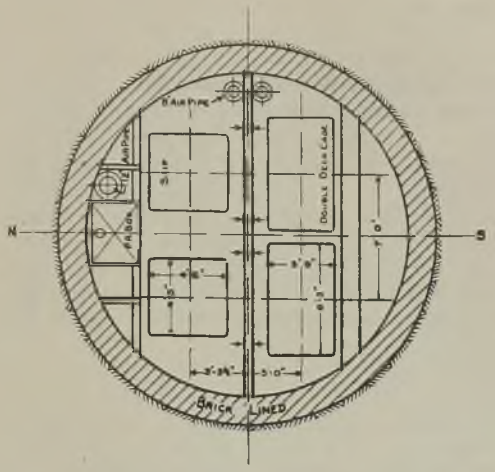


FIG. 6.—GIFFORD SHAFT, 18 FT. DIAM.

point is reached. This method of supporting the ground has minimized rockbursts and enabled ground to be stoped that would not have been possible with the old method.

Stoping the ore shoots is similar to the long wall system, retreating from lines of weakness. Telescopic machine drills are used with 1 in. hexagon solid steel, and the broken ore rests on a mat of old sand tailings. To insure that no fines remain, this sand mat, which is 2 ft. in thickness, is sampled after the ore has been removed. Mechanical scrapers are used to withdraw the ore and to assist with the filling, and as the rill advances, the chutes that are left behind are covered over and filled. Crib chutes are used for forming the ore passes in the filling.

VENTILATION AND TEMPERATURES.—The ventilation lay-out can be easily understood from Fig. 10. Two 53 in. double-inlet Sirocco fans are used, motor-driven by a belt drive. These fans are placed in the north and south sections of the mine. Care is taken to keep the downcast air as dry as possible, and to take the downcast air to the bottom of the mine by the shortest route. From the bottom levels the air is split and upcast through the working places. Hygrometer readings are taken daily in the downcast and upcast airways so that any marked increase in the moisture content can be ascertained and receive immediate attention.

Smooth lining of the main airways has considerably decreased the ventilation resistance of the mine, and the following are the average of the daily volume and temperature readings for the year 1931 :—

Depth in ft. below Surface.	*Volume Cub. Ft. Min.*	*Temperatures.* *Dry.*	*Wet.*	*Grains of Moisture per lb. of Dry Air.*	*Remarks.*
100	101,115	70·4	65·7	96·8	Downcast.
6880	—	104·3	87·6	143·6	do.
3770	—	91·6	83·4	153·4	Upcast.

The latest rock temperature, taken 6,980 ft. vertical depth below surface, was 125·7° F.

Small air-driven Sirocco fans and Typhoon and Venturi blowers are used for auxiliary ventilation in the sinks and drives.

PUMPING.—This, fortunately, is a small item. All the water channels on surface are faced in concrete to prevent percolation, and consequently the actual mine water is a comparatively small quantity, which is dealt with by five electric-driven treble-ram pumps with 500 ft. head, installed in the main upcast shaft. Drinking water is piped down the mine and any waste from this source is delivered by air-driven pumps to the pumps above mentioned. The average volume of water dealt with during the year 1931 was 57,811 gallons per 24 hours.

Ice is taken down the mine twice daily to cool the drinking water, the approximate consumption being 100 tons annually. To assist in counterbalancing loss of body salts through excessive perspiration, a supply of common salt is maintained at all drinking stations for addition to the drinking water by those who desire it.

WATER SUPPLY.—For purposes for which mine water would prove unsuitable the supply is obtained from a Government tank or reservoir 6 miles distant. The water is filtered, and pumped through a 16 in. pipe-line to high-level tanks, which in turn supply all the mines on the goldfield. The quantity

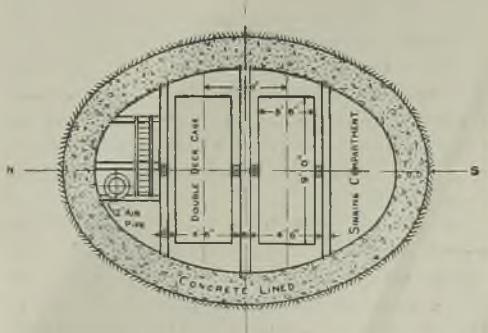


FIG. 7.—HEATHCOTE SHAFT, 18 FT. 6 IN. BY 12 FT. 6 IN.

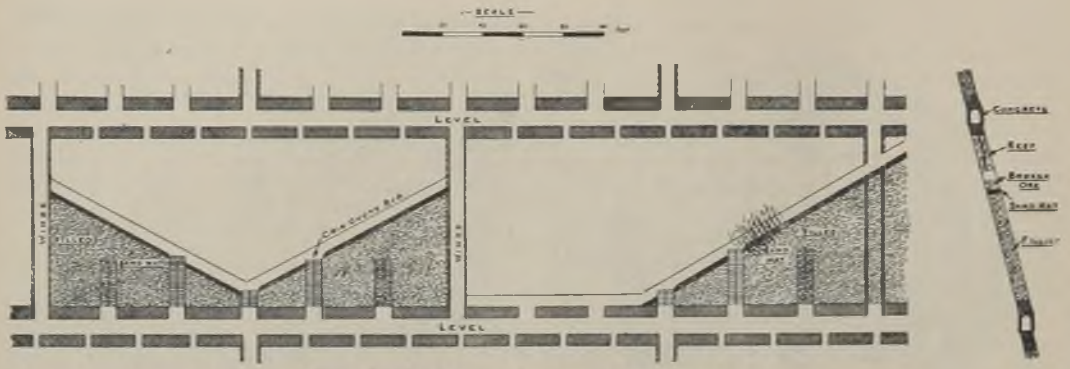


Fig. 8.—Sections showing a Rill Stope.

supplied to the field is one million gallons every 24 hours.

Compressed Air Plant.—This consists of five motor-driven compressors delivering a total volume of approximately 12,000 cu. ft. of free air per minute down the mine, the surface pressure being 55 lb. and the average underground pressure 60 to 65 lb. per square inch. To minimize pipe friction all mains are of ample area. The temperature of the compressed air is reduced from 160° F. to 85° by an after-cooler of the direct contact counter flow type, which was designed by the Superintendent, Mr. C. F. Heathcote, and made in the mine workshops.

Fig. 9.—74th Level, South Section, showing Concrete Arching.

Electric Equipment and Power Supply.—In common with the adjoining properties, the power supply to the Champion Reef mine is obtained from the Mysore Government hydro-electric scheme, the generating station being situated at Sivasamudram on the Cauvery River some 90 miles distant from the Kolar goldfield. Power is transmitted at 75,000 volts to a central receiving station, where it is stepped down to 2,200 volts for distribution to the company's sub-stations, the system of supply being three-phase at a frequency of 25 cycles per second. A 50 cycle, single-phase, three-wire supply for mine lighting is obtained through frequency changing plant.

The total nominal rating of motors connected is approximately 7,500 b.h.p. of which some 2,000 b.h.p. is in use underground for the operation of pumps, ventilating fans, hoists, etc., whilst the ratings of motors driving air-compressors amount to approximately 3,000 b.h.p. An Ilgner-Ward-Leonard hoist was installed underground some four years ago at the 40th level, Heathcote shaft. This equipment which is designed for winding both men and ore from a depth of 4,000 ft. vertical, is operated through single reduction gears by two direct current motors each having an R.M.S. rating of 600 b.h.p. Direct current at 600 volts is obtained from a 750 r.p.m. motor generator set fitted with a 22 ton flywheel, this equipment being housed in a separate chamber. The photographs in Figs. 11 and 12 illustrate this underground installation. The chamber is of masonry and arched.

All underground power cables are of the 3 core, varnished cambric, lead-covered, and double-wire armoured type, insulated for a working pressure of 3,300 volts and are controlled from sub-stations at surface

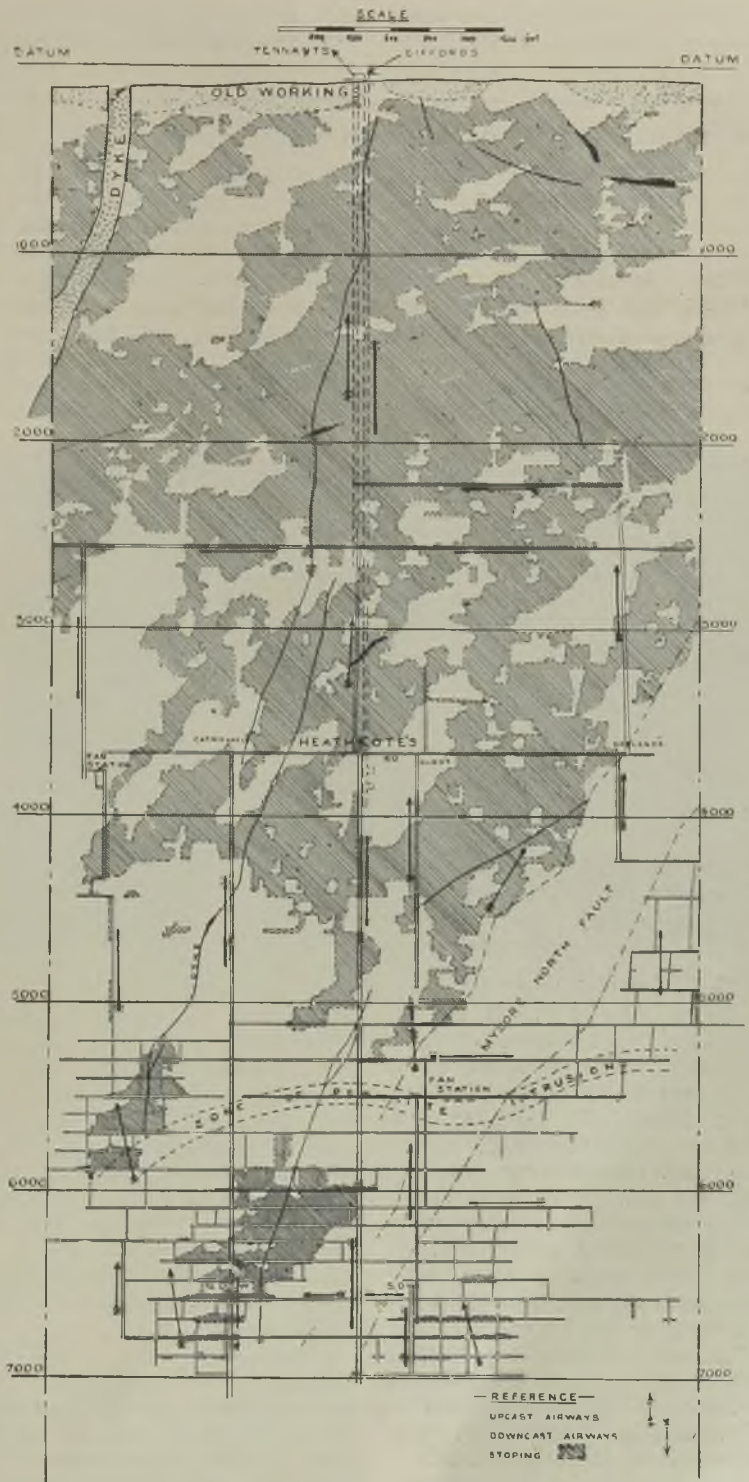


FIG. 10.—LONGITUDINAL SECTION OF THE CHAMPION REEF MINE, SHOWING THE VENTILATION SYSTEM.

by oil circuit breakers fitted with the usual protective devices. Motors of 50 b.h.p. rating and above, are wound for a pressure of 2,200 volts, whilst those of under 50 b.h.p. are operated from 220 volt circuits.

Battery-driven locomotives of special design are in use for underground haulage at the main levels, their overall dimensions being such as to permit of their being transported in the shaft cages from level to level as required. They pull 4 trucks each, the total load being 6 tons. The central battery charging station equipped with the necessary lifting racks to facilitate the rapid transfer of batteries is installed at the 40th level. The batteries are of the alkaline nickel-iron type each consisting of 40 cells having a normal capacity of 187·5 ampere-hours.

GIFFORD SHAFT WINDERS.—There are two steam winding engines at this shaft both made by the Sandycroft Foundry Co. These engines are double-cylinder, single-drum, direct-acting, each having cylinders 42 in. diameter by 7 ft. stroke with Corliss valve gear. The drums are of the cylindro-conical type, being coned from 16 ft. to 20 ft. diameter. One engine operates self-dumping skips with an ore capacity of 6 tons each. The other engine operates the man cages, which are double decked, carrying a total of 50 men per cage. The maximum shaft speed for winding ore and men is approximately 3,000 ft. per minute. The ropes are $1\frac{3}{4}$ in. dia. Langs-lay flattened strand.

The shaft is not working at full capacity, and for the present output steam is supplied by two Babcock and Wilcox boilers each with a capacity of 6,300 lb. of steam per hour and two Lancashire boilers each capable of evaporating 2,400 lb. of water per hour. The working pressure is 120 lb. per sq. inch.

ORE TREATMENT.—*Crushing and Sorting.*—Ore from the mine is tipped over grizzleys into shaft bins. The minus $1\frac{1}{4}$ in. size is sent direct to the mill bins, whilst the oversize passes over revolving picking tables, where pebbles for tube-mills and 8% waste rock are sorted out. Two Blake-Marsden crushers reduce the ore to $1\frac{1}{4}$ in. prior to its elevation to mill bins. The waste rock is spray washed on trays and repicked.

Milling.—Stamp mills with stamps of 1,250 lb. falling weight are used, the mortar boxes being of improved Homestake type, the number of drops per minute being 96, with discharge depth of $2\frac{1}{2}$ in. Mill screens are 9 and 16 holes per sq. in. Stamp duty is 11 tons per day.

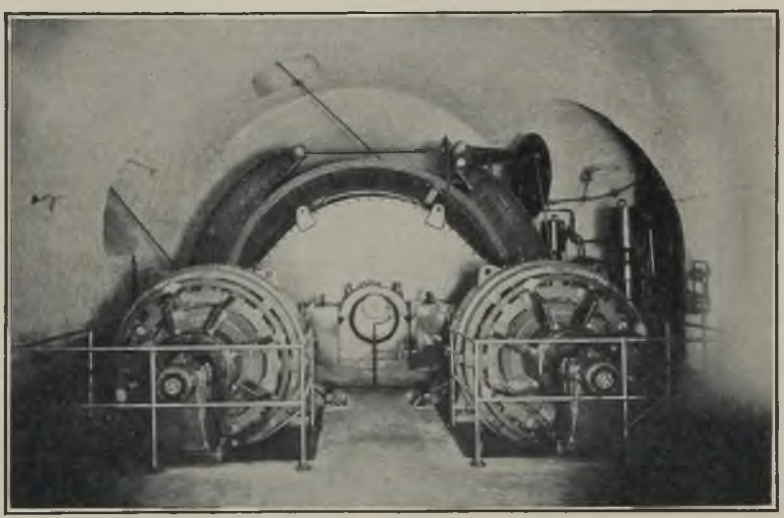


FIG. 11.—WARD-LEONARD HOIST AT 40TH LEVEL, HEATHCOTE SHAFT.

Mill Concentrates.—The mill pulp passes over blankets laid on wooden tables (cement faced) 8 ft. long by 5 ft. wide placed in front of the mortar boxes. The blankets are removed and washed in a tank every hour, the concentrates being dealt with as described under "Treatment of Concentrates."

Classification and Tube-Milling.—The tailings from the blanket tables, together with those from the blanket machines within the tube-mill circuit, are elevated by an 8 in. centrifugal pump to the main pulp distributor. At this point old sand tailings, previously pulped in water by a vortex mixer, are also delivered by pumps, and the pulp

now consisting of current ore and old tailings is divided evenly for the classification units, viz., 1 primary and 1 secondary cone for each of the seven tube-mills. The overflow of the secondary cones is the finished product, "One product pulp," which has a grading of approximately 80% minus 200 mesh. This flows to 50 ft. diameter slimes collectors for settlement and subsequent cyanide treatment, the water being returned to the mill-water storage tanks.

The underflow of the primary and secondary cones is fed into the tube-mills, where fine grinding takes place. Each carries a load of 7 tons of pebbles, and revolves at 28 r.p.m. The tube-mill discharge flows to a 6 in. centrifugal pump which elevates same to a pulp distributor from whence it flows evenly over fourteen blanket machines (see Fig. 13). Each machine has an endless belt of jute cloth to which blanketing 72 in. wide is sewn. The area of blanket exposed is 30 sq. ft. and is carried by two 12 in. diameter rollers. The gold here caught as concentrates is washed off by water sprays and pumped to the concentrate stock tank, the tailings flow to the tube-mill circuit for classification, etc.

Concentrates Treatment. — Concentrates obtained from mill blankets together with those from the blanket machines within the tube-mill circuit are sluiced from their stock tank into one of two 5-stamp mills of light weight stamps, each mill being fitted with a fine screen of 1,000 holes per sq. in. After crushing, the concentrate pulp flows over an amalgamating plate, where the free gold is extracted in the form of amalgam, the gold from which, after retorting, is cast into bars, the fineness being approximately 930 parts per 1000. In this process, 78% of the current ore value is obtained, the subdivision percentage being—mill blanket concentrates 44% and blanket machine concentrates (tube-mill circuit) 34%. The tailings from this concentrate treatment join the tube-mill discharge pulp, prior to its elevation and distribution over the blanket machines, the whole forming a closed circuit.

Cyanide Treatment. — The settled slimes, (One Product Pulp) after surplus water has been decanted is transferred in cyanide solution from the 50 ft. diameter slime collectors to Pachuca tanks by geared three-throw pumps with 9 in. plungers, where the charge is air-agitated for eleven hours, the cyanide strength being 0·045% KCN and protective alkali 0·002% CaO, the pulp density being kept at approximately 60% solids, 40% solution. Filtration of the pulp is effected in a Butters vacuum filter of 100 leaves, each 10 ft. long by 5 ft. deep, and by an Oliver vacuum filter of the revolving drum type, the size being 14 ft. diameter by 18 ft. long with 792 sq. ft. filtering area and revolving at 1 revolution per 6½ minutes.

The filtered and washed solids from the plants constitute the residue and after pulping are pumped to waste, their value being approximately 5 grains of gold per ton.

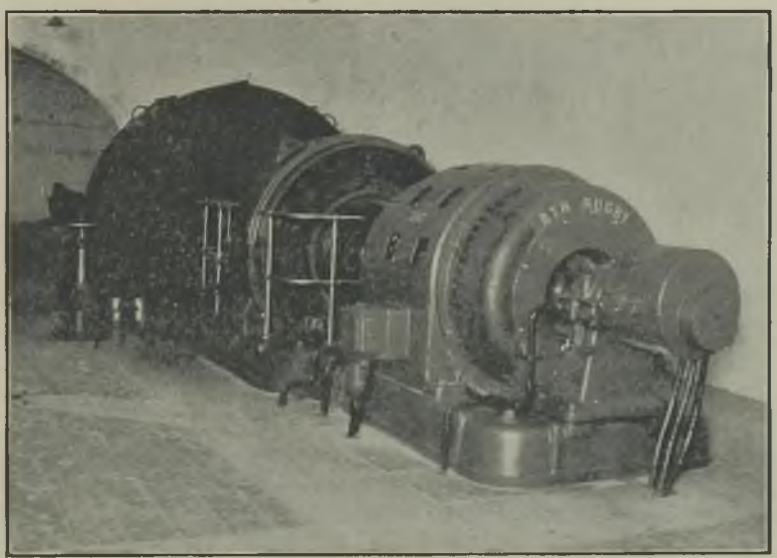


Fig. 12.—Converter Set for Ward-Leonard Hoist at 40th Level, Heathcote Shaft.

The filtrates are pumped to clarifying tanks, which, being provided with matting on which rests a layer of sand, assures the solution being perfectly clear before its passage through the five extractor boxes where the gold is precipitated on the zinc shavings with which the compartments are loosely packed. The "clean up" or gold recovery is effected by screening the zinc shavings in water, the coarse product being returned to the extractor boxes, whilst the finer gold-zinc slime is vacuum dried, roasted, and subsequently smelted in graphite crucibles in oil-fuel furnaces, the resultant bullion having a fineness of about 600 parts per 1,000 and being refined by air blowing (Rose's Bessemerising process) up to 760 per 1,000 gold approximately before being sent to the Mint.

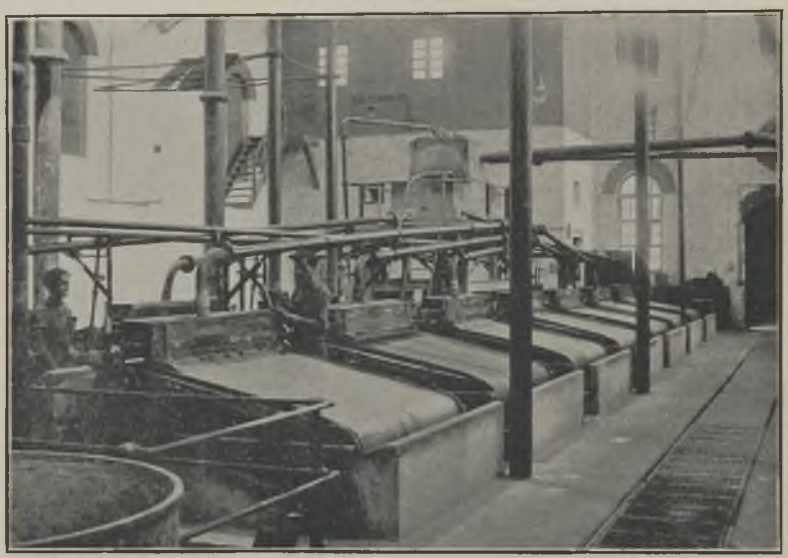


FIG. 13.—BLANKET MACHINES IN CHAMPION REEF MILL.

Gold extraction on the current ore by cyanide treatment is 20%, the total overall percentage being 98% made up as follows :—

Gold from Mill Blanket Concentration .	44%
Gold from Tube Mill Circuit Blanket Machine Concentration . . .	34%
Gold from Cyanide Process Treatment .	20%
	98%

LABOUR.—Although situated in Mysore State, which is essentially a Canarese country, it is curious to note that the Kolar goldfield labour was originally recruited almost entirely from the Tamil-speaking population of the Madras Presidency and the majority of the workers of to-day have been born and reared on the company's property. The artisan class learn readily and after a training extending over a period of not less than five years, an underground worker may present himself for examination by the Government Inspector of Mines, and if considered satisfactory, is given a metal disc and a certificate as a certified blaster, timberman, machineman, engine driver, etc. There are approximately 1,500 employed underground, and there is European supervision on each of the three 8-hour shifts. Wages are paid to the contract labour on a system of contract bonus, for all stopes and development points, and company wage men are paid a fixed daily rate. All the labour is paid an attendance bonus and there are two pay-days monthly. The company provides housing and a European official looks after their welfare. There is an excellent hospital for all the mines under the charge of four European doctors, and an Indian staff. Medical attention is free and sick and accident pay is on a generous scale.

The acknowledgments of the author are due to Messrs. A. F. Hosking, G. W. Richardson, H. A. Martin, and J. Keverne for their assistance in preparing this brief description of the Champion Reef mine, and to Indian Underground Pipe-Fitter Narasimhalu for the photographs which accompany the text. His thanks are also due to Mr. C. F. Heathcote, the Superintendent of the company, and to Messrs. John Taylor & Sons, for permission to publish.

CHROMITE IN THE SUDAN

By W. H. TYLER, M.Sc.

A description of a new area of chromite-bearing serpentines in the Sudan.

Some 400 miles from Port Sudan, on the Kassala branch of the Sudan Government Railways, lies a station called Qala en Nahl. It stands near a group of low hills, which are largely of serpentine and which form part of a considerable mass of basic and ultra-basic rocks. During 1930–32, the author was able to make a geological sketch map of some 1,000 sq. miles of country in this region, whilst examining chromite and asbestos deposits on behalf of Tanganyika Concessions, Ltd., by whose courtesy he is able to produce these notes. It was on the Sudan Government Survey plane-table map, scale 1/50,000, that the geological features were plotted. The map used here as an illustration (Fig. 1) is a smaller-scale reproduction of some 28 sq. miles only of the original map, but it includes one of the more interesting masses of ultra-basic rocks, as well as most of the other types outcropping over the larger area.

It is hoped that this brief account of the district will prove of interest to both mining engineers and geologists, as it concerns a newly-discovered mineralized region in Africa where no detailed geological mapping has been done previously.

TOPOGRAPHY.—The country is best described as a plain, standing some 1600 ft. above sea level and dotted over with hills, rising steeply out of it. It is only on and near the hills that hard rock outcrops can be seen, since by far the greater proportion of the area is covered with black cotton soil, forming perfectly level stretches of featureless country. The largest mass of hills, on the 1,000 sq. miles of territory mapped, is at Qala en Nahl and shown on the accompanying map (Fig. 1). The highest point of this only rises to 2,167 ft., that is, 510 ft. above plain level; Qala en Nahl station standing at 1,657 O.D.

The rivers are merely the flood drainage channels which carry off the storm water during the rainy season, lasting from June to September. The storms are very local and the rainfall is little over 25 in. per annum. The streams, for the most part, only exist near the hills, becoming lost as identifiable channels in the plains. None of them hold water in the dry season either at surface in pools, or at depth in their gravels.

The photograph (Fig. 3) taken looking north from the inside of the Qala en Nahl hills, shows the type of country and also the preponderance of plain over hills, even in what is one of the hillier districts.

GEOLOGY.—It will be seen from the sketch map that six rock groups have been distinguished.

(1) Basal Series.
(2) Serpentines.
(3) Talc-carbonate rocks.
(4) Gabbros.
(5) Granites.
(6) Cotton soil drift.

The groups (2), (3) and (4) it is believed, belong to one period in the history of the area and were originally intruded about the same time. In the following brief description of the geology, they are treated together.

(1) *The Basal Series.*—This consists of a series of altered sediments of considerable apparent thickness. Outcrops are seen on both sides, and at the north-east end of the eastern leg of the "V" of the Qala en Nahl hills. Here chlorite, mica, and graphitic schists and phyllites can be recognized and at one point a lenticular bed of marble, which represents what was originally a thin limestone in the sediments, appears. In places the mica and graphite schists contain large and beautiful pseudomorphs after pyrite, which lie about like dice on the weathered surface of the rock.

The rocks have been crushed, the strike of their foliation being generally some 40° east of north at Qala en Nahl. They all appear to be either vertical, or to dip very steeply to the south-east. The direction of dip is the same on both sides of the eastern leg of the Qala en Nahl serpentine. A boring put down for water at the Qala en Nahl station, entered mica schist, belonging to the same series, after passing through the cotton soil.

Much larger areas occupied by these rocks lie to the south-east of Qala en Nahl and they have been recognized as far away as 28 miles. Here the rocks form low ridges which have resisted weathering to the general plain level, owing to their having been hardened by the intrusion in these places of quartz reefs. Over these wider areas of outcrop, the strike of the foliation is some 20 to 30° east of

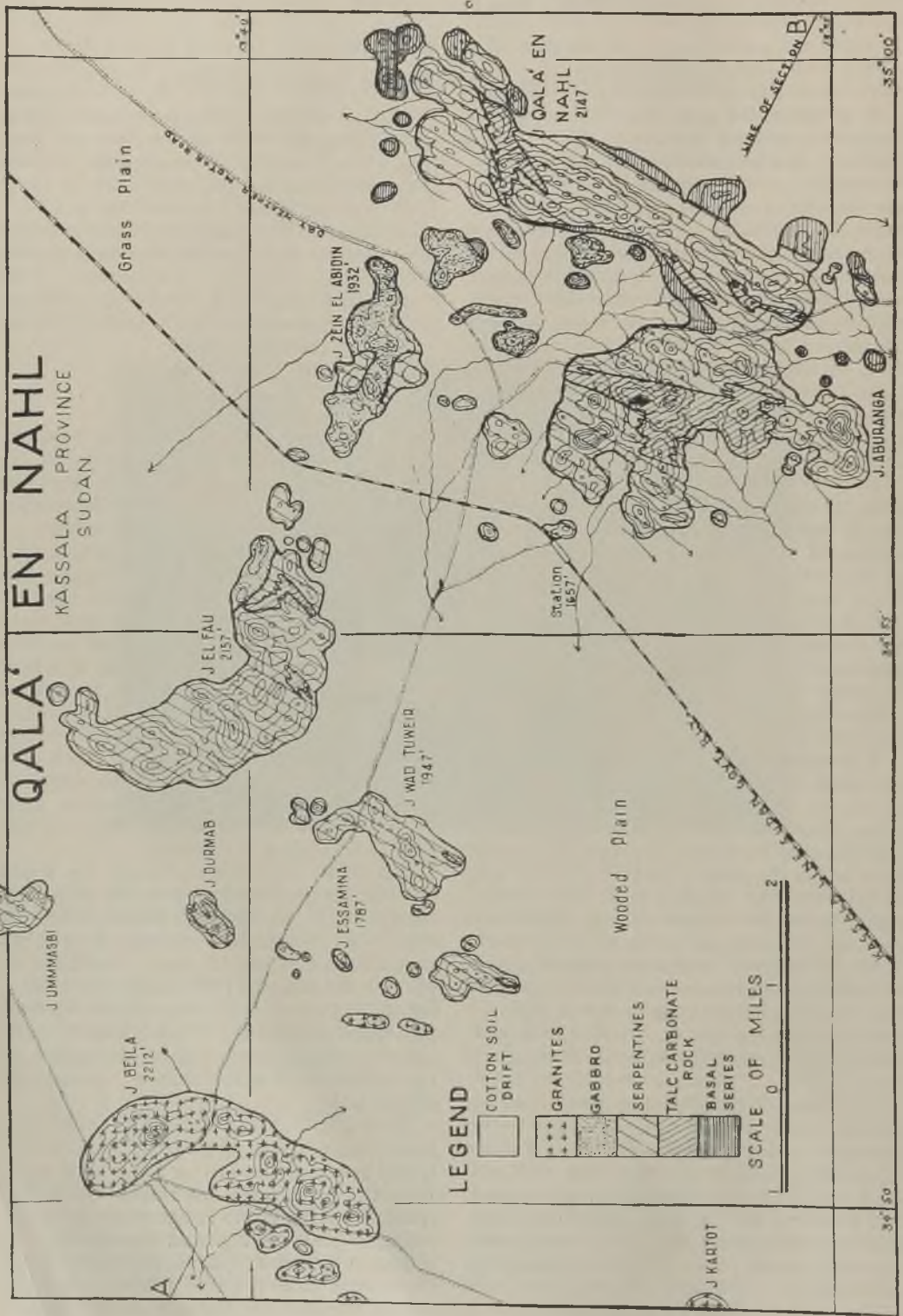


FIG. 1.—SKETCH GEOLOGICAL MAP OF THE QALA' EN NAHL HILLS.

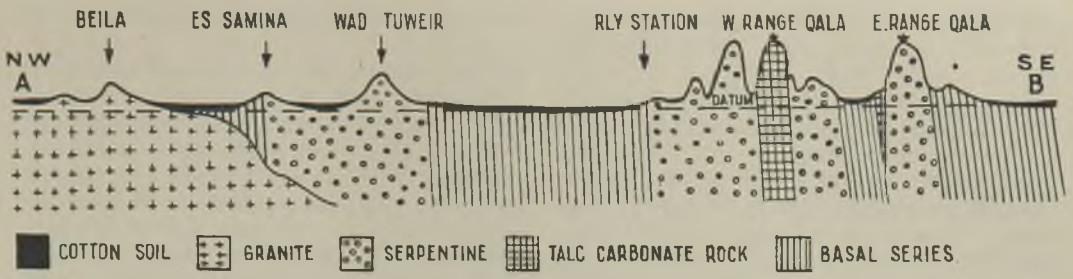


FIG. 2.—SUGGESTED SECTION ALONG LINE A–B ON FIG. 1.

north. Considerable modifications of this general strike can be seen to have been caused in places by local disturbances and contortion is sometimes evident.

At Jebel es Samina, about two miles east of Jebel Beila, there is a limited and somewhat obscure outcrop of a garnetiferous hornblende schist. This, it is believed, belongs to the Basal Series, but shows a greater degree of metamorphism and is probably a rock of different origin from those of the main outcrops. The series is unfossiliferous and any suggestion as to the age of the rocks can only be made by comparison with other similar areas.

(2), (3) and (4) *Serpentines, Talc-Carbonate Rocks, and Gabbros.*—The hills of Qala en Nahl and those close by are largely composed of rocks of these groups. For eight miles to the south-east of Qala en Nahl range, no similar rocks are seen. Then an irregular dyke of serpentine, intruded into basal rocks, varying in width from one hundred yards to half a mile, can be traced intermittently for five miles, where it joins a further large mass of a similar order of size to that of Qala en Nahl. In all, these rocks were traced over an area 30 miles in length from north-west to south-east.

The serpentines form the larger proportion of these groups. They are varied in appearance, showing a variety of colours; pale green, dark blue-green, green speckled with white, green speckled with black and a variety of brown and yellow weathered surfaces. One massive variety gives a shining crystalline fracture. This is due to the occurrence in the serpentine of crystalline magnesite. Other outcrops show fissures filled with the chalky variety of magnesite and the main mass of this rock is usually dull white in appearance owing to its content of non-crystalline magnesite.

Large masses of the rock are silicified; the silicification being due, it is believed, to the action of solutions from the later granite intrusion. In one place, a line of silicification appears to be a continuation of a quartz reef. Silica appears to have been deposited at one point from solution in a fissure, and further on, where the fissure ended, the same solution replaced the serpentine.

Some of the serpentines show evidence of crushing; in places being broken into a

FIG. 3.—VIEW ACROSS THE QALA' EN NAHL HILLS.

short-grained rock and at others appearing somewhat schistose, with the development of talc.

In most of the masses of serpentine, irregular and often lens-shaped masses of a Talc-Carbonate Rock occur. Several of these are shown on the map, the largest being in the western ridge of the Qala en Nahl range. This one is two miles long and three-quarters of a mile wide at its broadest part. There are however many others of all sizes down to a few feet long and a few inches wide. The rock is a mixture of talc and magnesite, varying in texture from fine-grained to extreme coarseness, with masses of talc up to six inches in diameter and crystals of magnesite two inches long. The fine-grained variety is however, the common type.

This rock is often speckled with tiny crystals of magnetite and chromite, and in one mass, shining flakes of ilmenite. It shows marked foliation, the strike of which is parallel to the long axes of the masses. This strike varies in direction, as may be clearly seen from the lie of the masses as mapped.

Fig. 4.—Adit in Talc-Carbonate Rock.

The photograph of the adit (Fig. 4) driven into the talc-carbonate rock shows, in the top left-hand corner, how the rock weathers with a smooth surface, and above the timber, the typical fracture of a foliated rock, broken into at right angles to the strike of the foliation. The outcrops of the rock have very interlocked boundaries with the serpentine, long fingers of the two rocks alternating and lying side by side and lenses of talc-carbonate rock lying in serpentine and vice versa.

A shaft sunk on a junction of the serpentine and the talc-carbonate rock showed slickensides at the contact and a complete lens of serpentine in talc-carbonate rock. This is illustrated in Fig. 5, which is a sketch of the shaft side, and it appears that the lens of serpentine has been torn from the main mass by earth movements.

Almost all these masses of talc-carbonate rock have a core of a quartz-magnesite rock almost free from talc running practically the whole length of their strike. The majority of this rock is a fine-grained mixture of quartz and magnesite, but the weathered surface sometimes shows a fine filligree of quartz stringers standing out above a smooth weathered surface of the ground mass. The cores vary in width from a few inches up to 20 ft.

The opinion formed in the field by the author, was that these talc- and quartz-carbonate rocks were originally serpentine, since altered by carbonate solutions. The central axes of the larger masses may be lines of major dislocation in the country, up which the solutions rose.

Inside the north end of the two limbs of the Qala en Nahl range, lie a number of small hills composed of an altered gabbro. This rock again appears at Jebel Zein el Abidin and Jebel Fau, to mention the places shown on the map. Fifteen miles to the south this rock again appears, intimately connected with a large mass of serpentine.

The rock presents a green and white mottled appearance and has been much altered. The green mineral is largely hornblende and the white a mixed aggregate from the breakdown of felspar. The intimate connexion of these gabbros with the serpentines seems to indicate that they are the products of the same phase of activity although it was not possible to note any

definite field evidence of their order of intrusion.

(5) *Granites.*—Jebel Beila, seen in the extreme north-west of the map, is composed of granite. This with part of Jebel Kartot, further to the south, is the only granite shown, but these are only two of several large granite outcrops.

South from Beila, a line of hills composed of granite extends for twelve miles. Again, seven miles due south from Qala en Nahl, large and small granite hills appear. To the north-east of these last-mentioned hills, but separated from them by country of basal rocks, a further low-lying mass of granite outcrops. Some outcrops are of a normal biotite-granite and some contain hornblende. Some only show gneissic structure and it is possible that there may have been two periods of granite intrusion. The author's interest however was centred mainly in the basic rocks and he collected very little information about the granites.

That the granites are newer than the serpentines is proved by the fact that pegmatites of exactly the same type as can be seen in Jebel Beila, are intruded into serpentine some two miles to the east of the main granite mass.

(6) *Cotton Soil.*—This is a fine black soil, very friable and traversed by wide cracks when dry, but becoming a black mud, almost impossible to cross even on foot, when it becomes wet in the rains. G. W. Grabham, the geologist to the Sudan Government, considers that the cotton soil, in the area under discussion, probably originated as wind-blown dust from the northern deserts, deposited on reaching the tree-clad areas. This explanation of its origin certainly fits the facts the author was able to observe over the limited area in which he worked. Similar deposits however, which the author has observed in central and eastern Africa, also known as " black cotton soil " can be explained as the product from the breaking down of lavas and tuffs, particularly those of basic composition, and it appears possible that a variety of processes may give rise to similar deposits.

Chromite and Asbestos.—No detailed account of these deposits can be given at present, since they are still under examination with a view to exploitation. The chromite occurs both in the serpentine proper and in the talc-carbonate rock. It is found in masses with a variety of shapes, often lens-like, and outcrops have been found every-

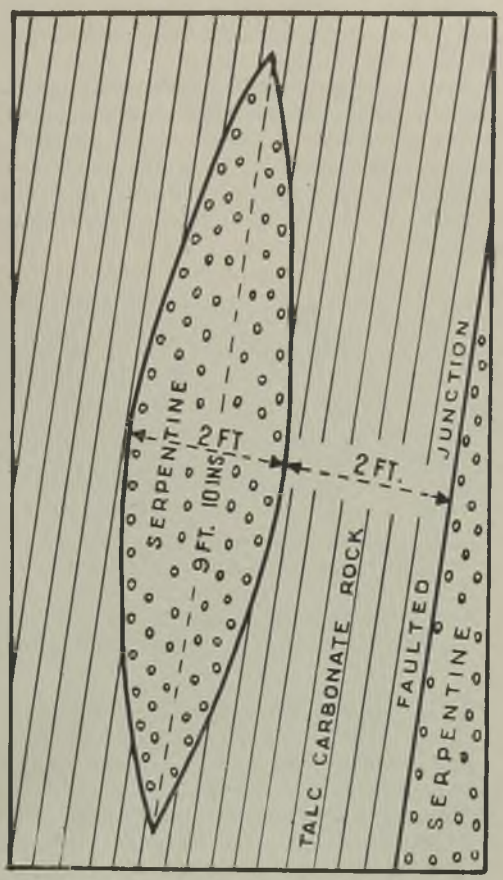


Fig. 5.—Lens of Serpentine in Talc-Carbonate Rock.

where where the ultra-basic rocks appear at surface.

The asbestos, which is chrysotile, is found in one particular type of serpentine; a blueish-green variety, weathering to pale green and yellow. Its appearance is very characteristic and easily recognized in the field. It is full of open fissures and when found, almost invariably carries asbestos.

Structure. — Briefly, the evidence indicates that the history of the region was as follows :—A series of sediments, the oldest rocks in the region, were intruded by the ultra-basic rocks and the gabbros. Pressure acting at right angles to a north-east and south-west line then set up a foliation in this direction. Later the granite was intruded as a large batholith, now only seen outcropping over a limited area, but probably underlying a great deal more of the country occupied by the older rocks. Lastly the

cotton soil was deposited after the country had been denuded to the present surface level of the older rocks.

In an area where only such a small percentage of the country shows rock exposures, it is very difficult to put forward anything, but a very tentative idea of the general structure and the section shown in Fig. 2 from N.W. to S.E. should only be regarded as such.

All the junctions between the basal series, the serpentines and the talc-carbonate rock are represented as faulted. Two of them can be demonstrated in the field to be so and there is no definite evidence concerning the others. The strike of the two proved faults is east of north, one being the junction between the basal schists to the east of the east limb of the Qala en Nahl hills and the serpentine, and the other, the junction between the talc-carbonate rock and the serpentine of the west limb of the range.

CONCLUSION.—Some ten miles to the south-east of the Qala en Nahl range there is another large mass of fresh rocks varying in composition from diorite to gabbro and clearly of a different age from those appearing on the map, so that the region is one of distinct interest. The map as produced here is not meant to be any more than the result of the rapid plotting of surface outcrops, but several major structural lines suggest themselves and are probably capable of further development.

Many of the rock types suggest a comparison of the area with the chromite-bearing country of Selukwe, Rhodesia, and it is hoped that detailed petrological work, which is being undertaken, will show how far this comparison holds good.

DERBYSHIRE MINING

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

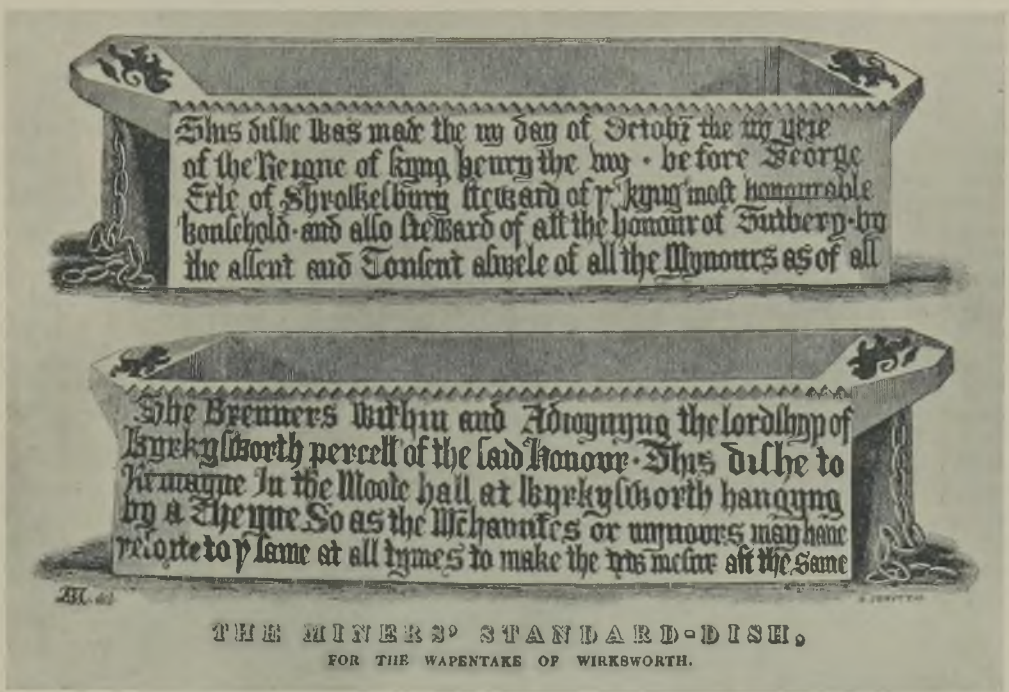
The author gives some account of the history of Derbyshire mining and of the customs which govern it.

The history of lead mining in Derbyshire has never been written in its entirety. The industry does not loom large in statistics of world production, but it is probable that at one time its proportion of European output was considerable. It occupies, however, a very important place in the more intimate social history of the county and it is so bound about by the records and traditions of the past that it has made no response to modern influences. It is perhaps typical of England in this that it has never been passive, but resistant to outside influences, and whatever progress it has made has been made grudgingly and well behind the thought and invention of younger countries. As a typical instance of this (a minor one it is true) no man may take below ground more than four pounds of explosive at a time. It is handed out to him at the surface and he carries it with him into the cage by which he descends to his working level. Modern usage elsewhere prohibits the handling of explosives in this way. The four pounds is his day's supply. The law which says so is fifty-five years old and measured from the point of view of modern metal mining that is a long time, but it is nothing to the antiquity of the customs, which governed the conditions of lead mining for many centuries, and which were embodied in the civil law of England only 80 years ago.

To come into close contact with Derbyshire mining then, is to step into the past. Where but here for instance could it be possible to find to-day a serious and painstaking official whose function it is to measure in a cumbersome trough of wood (capable of holding about 15 pints of water) ores of lead "washed and made merchantable" by hand—setting aside every thirteenth dish as the portion due to the Lord of the Soil—his "lot" as it is called—weighing a dish now and again and solemnly recording the fact that such and such a man had obtained so many loads (nine dishes to a load) and so many dishes of ore and that the dish of this ore weighed so many pounds? (There is such an official and he does so to-day and would so measure and so act if he were confronted with the output of one of the great lead mines of the world if it happened to be in the King's Field in Derbyshire.) Or to learn that the dish by which he measures can only be certainly correct if it has been tested against a certain brass dish, which Henry VIII is supposed

to have had made, and if that testing has been done by first filling the Brass Dish with Turnip Seed and pouring the seed into the dish which is to be tested? Or again to see this same official with arms extended, his hands touching the extended finger tips of a man on either side of him, marching the three abreast,[1] from the mine to the nearest highway, thus marking out for the miner his road to the King's highway

These notes pretend only to touch on some of the lighter and more evident aspects of the past. They are in no sense anything more than excursions into the open places of the history of mining in Derbyshire—the mere fringes of the field of discovery that lies waiting for the serious student of events that brought the very kings and common men of England into common touch. The scene is near, or in, the King's



The Brass Dish now in the Barmote Hall, Wirksworth.

"ad portandum et cariandum" his ore thither without reference to the Lord of the Soil? Or, at his annual or half-yearly court hearing the Steward calling on twenty-four or twelve men whose names are in his record as miners, to take an oath to do certain things in connexion with the mines, four being sworn at a time, each holding the bible in his right hand and at shoulder height, and each facing a different front as if ready to play some country game—and so on? These things persist because the laws and customs require them, and they are as alive to-day as when Charles II came to the throne, or indeed as they were two or three centuries before then.

[1] Or showing the way to two men following him with arms extended and hands touching.

field, or fee, or feod. The Crown draws revenue, very small in these days, but still revenue, by a right which goes back to the 13th century. Here, centuries ago a miner's day was an 8-hour day—probably the first time that any labourer of any land worked only from 8 a.m. until 4 p.m. The village churches bear records of the terrors of the miner's calling—on such and such a day this man was "damped," that is to say, killed by methane. If he were overcome, but not killed, the remedy was to cut the turf and lay him with his nose in Mother Earth. The "knocker" too, could be heard at times—the "noggie" of Cornwall, or the "bergmann" of the Austrian Alps—tap, tap, tapping with his elfin hammer. He stopped if anyone whistled—to-day

to whistle below ground is to frighten the ore away for ever. The church which buried him when he died through gas, or by drowning, or by falls of earth, took from him, while he lived and worked, a tenth of his produce—the tithe, because the ore of lead was "of a vegetability" and therefore grew annually as standing crops do. If the Church could not get its tenth it took what it could get, as it does to-day by right of custom. No man could mine in any man's orchards and, therefore, there are orchards everywhere that bear only sour apples despised by small boys.

If lead enters into any man he is said to be "bellanded," because the Anglo-Saxon who wheezed, or was asthmatic, was said to be bellende—that is, "roaring," as we say now of a horse, and that is one of the symptoms of lead poisoning, and so on. All these things belong or belonged to the everyday life of a community that still sings its own praise :—

> Derbyshire born and Derbyshire bred
> Strong i' th' arm and wick i' th' 'ead.

Deep down in every man born of this county there is an indefinable attribute that makes him part of the past. He looks into the future but little, but will fight with blind instinct and without reason for some immemorial nothing that brings him neither goods nor benefits except the simple satisfaction of having preserved some nebulous right. He is the very essence of the past.

The first mention in printed English of this county's mining was made in 1610, when the translation of William Camden's "Britannia" (1586) was published. Camden was Clarenceux King of Arms, of the College of Arms. The work is a sort of history of England, Scotland, and Ireland, dealing chiefly with the more important families and their estates, but touching as well on points of interest associated with the trades and industries of each county. It so happened that at the time he wrote, two of the principal industries of Derbyshire were the brewing of ale and the mining of lead ores—both with their beginnings in the mists of antiquity. He was enthusiastic over both. Speaking of Derby he says rather sorrowfully—"But now all the credit that it hath ariseth of the assizes there kept for the whole shire"—his spirits rise as he continues "and by the best nappie ale that is brewed there . . . This is the ancient and peculiar drink of the Englishmen and Britons, yea, and the same very wholesome."

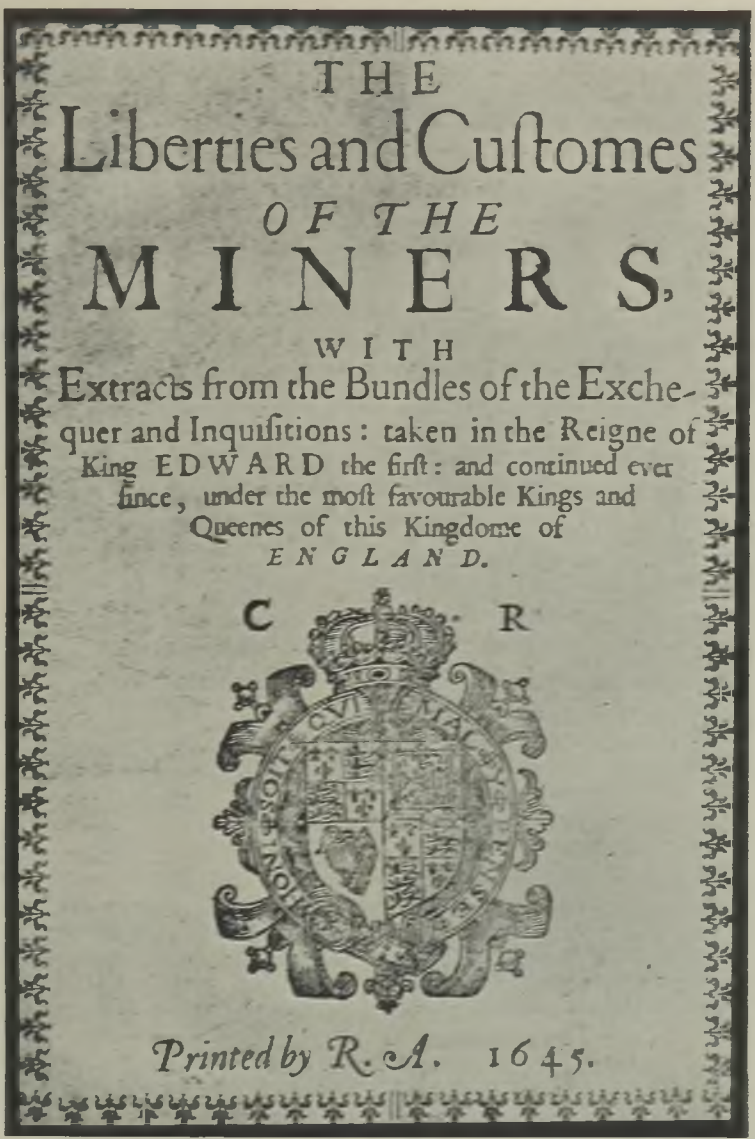
Later he speaks of Peakland—

> Verily I think that Pliny spake of this country when he said "in Britain in the verie crust of the ground without any deep mining is gotten so great store of lead that there is a law expressly made of purpose forbidding men to make more than to a certain stint": For (he continues) in these mountains fertile lead stones are daily digged up in great aboundance which upon the hill tops, lying open to the west winde when the western winde begins to blow they melt with mighty great fires of wood into lead in troughs or trenches which they dig of purpose for it to runne into and so make it into sowes. Neither only lead, but stibium, also called in the apothecaries shops, antimony, is here found by itself in veines which minerall all the women in Greece used in old time to colour their eyebrows with.

The "veines" of stibium are open to doubt, at least, and Pliny was probably referring to the south-west of England and not to Derbyshire. The water for the nappie ale came from wells in the limestone—the river waters were not used—at least in later times—and it is probable that the bulk of it came through the lead-bearing measures and kept them drowned until wars and the invention of steam-driven pumps made it possible for the lead to be mined.

Camden is quoted because his is the first printed reference in English to the lead mining industry of Derbyshire. At the time he wrote, England had been through an important mining revival under the fostering care of Elizabeth. Various monarchs had taken a spasmodic interest in England's metals, but this interest was confined chiefly to silver and to tin because of the value of both of these to the revenues, the former for its intrinsic value as a Royal metal, the latter as an article of trade. Elizabeth's interest in the baser metals was inspired by the desire for the safety of her realm.

Beginning in 1561 she had, by 1564, given grants to Daniel Hochstetter and Cornelius de Voz, to the former (in association with Thomas Thurland, Clerk of the Savoy) "to dig and mine for all manners of ewers of gold, silver, copper and quicksilver" in certain counties—to the latter, for "allom and copperas and all ewers of metals that are to be found in digging for the said allom and copperas." In the next year she gave a grant to "Christopher Schutz (in association with our faithful and well beloved William Humphrey, Saymaster of our Mint within the Tower of London) to search, open,

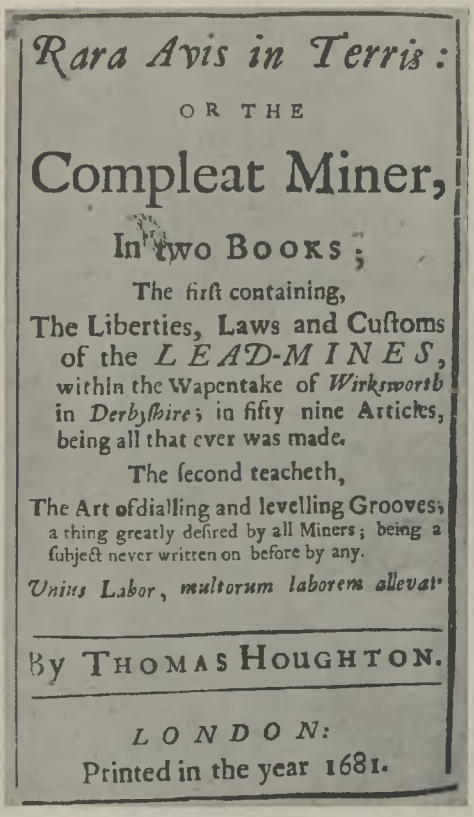

THE
Liberties and Cuſtomes
OF THE
MINERS,
WITH
Extracts from the Bundles of the Exche-
quer and Inquiſitions: taken in the Reigne of
King EDWARD the firſt: and continued ever
ſince, under the moſt favourable Kings and
Queenes of this Kingdome of
ENGLAND.
C R
Printed by R. A. 1645.

TITLE PAGE OF THE FIRST PRINTED RECORD OF THE DERBYSHIRE MINING CUSTOMS.

dig, mine and try all earths, grounds, soils and places of and in our Kingdom of England, etc., and of that part of Ireland known as the English Pale, except only the principalities and counties herein before exprest . . . , and for all other Minerals and Treasures likewise to be found in the said earths . . . , and for tin and lead in such sort as by the Laws and Customs of our said Realm is or hath been lawfully used."

She had followed this up by forming in 1565, the Company of the Mines Royal, and subsequently in the same year the Society for the Mineral and Battery Works, two joint stock companies with wide powers (the former of 24 shares and the latter 36 shares, each divisible into four) for the purpose of controlling all operations connected with the finding and mining of ores of all kinds, of extracting the metals from them and of fashioning them for merchandising. Incidentally, the grants made to Hōchstetter were transferred from Johann Steinberger to him on September

10, 1564, Steinberger having had them in 1561. The foreign mining and metallurgical experts had been brought over from Germany at the instance of Humphrey, "Saymaster of the Mint." The great Cecil (Lord Burghley) seems to have been the moving spirit in this business and


Rara Avis in Terris:

OR THE

Compleat Miner,

In two BOOKS;

The first containing,

The Liberties, Laws and Customs of the *LEAD-MINES*, within the Wapentake of *Wirksworth* in *Derbyshire*; in fifty nine Articles, being all that ever was made.

The second teacheth,

The Art of dialling and levelling Grooves; a thing greatly desired by all Miners; being a subject never written on before by any.

Unius Labor, multorum laborem allevat.

By THOMAS HOUGHTON.

LONDON:

Printed in the year 1681.

TITLE PAGE OF THE FIRST OF TWO EDITIONS OF 1681.

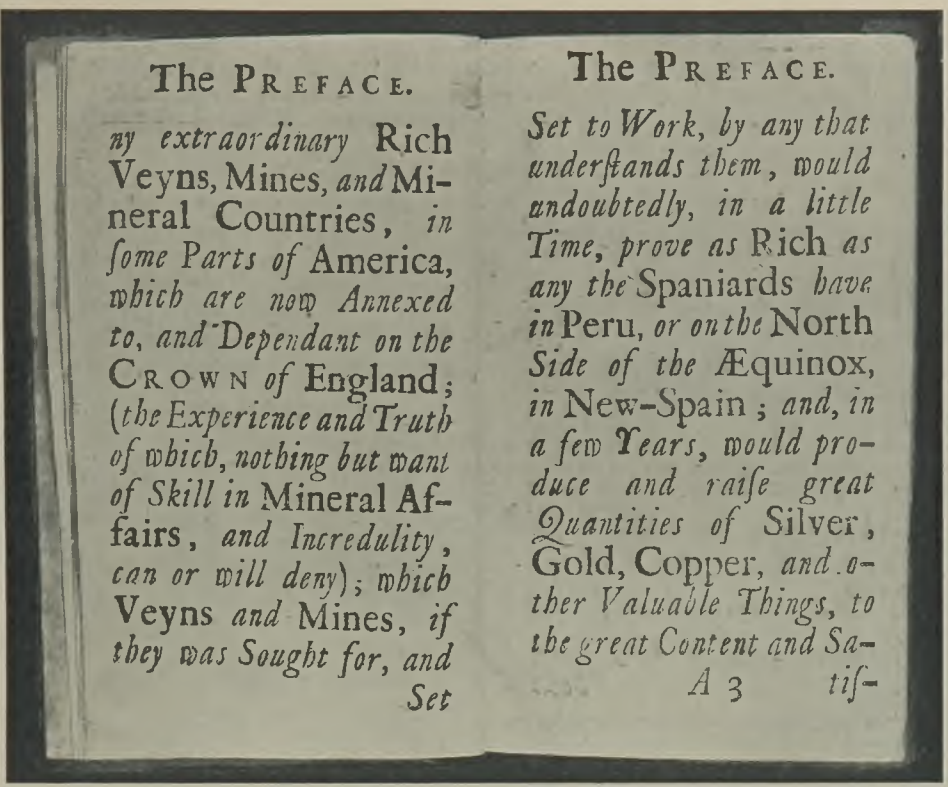
he was no doubt prompted by the knowledge that a trial of strength would take place sooner or later between England and Spain. The efforts of the company were directed almost wholly to the production of copper, zinc, and silver, the first two for the provision of munitions of war, the last, incidentally, arising out of the first and adding to the coffers of the State.

The lead of Derbyshire does not appear to have attracted much attention, but the Company of Mines Royal was interested at least, because in 1593 Cornelius Avenant, citizen and merchant taylor of London, conveyed to the company an interest in the lead works in Derbyshire which he appears to have obtained in 1582. The indenture, which he refers to as establishing the claim which he remised and released in 1592, was between himself and one "William Bird, late citizen and mercer of London." William Bird was treasurer to the company in 1567, so that Avenant's interest had probably been obtained, originally, as a form of lease from the company itself. This is a very interesting point. Camden's reference, slight as it is, definitely records that mining was being carried on at Wirksworth and Crich, and Cornelius Avenant's works must have treated ore obtained from these places, if indeed the "lead works" were not actually mines, and not smelting plants.

But mining dates back at least to the Roman occupation and if the aboriginal inhabitants had any need or use for lead ores prior to this occupation they could have had them without trouble. The ore lay open to the day in the caverns and joints of the mountain limestone, which, with the shales and grits, forms the highlands known as the High and Low Peaks of Derbyshire (as in Anglo-Saxon days they were known as "Peaclond"). Pre-Roman pommels of swords, and celts made of lead have been dug up and most, if not all, of the relics of the Bronze Age in England and Scotland contain lead. (Presumably, it was associated with the copper and not the tin of the bronze alloy and it came almost certainly from Cornwall, which county alone carried the three metals.) While tradition confidently names a number of caverns in the limestone of Derbyshire as being Roman work, evidence afforded by relics of such things as tools has been exceptionally meagre. In the case of one so-called Roman cavern at Matlock, which is visited annually by many people, contemporary evidence is fairly clear that it was never worked till about 1820.

Despite the absence of relics, however, it is reasonably assumed that the Romans did work here because of all the pigs of lead of undoubted Roman make found in England, five belong to Matlock.[1] One bears the mark of Hadrian. Another is referred by archaeologists to 50 B.C.—reference that is almost certainly wrong. Several of these pigs bear the letters EX ARG, etc. The inscriptions in which these letters occur have been variously interpreted, but

[1] See Hunt, "British Mining."



The PREFACE.

ny extraordinary Rich Veyns, Mines, *and* Mineral Countries, *in ſome Parts of* America, *which are now Annexed to, and Dependant on the* CROWN *of* England; (*the Experience and Truth of which, nothing but want of Skill in* Mineral Affairs, *and Incredulity, can or will deny*); *which* Veyns *and* Mines, *if they was Sought for, and Set*

The PREFACE.

Set to Work, by any that underſtands them, would undoubtedly, in a little Time, prove as Rich *as any the* Spaniards *have in* Peru, *or on the* North *Side of the* Æquinox, *in* New-Spain; *and, in a few Years, would produce and raiſe great Quantities of* Silver, Gold, Copper, *and other Valuable Things, to the great Content and Sa-*

A 3 *tiſ-*

"ROYAL INSTITUTIONS" (1693–4), BY THOMAS HOUGHTON. A PREDICTION OF THE MINERAL WEALTH OF NORTH AMERICA.

almost invariably are assumed to mean "free from silver." T. Wright suggests that the word LUT, which occurs in association with them on several pigs signified that they had been "washed" free from silver. In one case, instead of LUT, the word is LUTUD, but this seems to have escaped his notice.

Derbyshire lead does not carry silver in quantity sufficient to make its recovery possible by any means at the disposal of the Romans. In any case it is more than doubtful if the words could have such a meaning in Latin. The simplest explanation is that LUTUD stood for Lutudarum, identified with the present city of Chesterfield and lying on the main Roman road between Derby (Derventio) and York, the capital, that there was a depot at Lutudarum for the lead fields of the vicinity, and that the inscription means merely that the pig bore the brand of its own district and belonged to, or was destined for the depot (argentarium), bank, or treasury (argentaria) at Lutudarum.

These pigs are all that remain of the Roman work in Derbyshire and beyond the above there is no evidence that they were actually made in Derbyshire. Judging from the amount of ore that was left on the surface to be worked in periods subsequent to the Norman occupation with no better tools than the Romans had, the latter did not bother much with Derbyshire. They had more lead than they could deal with much nearer the capital and ports, and their greater need was for tin, copper, and silver. In Anglo-Saxon days mines at Wirksworth were in possession of the Crown, or at any rate in that of a representative of the royal house of Mercia. Pilkington[1] quotes Dugdale's "Monasticon" to record that in A.D. 714, the Abbess of Repton (then the capital of Mercia) sent a coffin of lead to Croyland Abbey (founded 713) to bury a saint in, and that later (A.D. 835) the Abbess Kenewara gave to a notable the right to mines on certain conditions, which

[1] "A View of Derbyshire," 1792.

included the gift of so much lead to the church at Canterbury.

In Edward the Confessor's time the manors of Bakewell, Hope, and Ashford held from the king and "paid £30 and five cartloads of 50 sheets yearly; but in the time of the Conqueror it paid £12 6s. only." (They were first called manors in Edward's day.) The preceding extract is taken from the Domesday Book which records seven mines at various places in the Peak. Peveril's Castle at the Peak is said to have been roofed with lead (Pilkington). These meagre details represent almost all that is known or recorded of lead mining in Derbyshire up to the Norman conquest.

(To be continued.)

The I.M.M. Benevolent Fund

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

John Taylor and Sons	£50	0s.	0d.
J. A. Agnew	£10	10s.	0d.
H. E. Proprietary (New), Ltd.	£10	10s.	0d.
Transvaal Agency, Ltd.	£10	10s.	0d.
E. H. Clifford	£10	0s.	0d.
E. Hibbert	£10	0s.	0d.
R. Annan	£5	5s.	0d.
Johnson Matthey and Co., Ltd.	£5	5s.	0d.
G. W. Campion	£5	0s.	0d.
G. W. Gray	£5	0s.	0d.
H. C. Robson	£3	3s.	0d.
A. F. Strickland	£3	3s.	0d.
A. H. Higgins	£2	2s.	0d.
Edward Hooper	£2	2s.	0d.
H. K. Picard (additional)	£2	2s.	0d.
A. T. Roberts	£2	2s.	0d.
H. Brelick	£1	1s.	0d.
P. St. J. Dixon	£1	1s.	0d.
C. H. Feldtmann	£1	1s.	0d.
R. Rawdon Johnson	£1	1s.	0d.
A. A. Jones	£1	1s.	0d.
J. C. Stokoe	£1	1s.	0d.
Previously acknowledged	£427	10s.	0d.
Total	£570	10s.	0d.

LETTERS TO THE EDITOR

Gold in Kenya and Uganda

SIR,—May I be permitted to draw attention to some inaccuracies in the article in your May issue?

1.—Officers of the Geological Survey of Uganda have been lent to Kenya, for various purposes, on no less than four occasions, not only two.

2.—Uganda had two official geologists, not only one, in 1919—namely, Mr. Simmons and myself. At the present time the European staff of this office numbers four, but for purposes of "economy" it has to be reduced to two by 1934.

3.—When you speak of the Nile valley in East Madi I presume you mean West Madi, although traces of gold have been found in East Madi.

4.—I would not care to say that the occurrence of alluvial gold in the Kafu valley has been fully investigated. It has received good preliminary investigation.

5.—As to gold in the Kigezi district, nuggets weighing a good deal more than half a gramme have been found and it cannot be said, so far as our experience goes, that the gold is frequently accompanied by native copper, nor is the copper coating you speak of anything but rare. Copper has been found in one stream only and only in one pit in that stream.

E. J. WAYLAND.

Entebbe, June 14.

Practical Control of Malaria

SIR,—You will, I am sure, allow me space in which to record an appreciation of the course in this subject recently held at the Ross Institute. It was under the personal control of Sir Malcolm Watson, who is not only in the front rank as regards knowledge and experience of his subject, but is also a good lecturer.

The course was essentially practical; a dozen or more highly-instructive films were shown, and on the last morning those attending were put through a test in Richmond Park, in which all came through successfully, although it is doubtful if they would have done so without the preliminary training which had been given. The course was free, although the instruction was worth a fee of several guineas, and in addition literature was liberally distributed. No payment was asked for or expected, in spite of the fact that the work of the institute was carried on during the past year at a loss of £1,900.

The outstanding lesson of the course was that anti-malarial work brings about a great decrease in the incidence, not only of malaria, but of all other diseases. In view

of this fact and its general importance to all mining men the facilities afforded are deserving of wider appreciation.

FRANK YEATES.

London, July 18.

BOOK REVIEWS

A Manual of Determinative Mineralogy, with Tables. By J. VOLNEY LEWIS. Fourth Edition, revised by A. C. HAWKINS. Cloth, octavo, 230 pages. Price 18s. London: Chapman and Hall.

This is the fourth edition of Professor Volney Lewis' well-known book on the determination of minerals by means of their physical, optical, and chemical properties, revised by Professor Hawkins, of Rutgers University, New Brunswick. By omitting the repetition of descriptions of minerals in the different tables, which rather encumbered the earlier editions, Professor Hawkins has succeeded in reducing the size of the volume and in incorporating much additional information of great value. For some unexplained reason the chapter on optical methods, promised in the preface, occupies only a page and a half of descriptive matter, the remaining two pages being devoted to the usual optical data relating to transparent minerals. It is a serious omission these days, in a book dealing largely with ore minerals, to confine optical properties to transmitted light and to give no information about the examination of opaque minerals by reflected light.

WILLIAM R. JONES.

A Key to Mineral Groups, Species, and Varieties. By EDWARD S. SIMPSON. Cloth, octavo, 84 pages. Price 10s. 6d. London: Chapman and Hall.

The task of finding the most recent data regarding many minerals is becoming increasingly difficult, owing to the rapid progress in research, and the absence of compendiums of mineralogy of recent publication. Larsen's "Non-opaque Minerals," and Winchell's "Optical Mineralogy," two highly-prized works, are incomplete in some particulars and there has been the need of a rapid and simple means of ascertaining the latest information about the composition and chief properties of diagnostic value of new minerals, and the best source of detailed information regarding recent work on them in different countries. Dr. Simpson, mineralogist and analyst to the Government of Western Australia, is to be congratulated on the compilation of an extremely useful dictionary of minerals, which, at a glance, gives not only their composition, specific gravity, crystallographic system, and refractive index (indices in the case of anisotropic species), but gives also valuable references to recent publications on the various minerals. This information is clearly set out in columns and the mineral names are conveniently arranged in alphabetical order.

WILLIAM R. JONES.

Water Diviners and their Methods. By HENRI MAGER. Cloth, octavo, 308 pages, illustrated. Price 16s. London: G. Bell & Sons, Ltd.

The present work is an English translation of the fourth edition of Henri Mager's "Les Sourciers et leurs Procédés" the translation having been made by A. H. Bell. In it, in addition to discussing methods of water divining, past and present, and the men who have used them, Henri Mager advances his own explanation and in conclusion describes the methods of water location and analyses which he himself employs. As giving an illuminating account of the leading water diviners, both of the present day and of past times, together with a description of the methods used by them and of numerous successes claimed by them, the book cannot fail to be of the greatest interest to everyone, be he believer or sceptic. There can be no doubt about the fact that water divining is an art, which is based upon certain phenomena which actually occur. Whether the reader of this book will go all the way with the author in his explanation and interpretation of these phenomena is entirely another matter, and is one which must be left to each individual. Be this as it may, the book is an interesting account of water diviners, their methods and beliefs, and if it is read as such, and not as a scientific explanation of water divination, it will be found to be of absorbing interest.

MURRAY STUART.

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

NEWS LETTERS

BRISBANE

June 22.

Mount Isa.—It is expected the construction work which has been going on at Mount Isa will reach completion by the end of July, and that with it the lead production will be increased from 3,500 to 5,000 tons a month. Mount Isa lead, it is stated, continues to be well received on the London market and all the output of the mine is being disposed of with the price stationary. The apex of output at Mount Isa since production began twelve months ago has just been reached, when for the seven days ended June 11 a quantity of 1,018 tons of lead bullion was recovered from 10,758 tons of crude ore. In the same week 880 tons of bullion was sent to Townsville for shipment to England. The third furnace is now ready, and work is proceeding with the installation of the new sintering machinery and a new unit to the Cottrell plant. The underground work in May embraced the continued operation regularly of the seven glory-holes on the Black Star section. From this lode hitherto only carbonates have been mined, but plans have now been prepared for the development of the sulphide ore-bodies at a greater depth. In the Black Rock section cut-and-fill stoping is in progress at the main lode stope on No. 2 level. The development work that was being carried out to the south on the sub-level, after having proved high-grade carbonate ore, has been stopped at E 24 winze. A west cross-cut from the winze at 132 ft. above No. 4 level confirmed ore expectations at the point reached. Preparations are being made to develop the southern section. In the Rio Grande section the middle lode stope was operated continuously during the month. Both from the surface and from underground, diamond drilling was continued. Crystallena No. 1 bore-hole is now at a depth of 513 ft. In the underground drilling a vertical hole is being put down from G 23 west cross-cut, to intersect the Rio Grande lode at a point 150 ft. below No. 4 level. Mr. H. A. Guess, vice-chairman of the Mining Trust, Ltd., interviewed at Mount Isa, said it is hoped that the Queensland Government can see its way clear at this critical juncture to ease substantially, through its railway freight rates, the burden of expenses for Mount Isa. He added that, with lead at the lowest price in history, Mount Isa is making a splendid fight to keep going, and to keep employment for its 1,200 or more workmen, even though each month the price received for its lead and silver is substantially less than the bare cost of operation, without regard to the interest on debentures. Of the mine's expenses, 40% are for rail and ocean freights.

Mount Wandoo.—A report on the recently discovered Mount Wandoo gold mine on a lease in North Queensland held in the name of Mr. Alexander Macdonald, has been furnished to the State Department of Mines by one of the Government Geological Survey staff (Mr. J. H. Reid). The report is dated April 7, but has only just been published. Four shafts have been sunk on the lease, but from the point of view of work done and development of gold values, easily the most important is the Hardman or main shaft. The mine is in an area of shattered gneiss, with auriferous veins, which extends for a length of 14 chains, with an undetermined width. The official report from the mine for May states that 12 men are now employed, chiefly on surface construction work. Development operations are being continued this month (June) in the Hardman and Wendy shafts.

Mount Coolon.—Work at the mines of the Mount Coolon Gold Mines, N.L., a British company operating at Mount Coolon, Queensland, was suspended some two or three weeks ago owing to a strike, which has since been settled. The cause of the strike was the refusal of the men to work single-handed the S49 type of air drill, demanding that a second man should be employed on each machine. The manager of the company states that this class of drill is light, is designed for single-handed work, and was only to be used at Mount Coolon when conditions were favourable.

Mount Morgan.—In the proposal for the working of the Mount Morgan mine, Queensland, on a larger scale, with assistance from the Federal Government, a decision has just been reached. The request of the company for an advance was submitted to a Commonwealth Industry, Mining and Works Sub-Committee, and a report has been obtained from Mr. H. W. Gepp, Consultant on Development to the Federal Government. The State Employment Council instituted by the Commonwealth Government has now recommended that an advance be granted of £15,000, chiefly

for experimental work on lines recommended by Mr. Gepp; and that the question of the granting of further advances (if any) be considered from time to time, based on progress reports and recommendations. These proposals mean the employment at an early date of 100 men, and it is hoped later of several hundred. Mr. Gepp, in his report, says the justification of his investigations at Mount Morgan is that recent experimental work has indicated a possibility of concentrating a considerable portion of copper and gold values into a small percentage of ore compared with the results from the original flotation process.

Great Boulder Find.—The company's office, in London, of the Great Boulder Company, Kalgoorlie, Western Australia, has already been advised of the piercing, by diamond drilling, of a rich lode, 27 ft. in width, with most promising indications. Additional particulars, supplied here by the manager (Mr. J. Warrick), show that the geological indications are most favourable, and that there is no apparent reason why the lode should not continue to a great depth. Being on the eastern side of the Great Boulder property, there is no danger of its coming into contact, as depth is attained, with the felsite porphyry dyke, which runs from south to north. The main lode, in its northern continuation, penetrated the dyke, and for some distance was embedded into it, but as the dyke had a westerly dip and the lode was running obliquely into it, it was thrown westerly, and in its downward pitch south passed into the Horseshoe Company's property below the 2,650-ft. level.

Broken Hill Block 14.—Resolutions for the reconstruction of the Broken Hill Proprietary Block 14 Company have been unanimously carried at an adjourned meeting of the company, held in Melbourne. Mr. F. G. White, who represented a large number of preference shareholders living at Broken Hill, announced that he had been authorized to say that rather than wreck the plan of reconstruction, the preference shareholders would support the original proposal, and would not persist in their opposition on the ground that they were not being treated fairly because of the existence of accrued dividends amounting to £15,000.

New Zealand Coal Strike.—According to advices from Wellington, New Zealand, the coal mines in the Waikato district, as well as those on the West Coast, are idle as a result of a strike on the part of the miners. The sole question at issue is the right insisted on by the owners that they shall engage or discharge miners at their own discretion—a right which the owners say is exercised by every other employer in New Zealand, but denied to the mine owners by the miners organization.

New Guinea Gold.—Passengers by a steamer which recently arrived in Brisbane from New Guinea and Papua report that the gold dredge which a short time ago was put into operation at Bulolo is recovering 2,000 oz. of gold a week, and that two more dredges will be erected at Butawat, at the junction of the Bulolo and Watut rivers, New Guinea. At Edie Creek, on the Bulolo field, a mine named the Daydawn, owned by a Sydney company, is yielding 2 oz. of gold to the ton, while the mill crushes 50 tons a day. The crushing plant is to be duplicated.

JOHANNESBURG

July 7.

Central Rand.—Giving evidence before the Union Parliament's Select Committee on the Gold Standard, Mr. P. M. Anderson, Manager of the Union Corporation, Ltd., stated that on the Central Rand the mining industry was getting beyond the economic range of the existing vertical shafts, and that unless at an early date it put down another row of deeper vertical shafts right from the East Rand Proprietary to Roodepoort, this ore would be lost. He saw no prospect of obtaining the capital for this purpose under existing conditions. Had the Union Government not clung to its gold standard policy the premium resulting from the sale of the output of the mines in devalued currency would have enabled the mining companies to contemplate the early commencement of work in connexion with these new super-verticals. It is understood that seven such shafts have been contemplated.

Low-Grade Ore Report.—It is understood that the report of the Low Grade Ore Commission has not yet been considered by the Cabinet and it is not likely that any action will be taken regarding it until after the return of Mr. A. P. J. Fourie, Minister of Mines and Industries, from the Ottawa Conference. Meanwhile the executive of the South African Mine Workers' Union will prepare a reply to the majority

report of the Commission. The report says that the workers will sooner or later be faced with the alternative of lower wages or no work.

Natal's Small Gold Propositions.—A mining engineer who is inspecting gold properties in Natal states that there are small gold propositions, which are well worth working by the small man. They are situated where there is an ample and cheap supply of native labour and there is also a good water supply adjacent. Many of these properties could be equipped with a plant and production commenced right away. The engineer considers that a 5 dwt. recovery from these small mines, having regard to the cheapness of the labour and other favourable working conditions, will yield a satisfactory return on the investment, so long as the right man tackles the job and is not afraid to work himself. His idea is to secure these properties, in many cases on a royalty basis, and lease them to the small men, at the same time giving them the benefit of any technical direction required.

Vlakfontein.—It is stated that the Union Corporation's work on the Lydenburg Gold Farms Company's farm Vlakfontein No. 21, in the Far East Rand has had three results. The first is that it has proved the presence of the Main Reef Series and Kimberley Reef Series on the farm at no great depth. The second is that it has shown the Main Reef Series to lie almost flat ; and the third is to indicate that the line of the sub-outcrop of the Main Reef series is considerably further east than shown by Dr. Mellor on his geological map of the Far East Rand. Work on the adjoining Marievale Nigel ground has also begun, and prospecting will be carried out by means of short bore-holes. The Union Corporation option on the latter property does not expire till 1935, by which time the value of the ground will have been thoroughly tested.

Africanadian Mines, Ltd. — Africanadian Mines, Ltd., has been placed in voluntary liquidation. The company was registered at Pretoria on March 11 last for the purpose of investigating certain gold discoveries in Namaqualand. It is understood that prospecting operations yielded very disappointing results. The company had a capital of £300,000 and was supported by ample financial resources in Canada.

Far East Rand.—Official information has now been published in connexion with a scheme for the opening up of a virgin area nearly 9,000 claims in extent, including large blocks of Government ground, lying between the Daggafontein Mines and Sub Nigel properties on the Far East Rand. No mining difficulties as far as depth is concerned are anticipated on any of the new propositions. Nothing definite can be said with regard to values, but results of work on the Daggafontein Mines and the Sub Nigel, and the geological evidence, justify the belief that the Vogelstruisbult Gold Mining Areas and the East Daggafontein should develop into profitable enterprises in the course of the next few years, and complete the continuous chain of gold mines extending from Randfontein in the west to Sub Nigel in the east.

Far West Rand Prospects.—For some months past the geologists and engineers of the New Consolidated Gold Fields have been engaged on the correlation of the reefs on the Western Areas property (formerly known as the Western Rand Estates), and it is believed that when the result of their researches is published it will reveal very interesting facts regarding Far West Rand geology. Drilling is proceeding on Venterspost, one of the Western Areas farms and if this gives confirmation to the very encouraging results obtained by the previous owners of the property some 30 years ago and establishes the theories on which the geologists are now working, it is possible that several large gold mines will be established on the western extension of the Reef.

Aerial Survey of the Rand.—Arrangements are being made for the carrying out of a complete aerial survey of the present activities and future prospects of the Witwatersrand mining industry. It is hoped that the survey will enable authorities to solve a number of geological riddles, including many points connected with the so-called Boksburg Gap and other occurrences of vast potential importance to the goldfields. The programme will, if carried out as at present contemplated, cover more than 600 square miles of country, from Springs to Randfontein in and possibly beyond. In this way it is expected to obtain an entirely new insight into the geological peculiarities of the Witwatersrand, and to establish links between formations in broken country, as also runs of reef in localities which have hitherto escaped the prospector's eye.

IPOH

July 13.

Industrial Adjustment. — Since the beginning of this month miners have been adjusting their work to suit the new conditions resulting from the recent further restriction of output and among the problems arising is that of the disposal of Chinese labour surplus to the total that can be usefully employed on the mines during the next twelve months. On State land, in many places, especially among the foothills near the valleys and lower slopes where mining has been or is still in progress, the secondary bush has been cleared and considerable areas prepared for cultivation of hill-rice and other food crops. So far as it goes this is an excellent solution of the difficulty, but it naturally has attracted those who have lived and worked near the hills, and where unalienated land is available, but does not yet suffice to meet the needs of or to attract discharged labour from the more closely occupied portions of the mining field. The Chinese Protectorate has again been besieged by crowds of labourers asking for repatriation. While many have applied on their own initiative, a majority have been sent by mine owners and managers, both Chinese and European, who state they cannot provide work. The F.M.S. Government has already intimated that repatriation will only be approved to genuine decrepits, unemployables, and to such others as can prove they are so situated as to be unable to find employment or to pay their own fares. The widespread distress in China itself does not yet greatly affect the districts in the provinces of Kwang-Tung and Fu-Kien from which most of the Chinese here have come, and if they are able to take even a few Straits dollars with them they benefit by a favourable rate of exchange. The considerable exodus of labour in and after August of last year consisted chiefly of mine workers; but the present claimants of repatriation include an important proportion of others among whom are many who hitherto made a living by planting vegetables for sale in markets where miners took an important share of the produce. The impoverished condition of the mine employees has reacted upon the vegetable growers so that many of that class have been among recent applicants for repatriation. The following are the numbers, approximately, of Chinese repatriated since April 1 of this year from the State of Perak, excluding children :—

	April 1 to June 30.	*Estimate for July.*
Chinese male labourers	7,780	
„ women „	570	
Total Perak only	8,350	3,000
Selangor	4,000 (approx. only). (Nearly all from Selangor.)	
Other States		

The Government have to finance all these approved repatriations, of which the total cost amounts to a very considerable sum. The above figures also serve to indicate what would have been some of the consequences in this country of a general closing down of mines as proposed in the original Byrne scheme.

Labour.—The loss of acclimatized and locally experienced labour is a very serious matter for the mining industry here and every effort should be made to keep those temporarily unemployed available for the time when all good labour will again be required. A real shortage of Chinese labour would result in a serious rise in working costs. It must also be remembered that legislation is proposed to enable a tax to be collected from all aliens coming into these States, and if the mining field became short of labour the mines might have to organize recruiting and to provide cost of transport of labour from China. The mines would then have to finance the whole costs of recruiting, transport, and the tax payable on landing. On the other hand the Federal Council on July 6 approved a resolution for special provision of $230,000 (Straits) towards the cost of repatriation of Chinese up to the end of the current month after which further provision might have to be asked for.

Grouping.—In the Federal Council on July 4 the following particulars were given in reply to a question as to how many mines grouped under the Tin and Tin ore (Restriction) Enactment 1931 had now absolutely ceased mining operations :—

	Chinese Mines.	*Mines Worked by Dredges.*
Perak	16	11
Selangor	13	8
Negri Sembilan	2	1
Total F.M.S.	31	20

As the question specified Chinese mines and did not mention European-owned open-cast mines, of which some are known to have closed down on grouping, it appears that the above total is not complete for all open-cast and hydraulic mines. During

the first six months after restriction came into effect the policy of the Government with regard to grouping was very fair and reasonable. It was never intended that grouping should be so used as to enable mines to be shut down and labour to be discharged which would otherwise have been kept working. The formation of very large groups or pools under the control, as to their output, of a few individuals, tends to facilitate closing down and discharge of labour in order to permit the whole group quota to be very profitably produced by a few of the mines in the group; and it is obvious that in such organizations it must be profitable to shut down as many as show only a small margin of profit in order to make a bigger margin by producing only at a few cheaply-worked centres. This policy does not tend to the production of a smaller total of ore for export, but it does tend to increase the proportion of labour discharged, and to restrict local expenditure, while the profits go into the pockets of the few who control the cheaply-worked units. All reasonable and proper purposes of grouping would probably be served by fixing a maximum of say ten units in any one group with sufficient discretion left to the Warden of Mines in each State. In view of rather loosely-expressed promises as to grouping facilities made to the Chinese when their agreement was sought in connexion with the proposed reduction of quotas, which is now effective, it may be more difficult than before to regulate the formation of groups including a large number of units. Some further regulation seems also to be required in connexion with the disposal of ore won by holders of " dulang " passes to prevent their being used in collusion with ore buyers for sale of stolen ore.

Assessment Committees.—When originally appointed it could not have been foreseen that the period would run into years during which the services of unofficial members of assessment committees would be required. It now seems desirable that the mining communities as represented by the Chamber of Mines and other similar organizations should have an opportunity at least once a year of proposing to the government who the unofficial members of the assessment committees should be for the next twelve months and that no unofficial member should be appointed for two consecutive periods.

Gold in Pahang.—Individual licences for prospecting and mining for gold in Pahang have been issued since 1929 for certain specified areas in the districts of Lipis, Raub, and Bentong. Most of the known gold-bearing areas, excluding river beds, are covered by prospecting licences and permits. In the river systems many people are employed washing with the wooden pan, or " dulang," with which they are skilled.

Workmen's Compensation Enactment.—The original enactment was passed in 1929 for the F.M.S., but was not brought into force pending the passing of a similar law in the Colony of the Straits Settlements. In the Federal Council Meeting on July 4 representatives of planters and miners expressed general agreement with the principle of the Bill, as now amended, to come into line with the law in the Colony, but requested postponement of its application in the interests both of labourers and of employers of labour. The Governor said there had been communications from the Secretary of State for the Colonies on the subject and the enactment could not any longer be postponed.

Decentralization.—The necessity for retention of the Senior Warden of Mines in an executive capacity while restriction remains in force has been acknowledged on behalf of the Government, and in the recent Federal Council meeting the complete agreement in this of the mining industry was recorded; but highly representative opinion was also expressed that an executive head of the Mines Department will continue to be essential, after the termination of restriction, for many important duties including co-ordination of the various interpretations and consequent rulings of individual Wardens on matters of great technical and practical consequence. The recent negotiations in connexion with restriction have also shown the great value to the mining industry of access to the Chief Secretary to Government at Kuala Lumpur as the representative of the Governor. In all matters gravely affecting the mining industry the presence of a responsible senior officer of the Malayan civil service as Chief Secretary is very highly advantageous and has recently as well as on former occasions made it possible to reach a satisfactory arrangement in difficult negotiations. An important point is that the Chief Secretary should always be an officer of the Malayan civil service with intimate knowledge of conditions in the Federated and Unfederated States.

Communications.—On June 29 His Highness the Sultan Iskandar Shah, of Perak, opened the newly completed bridge across the Perak River. Its importance to every section of the community was well proved when the 29-ft. flood of last December swept away the old pontoon bridge, and reached within about one foot of the top of the piers of the new bridge, with the result that direct communication by road from Ipoh and the South to Taiping and Penang was cut for many months.

Siam.—So far as is yet known the recent revolutionary changes in the Government do not injuriously affect the rights of foreigners interested in mining in that country. On the contrary the tendency seems to be towards increasing business activity generally.

VANCOUVER

July 9.

Bridge River.—At the general meeting of Bridge River Consolidated Mines, Ltd., held recently in Vancouver, the president of the company gave an account of the work that has been done on the property during the past year and of the ore occurrences generally. The company holds a number of claims on the lower reaches of Cadwallader Creek, covering a section of the augite-diorite formation, below the Lorne property. Of these claims, the Why Not and Forty Thieves are old locations on which quartz veins outcrop in a narrow tongue of the intrusive along the sides of a precipitous bluff. A considerable amount of prospecting work was done on these outcrops in the early days of the camp and some high assays in gold were obtained. A little tunnelling work was also attempted. During the past year development work was carried on by a syndicate headed by Col. Victor Spencer, who is interested largely in both the Pioneer and Lorne properties, under an option to purchase that embraced ambitious provisions for expansion. It was reported that a sum of $15,000 was expended on tunnelling work devoted to exploring the two principal veins at depth, but in neither case was any economic result achieved. Col. H. H. Yuill was retained by the company to report upon the work and found that in the case of the Forty Thieves vein it appeared probable that the driving had been done in the foot-wall country along parallel fracturing and that in the case of the Why Not vein some cross-cutting might be advisable also. A large part of the president's report embodied a re-iteration of the attractive features of the surface showings, but it appears that the prospects have not been improved as a result of the recent work. A considerable portion of the holdings of the company covers areas underlain by sedimentary formations in which quartz veins occur, but as described in official reports the known economic importance of this district is definitely confined to the intrusive formation. A party of prospectors has returned from Eldorado Creek, north of the Bridge River area, and reports that placer gold has been found along its entire length. The creek flows into Gunn Creek, a tributary of Bridge River, and heads in a basin flanked by hills on which several gold-bearing veins of arsenopyrite outcrop. An iron-stained weathered surface deposit extending to a depth of about 6 ft. covers a definitely localized area on one of these hills and carries a gold content derived from this system of veins. This occurrence is responsible probably for the placer gold in the creek.

Lillooet.—It is reported that Kamorley Oils, Ltd., a company with extra provincial rights, with headquarters at Kamloops and owning oil lands in the Turner Valley, has secured an option on the Gold King Group in the Pemberton area. A heavily mineralized shear zone about 11 ft. wide has been prospected by means of open-cuts and shallow workings and certain gold values are stated to have been encountered below a capping of pyrrhotite. These values are associated with lead and zinc sulphides in a quartz gangue. The company has let a contract to a Vancouver firm for diamond drilling and it is understood that the occurrence will be tested systematically at depth under technical supervision.

Portland Canal.—A carload of high-grade silver-lead ore had been made from the Silverado mine. This property is controlled by Premier Gold Mines, Ltd., Development by the company was suspended two years ago following the drop in the market price of silver. Shoots and pockets of high-grade ore occur in this mine, as on the Prosperity and Porter Idaho properties in the same area, and offer good opportunities for leasing operations. A section of the shareholders in Woodbine Gold Mines has instigated an official inquiry into the affairs and management of the company. The

property, adjoining that of Premier Gold Mines Ltd., covers mineralized porphyry zones of a similar character to those of the latter company's mine, and affords excellent opportunities for development. Some ten or twelve years ago, reports were circulated of valuable ore-shoots having been developed, but subsequent examination by independent engineers proved this to be incorrect, and further work has failed to disclose values.

Omenica.—The business population of Smithers has combined to form Jessie Gold Mines, Ltd., with the object of carrying on the development of the Jessie property near the town, on Hudson Bay Mountain. W. G. Norrie, of Vancouver, has been retained to direct the work and it is understood that he is making a thorough examination of the workings. Three veins of gold-bearing arsenopyrite occur on the property and are being developed from a tunnel on one of them that will afford backs of over 400 ft.

Boundary.—Hecla Mining Company, of Wallace, Idaho, has secured an option on the Homestake claim in the Franklin Camp, and is commencing an active programme of diamond drilling and exploration work. The company has been operating the Union mine in the same camp, from which a shipment of phenomenally rich gold ore was made last autumn. The development of this property has been attended by considerable difficulties connected with the lack of outcrops and conditions of faulting and, so far, no repetition of the exceptionally rich ore has been encountered. The company is also exploring the contiguous Maple Leaf claim, on which, in addition to high-grade copper deposits, platinum values have been recorded in a pyroxenite formation. On the Homestake claim, situated at a distance of about 3,000 ft. from the Union workings and more or less in line with the direction of the east–west zone of mineralization, a number of shallow shafts and open-cuts had exposed mineralization of the same character as that in the Union mine and apparently related to a similar favourable condition of faulting. One of these shafts was cleaned out by the owner last year and some ore assaying over $500 per ton was exposed. Subsequent work is said to have resulted in opening up a vein about 4 ft. wide having high gold values. In connexion with this discovery the Government mining engineer states that it is evident that the character of the ore and the uneven distribution of values resemble the Union ore deposition. Hecla Mining Company is leaving no stone unturned in the thorough exploration of this camp for gold values. Encouraging developments are reported on the Gold Drop-North Star group in the Jewel camp which is under option to a Penticton syndicate. These claims lie at a little distance from the Jewel mine and cover extensions of the same series of gold-quartz veins that cut the schist and granite formations. In a tunnel that is being driven, two shoots of high-grade ore have been encountered 30 and 40 ft. long upon which stopes have been started. Good values are being encountered in opening up the vein on the C.O.D. claim in the Jewel camp near Greenwood. The vein lies entirely in the granite and on this account the results of its development are being watched with particular interest, as opinions have been expressed by engineers that the better prospects of the camp are in relation to the fissuring in this formation. In the workings of the Jewel mine, it was found that the vein was less defined and of lower grade where it traversed the schist, and it is believed that this mine still offers opportunities for more extensive lateral and depth development. With the satisfactory results that are being achieved on the adjoining properties, it is expected that work will be resumed on the Jewel, which is now held by the Dentonia Company of Calgary under an option calling for certain payments that are being met as they become due. Low-level developments at the Wellington mine in the Beaverdell camp have resulted in picking up the shoot of high-grade silver-lead ore at a depth of 100 ft. below the adit workings. This work was carried out from an interior shaft and it is understood that a largely increased production is indicated by the reserves of ore that have been outlined. Heavier equipment is being installed. The mine has been a steady shipper of high-grade ore in carload lots.

Lardeau.—Reports have been circulated of the discovery of an occurrence of placer gold in an ancient lake area on Lardeau Creek. Preparations are said to be under way for the washing of this ground by Ganor Creek Gold Washing Syndicate.

Hedley.—It is understood that representatives of United States interests are investigating the Nickel Plate and adjoining properties at Hedley with a view to re-opening the mine and enlarging the field

of operations. This has been a one-mine camp, it having been found that the irregular sheet-like deposits of gold-bearing arsenopyrite were confined to certain strata and structural conditions occurring on the Nickel Plate property, although several other orebodies of promising appearance at and near surface are found on adjoining claims.

Clinton.—E. J. Taylor, who made the original discovery of gold on the Windfall claim in the Whitewater Camp, has succeeded in making a discovery, which is thought to be of importance in regard to affording an explanation of this unusual occurrence. The gold was found in a surface deposit described by V. Dolmage in 1925 as occurring over an area of a few hundred square feet in eluvial iron-stained clayey material from one to two feet thick, and in a tourmaline vein about three inches wide in which cavities formed by the removal of pyrite were filled with limonite containing surprisingly large amounts of coarse cellular gold. These occurrences lent themselves readily to panning work and Mr. Taylor has won considerable amounts of gold every year in this way while continuing to prospect the ground. The property was bonded by a Vancouver company and tunnels were driven some 8 years ago which failed to encounter any trace of the continuation of the vein in depth. Recent work has resulted in tracing the vein occurrence on surface for some considerable distance in another direction, with free gold showing in the tourmaline. In the same area, there is a notable amount of copper-gold mineralization in shear zones in an altered quartz-diorite. Good assay values in gold have been obtained from the oxidized surface material of these zones, but underground development carried on three or four years ago by Consolidated Mining and Smelting Company failed to prove values of sufficient importance to offset the handicaps of inaccessibility.

Sheep Creek.—The progress of the work of construction of the aerial ropeway from the Reno mine to the Motherlode mill has been delayed by the heavy snow conditions, but it is reported that arrangements for the conduct of this work under contract are now under way and that the reconditioning of the mill is well advanced. It is stated also that developments on the No. 5 level of the Reno mine are entirely satisfactory and that drive and rise headings are both in ore. Ore reserves are estimated to be more than adequate for the supply of the 100-ton mill at capacity.

Coast.—Samples of carnotite ore from Quadra Island that have been submitted for examination and analysis to the University of British Columbia are reported to have shown a high content of uranium and vanadium pentoxide. Professor W. F. Seyer of the University is reported as saying that samples of the surrounding rock also evidenced radio-activity and that the results of the testing work warrant fully a close examination of this radium-bearing occurrence. It is understood that a detailed investigation is to be made by Professor Seyer. Samples have been submitted also to Ottawa and the Washington University.

TORONTO

July 18.

Gold Production of Canada.—A new high record for the production of gold in Canada was established in 1931, the output amounting to 2,693,892 oz., valued at $55,687,688, as compared with the production of the previous year of 2,102,068 oz., valued at $43,453,601. This for the second time makes Canada the second largest gold producing country in the world. Gold is now Canada's most valuable mineral output, surpassing coal which headed the list for many years. The Ontario Department of Mines reports that the output of gold for June amounted to $4,179,045 as compared with $4,079,045 for the preceding month. The production for the six months ending June was valued at $23,205,663, as against $20,402,080, for the corresponding six months of 1931.

Porcupine.—The eight producing mines of this area during June yielded bullion to the value of $1,864,913 from the treatment of 275,075 tons of ore, as compared with $1,810,009 from 285,759 tons of ore in May. The mill of the Hollinger Consolidated is now treating about 5,000 tons of ore per day, the open-cut surface deposits now receiving attention as a source of mill feed. Underground development is being pushed on a large scale, and the company is doing better than keeping pace with consumption in opening up new ore, some sections showing improved ore values. During the first six months of the year the value of the gold and silver produced was $5,558,507, as compared with $4,862,827, for the corresponding period of 1931.

Expenses were $3,652,276, leaving a profit of $369,433. Dome Mines for the month of June is reported to have produced bullion to the value of $382,850, as against the high record for May of $411,201. On the 13th level ore has been opened up averaging about $9 per ton, with occasional pockets of higher grade. The mill is now treating 1,500 tons of ore per day. The McIntyre has laid out a programme of deep development and will sink a four-compartment winze to a depth of 6,700 ft., with the object of following the downward continuation of a large body of quartz located on the 3,750-ft. level. The new development will also open up the downward extension of Number 22 vein known to persist down to 4,300 ft. Vipond Consolidated continues its search for new ore-bodies, but so far has met with comparatively little success. The company is maintaining its programme of development on the 1,450-ft. level and is pushing on into the old Porcupine Crown territory. The Coniaurum has declared a dividend of 3 cents a share. The mine supplied an exceptionally high grade of ore for six or seven months and although the grade has been lower recently profits have continued at a good rate. Exploration of the upper levels where little work has been previously carried out is now under way. The Canusa Mining and Exploration Company, Ltd., has been re-organized under the name of the Canusa Gold Mines, Ltd., and the capital reduced from $3,000,000 to $1,500,000. Work will shortly be resumed on the property, on which there is a 50-ton mill and it is intended to start production without delay.

Kirkland Lake.—Bullion was produced by six mines of this field during June to the value of $2,152,718, from the 147,781 tons of ore handled, compared with $2,104,157, from 149,188 tons, for the preceding month. The mill of the Lake Shore is maintaining a daily rate of between 2,300 and 2,400 tons of ore. Excellent progress is being made in opening a series of new levels between 2,900 and 3,950 ft. The No. 1 shaft is now approaching the 3,700-ft. level. The main vein has been proven to 3,575 ft., and in the next two weeks it is expected that two veins will be cut at 3,700 ft. Wright-Hargreaves is obtaining good results from development work on the 2,400- and 3,000-ft. levels. During May some 900 ft. of driving was done in ore averaging $17·73 to the ton in gold. Improved ore conditions are reported on the upper levels, steady progress being made with the new central shaft, and when it is completed development work will be increased to step up mill production. An improvement in the grade of the ore going to the mill of the Teck-Hughes has resulted in increased production. The output for April was the best showing the mine has made, exchange premium bringing the amount up to $639,000. Production for May was slightly less. Lateral work has been started on the 36th level, and the winze is below that horizon. At the Sylvanite the two new levels at 2,500, and 3,000 ft. are producing a better grade of ore than that obtained on the upper levels. A cross-cut is being driven from the bottom level with the object of intersecting a new parallel vein indicated by diamond drilling. The Kirkland Gold Belt, located in the eastern section of the camp, is pushing work on the 125-ft. level and opening up good ore values. The average grade over the 90 ft. opened up is stated to be $18 per ton.

Other Ontario Gold Fields.—In the Michipicoten area the Holdsworth property of the Soo Mining and Prospecting Syndicate has gone into production on a small scale and will make shipment at regular intervals. The New Goudreau Gold Mines, Ltd., operating the old Goudreau gold property, have installed a 10-ton mill, which will shortly be put in operation. The Howey in the Patricia district shows steady improvement in gold production, the output for the first six months of the year amounting to $680,000, as compared with $913,000 for the whole of 1931. A winze put down from the 1,000-ft. level has encountered good ore and two new levels will be opened up.

Sudbury.—Mining activity in this area has been hampered by inadequate supplies of power and in order to meet the deficiency the Ontario Power Service Company undertook the development of the Abitibi Canyon site capable of generating 275,000 h.p. after spending about $16,000,000. The company was forced to abandon construction work on account of financial difficulties and in view of the importance of the undertaking to the mining and other industrial interests in Northern Ontario, the Provincial Government is arranging to take over and complete the work if it makes satisfactory terms with the company. The Falconbridge Nickel company is proceeding with its preparations

for its programme of back-filling portions of the mine from which the ore has been removed. A rise has been completed from the 350-ft. to the 225-ft. level, and a comparatively small amount of sinking will be necessary to connect the stopes in this area with the surface. Production is steadily maintained, contracts signed last year assuring the company of a market for at least a year. International Nickel has ceased to market its copper output through Copper Exporters Inc. of New York.

North-Western Quebec.—The Noranda, which found its business with the United States adversely effected by the American tariff on copper, has been successful in obtaining new markets for its output. Production is being steadily maintained, the company having contracts for all the copper it can produce this year. The recovery of gold continues to increase, the yearly rate of production being officially estimated at $7,000,000. The ore reserves have been increased by the discovery of new gold ore-bodies, the total value of gold in sight or indicated being approximately given as $85,000,000. The Granada gold mine has installed a new electric hoist and the work interfered to some extent with production, the June output being valued at approximately $32,000, as compared with $35,000 in April. The new cyanide mill is working satisfactorily, greatly facilitating recovery, The workings have been carried to a depth of 1,075 ft. and new levels will be opened up. Siscoe Gold Mines, Ltd., reports bullion production for June of a value of $71,037, compared with $77,860 for May, the decline being due to the lower grade of ore treated. The company is preparing to increase its power plant equipment with a view of operating on a more extensive scale, including the opening up of two new levels. The Sullivan Mines is installing new equipment and will carry out an active development programme, being encouraged by the good results obtained on the adjoining Siscoe property. The Pandora in the Cadillac district is pushing development, and good values have been opened up on the 250-ft. level. The shaft will be put down to a depth of 500 ft. The Treadwell Yukon has made rapid progress in developing its property in the Pascalis district with a view to early production.

Manitoba.—The Hudson Bay Mining and Smelting Company is operating its smelter at capacity handling over 3,000 tons of ore per day, the gold content of the ore enabling the company to make a profit on production. Mining operations are being increased and new ore is being opened up which shows a slightly higher grade in both copper and gold. The Sherritt-Gordon mines suspended operations on June 15 and work will not be resumed so long as copper remains at present low price.

PERSONAL

Charles A. Banks has left for British Columbia.

H. R. Borner has returned to Germany from Russia.

Nigel C. Cooke is home from Nigeria.

James A. Faull is returning from Algeria.

W. T. Harry has left for Canada.

L. J. R. Hawkey has left for West Africa.

E. Littleton Hay is returning from Burma.

A. S. Howie is home from Yugoslavia.

R. J. Lemmon is proceeding to South America.

H. R. Mackilligan is returning from Nigeria.

E. T. Mellor is here from South Africa.

James P. Norrie has left for the Argentine.

Alfred Otter has left for West Africa.

F. W. Payne has returned from New Zealand.

Harold Roberts is returning from Nigeria.

James Roberts is returning to Italy.

W. H. Trewartha-James has left for Alaska.

A. H. E. Turner is returning from the Gold Coast.

Vernon Turner has left for Kenya.

K. S. Twitchell was here on his return to New York from Arabia.

W. J. Wilson is now in Nigeria.

Ralph Anderson died at Kalgoorlie on July 14. Mr. Anderson, who was underground manager of the Lake View and Star Mines, was the author of the article on that company's properties which appeared in last month's issue.

James Andrew Shepard died on July 13 in Northern Rhodesia at the age of 44. Mr. Shepard, who was assistant general manager of the Roan Antelope copper mine, had formerly been with the Phelps Dodge Corporation, at their Copper Queen branch at Bisbee, Arizona, where he was general superintendent, in succession to Mr. D. D. Irwin. Prior to this he had served with a number of public utility companies in the States and also for a time with the Detroit Copper Mining Co., at Morenci.

Ross Kenneth Macartney died on August 2, at the age of 60. He was a graduate of Melbourne University, of which he was M.M.E. and B.C.E., and a Member of the Institution of Mining and Metallurgy, and successively held the position of metallurgist to the Tasmanian Gold Mining Co., general manager of Crowl Creek and Shuttleton copper mine, and engineer and acting general manager of the Mount Bischoff tin mine. Coming to England in 1912, he became general manager first of the Cornwall Tailings Co. and later of the Carnon Valley venture, subsequently taking over the management of the Rhodesia Broken Hill, a position he held for about eight years. In 1927 he investigated some tin properties in the Tavoy district and was later appointed technical adviser to the Consolidated Tin Mines of Burma, of which he was also a director.

TRADE PARAGRAPHS

G. D. Peters and Co., Ltd., of Slough, announce that they have received an order from the Iraq Petroleum Co., Ltd., for 14 Wilson "S" type portable petrol driven electric arc-welding plants for use on the construction of their pipe-line in Iraq.

Belliss and Morcom, Ltd., of Ledsam Street Works, Birmingham, write to point out that the reference to their air-compressors in the article describing the Lake View and Star Mines in the July issue contained a misstatement in that the capacity was given as 200 cu. ft. per min. when in fact it should have been 2,000 cu. ft. per min.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, in their *Edgar Allen News* for July have a further description of McCully gyratory crushers, which they are manufacturing under licence from the Allis-Chalmers Manufacturing Co., of Milwaukee, and also further reference to their centrifugal vibrating screens already described in these columns.

Ruston-Bucyrus, Ltd., of Lincoln, have issued a catalogue describing their range of excavators which are manufactured at Lincoln. These include the No. 4 ¾ yard, the No. 21-B ¾ yard, the 32-B 1 yard, 37-B 1¼ yard, 43-B 1¾ yard, and the 52-B 2¼ yard, all types being convertible for use as shovels, draglines, cranes, grabbing cranes, while the smaller types may also be used as skimmers.

Hadfields, Ltd., of East Hecla and Hecla Works, Sheffield, issue a leaflet describing their improved nickel-chromium-molybdenum steel for steam-pipe flange bolts, which fulfils the mechanical requirements of the B.E.S.A. and the composition of which is the outcome of a considerable amount of research work undertaken with a view to overcoming a serious defect in the usual steels of this composition, namely, embrittlement under working conditions.

Bell and Smart, Ltd., of 48–50, Tottenham Street, London, W. 1, issue particulars of a new type of dust trap evolved by Captain P. S. Hay, of the Mines Department which incorporates certain modifications to that described in the MAGAZINE for September, 1926, and in January, 1930. The outstanding features are that the suction hood is in the form of a separate unit which can be secured instantly on the rock face. The filtering appliance can be placed well out of the way of the driller, and all risk of the filter clogging when drilling on wet ground is obviated.

Samuel Osborn and Co., Ltd., of Clyde Steel Works, Sheffield, issue a leaflet describing their "So-Tuff" steel which is a constructional steel having the mechanical characteristics of the nickel steels. It can, however, be machined more readily. It may be used wherever a steel of 40/55 tons per sq. in. is necessary and where resistance to shock is desired. By suitable heat treatment a fine Sorbitic structure is obtained, which is the most suitable condition for steels subject to high stresses. Particulars are given of the heat treatment required for the three qualities in which the steel is made. It is supplied in bars of any section and as forgings.

Svenska Export Aktiebolaget, of Stockholm, Sweden, through their London Representatives, **Scott and Strutt, Ltd.**, of 25, Victoria Street, London, S.W. 1, inform us that in a description of their hollow drill-steel last month an error occurs with reference to this being rolled on a hollow core. Actually the drill-steel is first cast as an ingot on an annulus or hollow lining consisting either of a high-chrome steel or charcoal iron, which it is claimed forms a perfect weld. An special alloy steel core is then inserted on which the bar is rolled, the core being subsequently withdrawn. The makers contend that the special lining of finished steel cannot become detached.

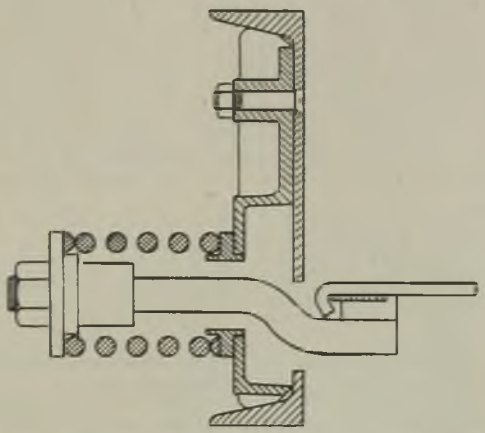
H. Tollemache and Co., Ltd., of Canada House, Norfolk Street, Strand, London, W.C. 2, announce that they have received instructions from British Insulated Cables, Ltd., for supplying the pulverized coal plant required for the new copper refinery in course of erection at Prescot. They also state that they have made a speciality of the application of pulverized fuel to metallurgical purposes and issue a fully illustrated brochure giving brief descriptions of a number of typical installations for which they have been responsible. The firm are not manufacturers of the plant employed but act in an advisory capacity for the supply of any plant that may be suitable for the particular requirement of the case.

Evershed and Vignoles, Ltd., of Acton Lane Works, Chiswick, London, W. 4, have published a handsomely printed brochure with photographs illustrating all departments of their organization to commemorate 47 years of electrical instrument manufacture. This, after dealing with the origin of the company, goes on to refer to their most important work, namely, that in connexion with insulation testing and in particular to Meggers and various alternative means for this testing. Developments in the direction of electrical signalling and distant indication are also traced as are other sections of their work. Insulation testing equipment is now widely used and generally known but mining men have recently been made aware of another use for these instruments, namely, in certain forms of electrical prospecting for minerals.

Wild-Barfield Electric Furnaces, Ltd., of Elecfurn Works, North Road, Holloway, London, N. 7, draw attention to three new alloys possessing electric resistance properties that are specially manufactured by induction melting and are known respectively as pyromic, calomic, and telconstan. Pyromic is a binary alloy of 80% nickel and 20% chromium, commercially free from carbon, iron, manganese, and silicon, is specially suitable for high temperature heavy duty service, and has a melting point of 1,390° C. Calomic is a ternary alloy containing nickel, iron, and chromium in the proportions of 65 : 20 : 15. While it is not capable of withstanding such high temperatures as pyromic it is safely used up to 1,000° C. and its strength at this temperature is rather greater than pyromic. Its melting point is 1,400° C. Telconstan is a copper-nickel alloy suitable for use for electrical resistance and in motor starters, etc., it has a melting point of 1,250° C.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, issue information with regard to the new spring Hum-mer screen. They point out in this that it has been found that vibrating screens in general have a limit of about 1 in. to 1½ in. as a maximum practical separation, as about this size a bigger movement of the screen meshing is necessary. After experimenting for some time on several types of vibrators the solution was finally found to be not in changing

the vibrators but in the method of cloth suspension. In this new type of screen the cloth is suspended at four, six, or more points depending on the total screen area, one such member being illustrated by the cross-sectional elevation shown here. The spring mounting affords what the makers describe as a reflected vibration. The screen has an increased capacity over other types of about 25%, and a 4 ft. by 7 ft. screen fitted with two vibrators and with three tensioning springs at each side has handled 300 tons per hour on a 3 in. separation



Cross Section of Spring Suspension Member of New Hum-mer Screen.

without any blinding. They also report the following orders received:—For England: One LM. 7 Lopulco mill for plumbago, one 6 ft. by 22 in. Hardinge ball-mill for lead balls, two No. 0 Raymond pulverizers for conditioning hydrated lime, one No. 3 Impax pulverizer for limestone, one 4 ft. by 5 ft. Hum-mer screen for coke, one 4 ft. by 7 ft. Hum-mer screen and two 4 ft. by 5 ft., type 39, Hum-mer screen for granite, two 4 ft. by 8 ft., type 70, Hum-mer screen for unnamed problem, one 50 sq. ft. Rovac filter for vacuum salt, one 75 sq. ft. Rovac filter for dealing with 2,000 gallons of liquor, one 50 sq. ft. Rovac filter for starch similar to rice starch, and one 5 in. Grit pump for magma. For South Africa: One 4 in. Grit pump for gold ore. For Russia: One 54 in. by 16 in. Hardinge ball-mill for calcined anthracite and dry coke.

METAL MARKETS

Copper.—The standard copper market underwent moderate fluctuations during July, being influenced both by political developments and by exchange movements. At times there was a tendency towards optimism, based on a tendency noticeable in certain quarters to regard the worst of the economic crisis as over. On the other hand, the vagueness of the decisions reached at Lausanne and the tangled political situation in Germany held business enterprise in check, as did the doubt as to whether or not Britain will impose an import duty on foreign copper as a result of the Ottawa Conference. The tendency of electrolytic was weak during most of July, the quotation falling at one time to 4·25 cents c.i.f. Europe, although it closed the month somewhat better than this.

Average price of Cash Standard Copper: July, 1932, £26 2s. 5d.; June, 1932, £26 18s. 4d.; July, 1931, £34 9s. 1d.; June, 1931, £35 17s. 6d.

Tin.—The tendency of values during the past month was pronouncedly firmer, prices advancing about £14. The belief that, for the time being at least, the statistical position is improving as a result of the measures taken by producers, has helped to strengthen the market, although in some quarters there is a feeling that the diminution in the supplies in sight is not adequate to justify unrestrained confidence. Industrial demand remains dull and there is no sign yet of any genuine trade revival in the United States, which is the biggest tin-consuming country.

Average price of Cash Standard Tin: July, 1932, £125 19s. 5d.; June, 1932, £114 12s. 11d.; July, 1931, £111 11s. 1d.; June, 1931, £105 0s. 8d.

Lead.—Prices wore an uncertain aspect throughout June, and sentiment is obviously doubtful in view of the continued paucity of industrial demand and the continued ominous growth of stocks throughout the world. Producers have been unable to agree upon any fresh concerted measures to meet the situation and meanwhile the statistical position goes from bad to worse. Stocks in the United States, already enormous, were swollen further during June to the colossal total of 180,500 short tons. The situation there, however, is expected to improve from now onwards thanks to fresh curtailment measures which circumstances have forced on the producers. Obviously, however, it is difficult to take a very rosy view of the future of prices.

Average mean price of soft foreign lead: July, 1932, £9 19s. 8d.; June, 1932, £9 15s.; July, 1931, £12 16s. 3d.; June, 1931, £11 15s. 4d.

Spelter.—The tendency last month was quite firm, sentiment being cheered by the steady reduction in the stocks held by the International Zinc Entente and by the decision of the latter to effect a further curtailment in output as from August 1, bringing the quotas of its members down from 50% to 45% of the agreed basis. Industrial demand, however, remains subdued.

Average mean price of spelter: July, 1932, £11 15s. 6d.; June, 1932, £11 14s. 1d.; July, 1931, £12 10s. 9d.; June, 1931, £11 10s. 2d.

Iron and Steel.—The holidays have begun to affect the British pig-iron market and output has had to be reduced. Cleveland prices, however, are maintained at their previous minimum levels, No. 3 foundry being still 58s. 6d. for local delivery though less is accepted for Scotland. Hematite has become an easier market, East Coast mixed numbers being quoted at down to 61s. As regards finished iron and steel, the British mills are heavily handicapped by the stagnation in the shipbuilding industry and demand from other consuming trades is also quiet at present. Hopes are placed, however, on the pending naval orders, whilst a fair amount of overseas inquiry suggests that business may mature from that direction, particularly in view of the labour troubles in Belgium. A favourable impression has been caused by the Anglo-Canadian steel pact. The new Irish duties discriminating against Great Britain are, however, an adverse factor.

Iron Ore.—Business has been to all intents and purposes at a standstill during the past month, and prices are rather easier at about 14s. 6d. to 14s. 9d.

LONDON DAILY METAL PRICES.

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard.		Electro-lytic.	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	Forward.	
July	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
12	26 13 9	26 8 9	30 15 0	29 0 0	125 17 6	127 12 6	11 11 3	10 3 9	12 0 0	17	17 1/16	115 11
13	26 8 9	25 18 9	30 0 0	—	126 15 0	128 2 6	11 7 6	9 16 3	11 15 0	16 15/16	16 15/16	116 1
14	26 8 9	25 16 10 1/2	30 0 0	—	127 18 9	129 11 3	11 6 3	9 16 3	11 15 0	17	17 1/16	116 2
15	26 1 3	25 12 6	29 10 0	28 5 0	127 17 6	129 7 6	11 6 3	9 12 6	11 10 0	17 1/16	17 1/16	116 3
18	25 13 9	25 6 3	28 15 0	—	127 2 6	128 17 6	11 3 9	9 8 9	11 10 0	17	17 1/16	116 0
19	25 12 6	25 4 4 1/2	28 15 0	28 0 0	125 16 3	127 13 9	11 5 0	9 7 6	11 5 0	16 15/16	16 15/16	115 8
20	25 8 1 1/2	24 19 4 1/2	28 5 0	—	123 12 6	125 13 9	11 8 9	9 5 0	11 5 0	16 15/16	16 15/16	115 7
21	25 6 3	24 18 1 1/2	28 0 0	—	125 11 3	127 8 9	11 11 3	9 11 3	11 10 0	17	17 1/16	115 5
22	25 8 9	25 2 6	28 0 0	27 5 0	124 17 6	126 17 6	11 11 3	9 12 6	11 10 0	16 15/16	17	115 11
25	25 0 7 1/2	24 11 3	28 0 0	—	124 7 6	126 2 6	11 12 6	9 12 6	11 10 0	17	17 1/16	115 9
26	25 1 3	24 11 10 1/2	27 15 0	26 10 0	125 13 9	127 7 6	11 15 0	9 12 6	11 10 0	17 1/16	17 1/16	115 10
27	25 3 1 1/2	24 15 7 1/2	27 15 0	—	127 2 6	128 12 6	11 17 6	9 13 9	11 10 0	17 1/16	17 1/16	116 4
28	26 3 1 1/2	25 15 7 1/2	29 0 0	—	129 3 9	130 15 0	12 2 6	10 0 0	12 0 0	17 1/16	17 1/16	116 7
29	26 8 9	26 1 3	29 10 0	28 0 0	131 2 6	132 12 6	12 5 0	10 5 0	12 0 0	17 1/16	17 1/16	117 8
Aug.												
2	27 15 0	27 8 9	31 15 0	29 10 0	133 2 6	134 17 6	12 7 6	10 8 9	12 5 0	17 1/16	17 1/16	117 0
3	27 8 9	27 3 9	31 10 0	—	133 2 6	134 12 6	12 6 3	10 1 3	12 0 0	17 1/16	17 1/16	117 2
4	28 5 7 1/2	28 4 4 1/2	32 5 0	—	136 2 6	137 17 6	12 13 9	10 5 0	12 5 0	17 1/16	17 1/16	117 5
5	28 14 4 1/2	28 11 10 1/2	33 5 0	31 0 0	138 12 6	139 17 6	12 15 0	10 8 9	12 5 0	17 1/16	17 1/16	118 6
8	30 13 9	30 13 1 1/2	35 0 0	—	139 7 6	141 2 6	13 3 9	10 12 6	12 10 0	17 1/16	17 1/16	119 1
9	30 3 9	30 3 9	34 10 0	32 10 0	140 2 6	141 12 6	13 3 9	10 15 0	12 15 0	17 3/16	17 1/16	118 7
10	29 1 10 1/2	29 1 3	34 10 0	—	140 7 6	141 17 6	12 15 0	10 7 6	12 10 0	17 1/16	17 3/16	118 2

per ton c.i.f. for best Bilbao rubio and 13s. 9d. to 14s. c.i.f. for good Mediterranean ores.

ANTIMONY.—Although there has been no appreciable expansion in demand sellers have adopted a firmer attitude and Chinese regulus for forward shipment is now about £18 10s. to £19 c.i.f., whilst spot is about £22 10s. to £23 ex warehouse.

ARSENIC.—The market is quietly steady at about £22 5s. to £22 10s. c.i.f. for high-grade Mexican and £24 10s. f.o.r. mines for 99% Cornish white.

BISMUTH.—A steady business is reported at the unaltered official price of 4s. 6d. per lb. for 5 cwt. lots and over.

CADMIUM.—Competition has been rather keener recently and prices have been reduced to about 1s. 9½d. to 1s. 10½d. per lb., according to quantity.

COBALT.—Metal is slow, but officially unchanged at 7s. 6d. per lb.

COBALT OXIDES.—Oxides are not in much request, but quotations are pretty well upheld at about 4s. 3d. per lb. for black and 5s. to 5s. 1d. for grey.

CHROMIUM.—Prices are without change at about 2s. 9d. per lb. delivered.

TANTALUM.—Inquiry has been very restricted recently, but prices are nominally unaltered at £15 to £20 per lb.

PLATINUM.—Buyers have not been much in evidence recently, and prices remain at about £9 9s. to £9 15s. per oz. for refined metal, although more is sometimes asked.

PALLADIUM.—In the absence of business quotations are unchanged at £4 to £4 5s. per oz.

IRIDIUM.—The market is quiet, but prices are steady at about £12 to £14 per oz.

OSMIUM.—Around £11 10s. to £12 10s. per oz. represents the present value, interest being negligible.

TELLURIUM. — Quotations can only be called nominal at about 20s. per lb.

SELENIUM.—A steady business is passing at about 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse.

MANGANESE ORE.—Demand throughout July was on a decidedly meagre scale, no contracts of any importance being heard of. Prices, however, are quotably unchanged at about 9d. to 9½d. per unit c.i.f. for best Indian, and 8½d. to 9d. c.i.f. for good 48% Indian and washed Caucasian ore.

ALUMINIUM.—There has not been any appreciable demand for raw metal recently, but makers continue to maintain a firm attitude, quoting £95 for ingots and bars and £98 for rolling billets, both less 2% delivered.

SULPHATE OF COPPER.—Quite a good business is reported at about £16 5s. to £16 15s. per ton, less 5%, for English.

NICKEL.—Rather slow conditions continue to prevail in this market, but prices are without alteration at £230 to £235 per ton, according to quantity.

CHROME ORE.—Very little inquiry has been forthcoming recently, but leading interests continue to quote 80s. to 85s. per ton c.i.f. for good 48% Rhodesian ore, and 100s. to 110s. c.i.f. for 55 to 57% New Caledonian.

QUICKSILVER.—The undertone of the market continues easy, the breaking away of Italy from the syndicate naturally tending to depress values. Current quotations are about £9 15s. to £10, net, for spot.

TUNGSTEN ORE. — Business has remained practically at a standstill, with forward shipment from China valued at about 11s. per unit c.i.f. by sellers, although buyers' ideas have been lower.

MOLYBDENUM ORE.—Supplies are short and prices are rather nominal at around 37s. 6d. to 39s. per unit c.i.f. for 80 to 85% concentrates.

GRAPHITE.—The market is very quiet, but prices are unchanged at about £16 to £18 per ton c.i.f. for good 85 to 90% raw flake, and £17 to £19 c.i.f. for 90% Ceylong lumps.

SILVER.—On July 1 spot bars were 16 1/16d., and with the Continent inclined to sell, and some easiness in America tended to offset the hardening effects of weaker sterling. India turned buyer, however, and on July 15, spot bars rose to 17 1/16d. In the second half of the month China was a buyer on any signs of a fall, but India offered moderately and prices kept fairly steady, spot bars closing at 17 3/16d. on July 29.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
July, 1931	872,198	44,645	916,843
August	870,822	45,603	916,425
September	872,053	43,971	916,024
October	900,353	44,760	945,113
November	855,102	45,408	900,510
December	877,178	46,175	923,353
January, 1932	890,688	46,096	936,784
February	869,711	44,301	914,012
March	914,017	46,018	960,035
April	901,894	47,902	949,796
May	919,223	46,421	965,644
June	913,297	45,714	959,011
July	933,947	47,213	981,160

TRANSVAAL GOLD OUTPUTS.

	June.		July.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	107,000	£160,658	107,500	£159,489
City Deep	84,500	21,789	85,000	21,899
Cons. Main Reef	71,000	23,657	74,000	24,210
Crown Mines	278,000	86,067	284,000	88,064
Daggafontein	41,700	£66,197	42,000	£67,715
D'rb'n Roodepoort Deep	48,000	16,009	50,000	15,630
East Geduld	59,000	18,929	60,000	19,283
East Rand P.M.	157,000	40,595	161,500	42,522
Geduld	83,000	26,621	86,500	27,892
Geldenhuis Deep	74,000	16,829	77,000	17,164
Glynn's Lydenburg	6,400	2,554	7,200	2,555
Government G.M. Areas	208,000	£406,976	207,000	£406,036
Kleinfontein	51,600	10,298	53,800	10,953
Langlaagte Estate	81,000	£109,856	82,000	£108,996
Luipaard's Vlei	33,400	8,395	34,600	8,689
Meyer and Charlton	16,000	£15,576	12,600	£18,199
Modderfontein New	167,000	64,621	171,000	64,144
Modderfontein B	75,000	21,166	77,500	21,805
Modderfontein Deep	44,400	21,570	44,400	21,507
Modderfontein East	73,500	21,242	74,500	21,721
New State Areas	89,000	£184,036	88,000	£180,453
Nourse	69,500	20,751	72,000	21,201
Randfontein	240,000	£282,984	249,000	£300,276
Robinson Deep	98,000	28,724	100,000	28,502
Rose Deep	60,500	12,610	64,500	13,150
Simmer and Jack	78,000	21,977	82,100	21,857
Springs	76,100	£164,566	76,200	£164,738
Sub Nigel	36,000	32,453	37,000	33,022
Transvaal G.M. Estates	18,500	5,255	19,100	5,637
Van Ryn	50,000	£44,873	51,000	£46,508
Van Ryn Deep	70,000	£92,702	71,000	£92,153
West Rand Consolidated	93,500	£103,438	96,500	£106,372
West Springs	77,500	£80,839	77,100	£79,159
Witw'tersr'nd (Knights)	65,000	£55,461	69,000	£56,034
Witwatersrand Deep	46,100	14,968	49,000	14,939

Values in S.A. currency.

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
April, 1931	2,592,800	28 7	20 1	8 6	1,105,711
May	2,751,400	27 10	19 6	8 4	1,149,105
June	2,698,100	28 0	19 7	8 5	1,140,399
July	2,771,400	27 10	19 6	8 4	1,155,466
August	2,799,800	27 10	19 5	8 5	1,159,382
September	2,765,400	27 10	19 5	8 5	1,162,355
October	2,870,800	27 8	19 3	8 5	1,210,743
November	2,726,720	27 10	19 5	8 5	1,144,208
December	2,793,900	27 10	19 5	8 5	1,173,732
January, 1932	2,880,500	27 5	19 4	8 1	1,163,434
February	2,775,400	27 8	19 6	8 2	1,133,212
March	2,901,300	27 10	19 7	8 3	1,200,278
April	2,883,500	27 9	19 5	8 4	1,196,011
May	2,964,100	27 6	19 2	8 4	1,228,198
June	2,927,200	27 9	19 3	8 6	1,241,392

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
July 31, 1931	208,155	13,512	1,817	223,484
August 31	209,409	13,563	1,705	224,677
September 30	209,424	13,276	1,626	224,326
October 31	208,987	13,061	1,517	223,565
November 30	209,270	12,882	1,429	223,581
December 31	211,552	12,260	1,402	225,214
January 31, 1932	215,752	12,394	1,598	229,744
February 29	216,171	12,177	1,363	229,711
March 31	214,024	12,009	—	226,033
April 30	214,334	11,943	—	226,277
May 31	215,926	11,972	—	227,898
June 30	217,077	11,833	—	228,910
July 31	217,525	12,056	—	229,581

PRODUCTION OF GOLD IN RHODESIA.

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

RHODESIAN GOLD OUTPUTS.

	June.		July.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,800	11,667	25,200	9,648
Globe and Phœnix	6,110	6,368	6,222	6,281
Lonely Reef	8,500	2,474	8,500	2,443
Luiri Gold	—	—	—	—
Rezende	6,500	2,593	6,500	2,551
Sherwood Star	4,800	£8,321	4,800	£8,367
Wanderer Consolidated	15,300	3,157	15,600	3,231

WEST AFRICAN GOLD OUTPUTS.

	June.		July.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	5,088	£15,457	5,273	£15,549
Ashanti Goldfields	13,300	14,608	13,430	14,605
Taquah and Abosso	10,391	3,391	10,528	3,479

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
July, 1931	38,785	3,641	1,220
August	52,501	3,020	610
September	38,173	—	638
October	52,741	7,838*	1,031
November	53,869	4,758	1,428
December	49,215	4,700	1,224
January, 1932	44,037	—	916
February	44,672	—	981
March	47,103	9,735†	769
April	48,936	—	1,216
May	53,928	—	—
June	50,079	—	—
July	53,585	—	—

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

AUSTRALASIAN GOLD OUTPUTS.

	June.		July.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,281	8,753	5,067	6,324
Blackwater (N.Z.)	3,540	8,395	3,582	11,523
Boulder Persev'ce (W.A.)	7,211	14,706	7,266	14,814
Grt. Boulder Pro. (W.A.)	7,762	23,183	7,662	20,846
Lake View & Star (W.A.)	28,879	32,506	—	—
Sons of Gwalia (W.A.)	12,154	14,522	13,088	15,554
South Kalgurli (W.A.)	9,241	16,409	9,751	16,186
Waihi (N.Z.)	18,302	6,177* / 41,114†	18,981	6,110* / 40,028†
Wiluna	27,524	48,140	—	—

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	June.		July.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	—	1,809	—	1,485
Champion Reef	8,970	5,524	9,350	5,575
Mysore	14,310	7,088	14,420	7,562
Nundydroog	12,514	7,408	14,970	9,329*
Ooregum	11,980	4,387	11,750	4,352

*1,939 oz. from 1,870 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	June.		July.	
	Tons	Value £	Tons	Value £
Bulolo Gold	—	62,950*d*†	—	—
Chosen Corp. (Korea)	9,660	13,250	10,400	16,197
Frontino Gold (Colbia)	3,860	18,011	3,890	19,219
Fresnillo	—	—	—	—
New Goldfields of Venezuela	7,651	2,306*	7,886	2,228*
Oriental Cons. (Korea)	—	80,858*d*	—	69,744*d*
St. John del Rey (Brazil)	—	40,600	—	42,500
Santa Gertrudis (Mexico)	25,105	59,889*d*	24,471	37,634*d*
Viborita	—	—	—	1,564
West Mexican Mines	1,440	21,500*d*	—	—

d Dollars. * Oz. gold. † To July 17.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

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

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	May.	June.	July.
Ayer Hitam	—	38½	—
Batu Caves	—	—	—
Changkat	68	—	—
Gopeng	—	27	—
Hongkong Tin	—	35½	—
Idris Hydraulic	—	13½	—
Ipoh	27	31½	—
Kampar Malaya	—	—	—
Kampong Lanjut	30	42	35
Kamunting	99½	117	—
Kent (F.M.S.)	—	—	—
Killinghall	22½	46	32½
Kinta	—	12½	—
Kinta Kellas	—	—	—
Kramat Tin	72	60	70
Kuala Kampar	33	42	—
Kundang	—	—	—
Lahat	15½	14½	11½
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	54½	71½	59½
Malim Nawar	25	22	20
Pahang	125	105	78
Penawat	47½	42½	—
Pengkalen	—	25	—
Petaling	—	100	—
Rahman	40½	25	25
Rambutan	—	4½	—
Rantau	—	—	—
Rawang	44	38	30
Rawang Concessions	48	21	35
Renong	19½	20½	—
Selayang	—	9½	—
Southern Kampar	—	60	—
Southern Malayan	27½	70	59½
Southern Perak	—	25½	38½
Southern Tronoh	2⅜	19½	—
Sungei Besi	33	27	—
Sungei Kinta	33½	32½	—
Sungei Way	9	41½	—
Taiping	11	—	—
Tanjong	—	12½	—
Tekka	—	18	—
Tekka-Taiping	—	24½	—
Temoh	—	—	—
Tronoh	66	43½	—
Ulu Klang	—	—	—

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	May.	June.	July.
Anglo-Nigerian	7½	15½	12½
Associated Tin Mines	114	145½	108
Baba River	—	—	—
Batura Monguna	—	1	—
Bisichi	16	25	—
Daffo	—	—	—
Ex-Lands	15	32	23
Filani	2	—	—
Jantar	13	10	10
Jos	13½	10½	—
Juga Valley	8	8	5
Kaduna Syndicate	17	13	13
Kaduna Prospectors	8	6	7
Kassa	4½	7	8
London Tin	48	102	75
Lower Bisichi	1	½	—
Naraguta Extended	—	—	—
Nigerian Consolidated	7	7	5
Offin River	—	—	—
Ribon Valley	4	18	10
Tin Fields	—	—	—
United Tin Areas	—	17	11
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	May.	June.	July.
Anglo-Burma (Burma)	12½	25½	—
Aramayo Mines (Bolivia)	106	84	119
Bangrin (Siam)	57	61½	—
Beralt	29*	26½*	26½*
Consolidated Tin Mines (Burma)	82	83	120
East Pool (Cornwall)	50½	48½	—
Fabulosa (Bolivia)	43†	41†	—
Kagera (Uganda)	22	25	25
Kamra	—	—	—
Malaysiam Tin	8½	13	13½
Mawchi	230*	208*	193*
Patino	813	—	—
Pattani	—	—	—
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	92½	79	—
South Crofty	50½	52½	52
Tavoy Tin (Burma)	73½	91	73
Tongkah Harbour (Siam)	35	30	30
Toyo (Japan)	80	70	72
Zaaiplaats	15½	—	—

* Tin and Wolfram. † Tons fine tin.

COPPER, LEAD, AND ZINC OUTPUTS.

		June.	July.
Britannia Lead	Tons refined lead.	3,319	—
	Oz. refined silver.	116,836	—
Broken Hill South	Tons lead conc.	4,698	7,492
	Tons zinc conc.	5,045	8,059
Burma Corporation	Tons refined lead.	5,880	5,880
	Oz. refined silver	530,615	463,542
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	370	370
Messina	Tons copper	810	883
Mount Isa	Tons lead bullion	3,940	—
Mount Lyell	Tons concentrates	4,294*	2,813†
North Broken Hill	Tons lead conc.	5,890	5,760
	Tons zinc conc.	5,560	5,440
Rhodesia Broken Hill	Tons V_2O_5	30	30
	Tons V_2O_5 conc.	100	100
Roan Antelope	Tons concentrates	—	—
	Tons blister copper	2,089	2,178
Sulphide Corporation	Tons lead conc.	1,823	—
	Tons zinc conc.	2,662	—
Trepca	Tons lead conc.	4,671	4,984
	Tons zinc conc.	6,093	6,691
Villemagne	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Zinc Corporation	Tons lead conc.	4,391	—
	Tons zinc conc	3,237	—

* To June 15. † To July 13.

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

	May.	June.
Iron Ore ..... Tons ..	162,103	164,617
Manganese Ore ..... Tons ..	4,595	11,891
Iron and Steel ..... Tons ..	144,013	126,079
Copper and Iron Pyrites ..... Tons ..	35,484	23,284
Copper Ore, Matte, and Prec. ... Tons ..	4,394	2,056
Copper Metal ..... Tons ..	10,534	10,598
Tin Concentrate ..... Tons ..	4,293	5,294
Tin Metal ..... Tons ..	250	100
Lead Pig and Sheet, ... Tons ..	22,457	24,765
Zinc (Spelter) ..... Tons ..	6,605	6,287
Zinc Sheets, etc. ..... Tons ..	1,263	1,367
Zinc Oxide ..... Tons ..	2	11
Zinc Ore ..... Tons ..	7,074	7,638
Aluminium ..... Tons ..	504	554
Mercury ..... Lb.	79,312	87,085
White Lead ..... Cwt.	1,738	3,479
Barytes, ground ..... Cwt.	16,007	21,000
Asbestos ..... Tons ..	1,646	1,725
Boron Minerals ..... Tons ..	602	1,117
Borax ..... Cwt.	12,184	10,107
Basic Slag ..... Tons ..	850	100
Superphosphates ..... Tons ..	2,852	1,140
Phosphate of Lime ..... Tons ..	29,668	19,473
Mica ..... Tons ..	78	194
Tungsten Ores ..... Tons ..	237	474
Sulphur ..... Tons ..	3,606	5,264
Nitrate of Soda ..... Cwt.	10,074	8
Potash Salts ..... Cwt.	44,248	51,277
Petroleum : Crude ..... Gallons	34,096,562	34,046,642
Lamp Oil ..... Gallons	10,250,317	14,218,997
Motor Spirit ..... Gallons	89,077,618	99,200,744
Lubricating Oil .... Gallons	9,454,659	7,254,847
Gas Oil ..... Gallons	6,593,430	11,593,696
Fuel Oil ..... Gallons	43,925,353	48,843,402
Asphalt and Bitumen ..... Tons ..	10,021	14,124
Paraffin Wax ..... Cwt.	84,033	62,029

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	May.	June.	July.
Anglo-Ecuadorian	17,113	16,608	16,926
Apex Trinidad	44,670	47,140	51,260
Attock	2,626	2,056	1,998
British Burmah	3,691	3,767	3,875
British Controlled	44,289	40,318	42,263
Kern Mex	1,091	980	830
Kern River (Cal.)	2,358	1,999	2,067
Kern Romana	178	164	76
Kern Trinidad	1,845	1,863	1,766
Lobitos	24,809	24,134	25,260
Phœnix	68,380	65,286	80,434
St. Helen's Petroleum	5,208	4,675	4,903
Steaua Romana	91,182	84,604	98,968
Tampico	2,891	2,596	2,294
Tocuyo	1,283	1,056	1,253
Trinidad Leaseholds	31,050	28,950	28,600

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted

	July 11, 1932.			Aug. 10, 1932.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		6	0		9	3
Anglo-Egyptian B.	1	3	0	1	7	6
Anglo-Persian 1st Pref.	1	7	9	1	8	0
,, ,, Ord.	1	14	3	2	2	6
Apex Trinidad (5s.)		10	9		13	3
Attock		9	6		10	0
British Burmah (8s.)		3	3		3	9
British Controlled ($5)		1	3		1	6
Burmah Oil	2	6	3	2	18	0
Kern River Cal. (10s.)		1	6		2	0
Lobitos, Peru	1	5	6	1	15	0
Mexican Eagle, Ord. (4 pesos)		6	0		6	3
,, ,, 8% Pref. (4 pesos)		5	9		6	0
Phœnix, Roumanian		4	6		8	0
Royal Dutch (100 fl.)	14	12	6	17	12	6
Shell Transport, Ord	1	16	9	2	5	0
,, ,, 5% Pref. (£10)	11	0	0	11	0	0
Steaua Romana		5	6		7	6
Trinidad Leaseholds	1	7	6	1	9	3
United British of Trinidad (6s. 8d.)		2	0		3	0
V.O.C. Holding	1	3	0	1	8	0

PRICES OF CHEMICALS. Aug. 9.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	9
,, 80%	,,	1	16	5
,, Glacial	per ton	59	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	0
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	5	5	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	24	0	0
Barium, Carbonate (native), 94%	,,	4	10	0
,, Chloride	,,	10	10	0
Barytes	,,	8	5	0
Benzol, standard motor	per gal.		1	4
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	,,	16	10	0
Boric Acid	,,	26	10	0
Calcium Chloride, solid, 70/75%	,,	5	15	0
Carbolic Acid, crude 60's	per gal.		1	7
,, ,, crystallized, 40°	per lb.			6
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.		1	0½
Copper Sulphate	per ton	15	10	0
Creosote Oil (f.o.b. in Bulk)	per gal.			4½
Cresylic Acid, 98-100%	,,		1	4
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per lb.	1	0	11
Iron, Nitrate 80° Tw.	per ton	6	0	0
,, Sulphate	,,	1	17	6
Lead, Acetate, white	,,	33	10	0
,, Nitrate (ton lots)	,,	27	10	0
,, Oxide, Litharge	,,	27	10	0
,, White	,,	37	10	0
Lime, Acetate, brown	,,	8	10	0
,, ,, grey, 80%	,,	11	0	0
Magnesite, Calcined	,,	8	5	0
Magnesium Chloride	,,	5	10	0
,, Sulphate, comml.	,,	4	10	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	0
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	2	7	0
Phosphoric Acid. (Conc. 1·750)	per lb.			10
Pine Oil	per cwt.	2	7	6
Potassium Bichromate	per lb.			5
,, Carbonate, 96/98%	per ton	29	0	0
,, Chlorate	per lb.			4
,, Chloride 80%	per ton	12	10	0
,, Ethyl Xanthate	per 100 kilos	7	0	0
,, Hydrate (Caustic) 88/90%	per ton	39	0	0
,, Nitrate	,,	30	0	0
,, Permanganate	per lb.			9½
,, Prussiate, Yellow	,,			8
,, ,, Red	,,		2	0
,, Sulphate, 90%	per ton	12	10	0
Sodium Acetate	,,	20	0	0
,, Arsenate, 45%	,,	28	0	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			4
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	28	10	0
,, Cyanide 100% NaCN basis	per lb			8
,, Ethyl Xanthate	per 100 kilos	6	12	6
,, Hydrate, 76%	per ton	14	0	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	9	0	0
,, Phosphate, comml.	,,	12	5	0
,, Prussiate	per lb.			5
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	3	1	0
,, Sulphide Conc., 60/65%	,,	10	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	10	10	0
,, Roll	,,	10	0	0
Sulphuric Acid, 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw. .	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	0	0
Tartaric Acid	per lb.		1	0
Turpentine	per ton	62	0	0
Tin Crystals	per lb.		1	0
Titanous Chloride	,,			10½
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	8	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

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

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	2 0	3 3
Esperanza Copper	13 9	13 9
Indian (2s.)	10	1 3
Loangwa (5s.), Rhodesia	1 3	1 9
Luiri (5s.), Rhodesia	1 6	1 6
Messina (5s.), Transvaal	4 2	5 0
Mount Lyell, Tasmania	16 0	16 6
Namaqua (£2), Cape Province	3 0	3 6
Rhodesia-Katanga	10 0	10 0
Rio Tinto (£5), Spain	13 10 0	16 5 0
Roan Antelope (5s.), Rhodesia	6 6	8 3
Tanganyika Con.	17 0	1 0 6
Tharsis (£2), Spain	2 11 3	3 2 6

LEAD-ZINC:	July 11, 1932. £ s. d.	Aug. 10, 1932. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	7 6
Broken Hill Proprietary, N.S.W.	13 0	14 6
Broken Hill, North, N.S.W.	2 8 9	2 12 6
Broken Hill South, N.S.W.	1 13 9	1 16 3
Burma Corporation (10 rupees)	8 0	9 6
Electrolytic Zinc Pref., Tasmania	16 3	18 9
Mount Isa, Queensland	8 6	8 9
Rhodesia Broken Hill (5s.)	9	1 1
San Francisco (10s.), Mexico	6 3	7 3
Sulphide Corporation (15s.), N.S.W.	6 6	7 9
ditto, Pref.	8 9	9 6
Zinc Corporation (10s.), N.S.W.	19 6	1 1 3
ditto, Pref.	2 17 6	2 16 3

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

DIAMONDS:		
Consol. African Selection Trust (5s.)	5 6	7 0
Consolidated of S.W.A. (10s.)	3 0	2 9
De Beers Deferred (£2 10s.)	3 0 0	3 12 6
Jagersfontein	15 0	1 1 3
Premier Preferred (5s.)	17 6	1 0 0

FINANCE, ETC.:		
Anglo-American Corporation (10s.)	7 0	8 9
Anglo-French Exploration	7 6	10 6
Anglo-Continental (10s.)	2 6	2 9
Anglo-Oriental (Ord., 5s.)	6 6	6 6
ditto, Pref.	8 0	9 6
British South Africa (15s.)	16 9	19 9
Central Mining (£8)	9 5 0	10 15 0
Consolidated Gold Fields	1 2 0	1 5 9
Consolidated Mines Selection (10s.)	5 0	7 6
Fanti Consols (8s.)	5 6	6 6
General Mining and Finance	17 0	1 0 6
Gold Fields Rhodesian (10s.)	3 0	3 0
Johannesburg Consolidated	1 3 6	1 0 6
London Tin Corporation (10s.)	9 3	11 3
Minerals Separation	2 5 0	2 10 0
National Mining (8s.)	3	3
Rand Mines (5s.)	3 8 9	3 13 9
Rand Selection (5s.)	7 9	9 0
Rhodesian Anglo-American (10s.)	6 0	10 6
Rhokana Corp.	2 17 6	3 18 9
Rhodesian Selection Trust (5s.)	4 0	4 9
South Rhodesia Base Metals	2 0	2 0
Tigon (5s.)	2 6	2 6
Union Corporation (12s. 6d.)	2 7 0	2 11 3
Venture Trust (10s.)	4 0	5 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

THE AIR TRANSPORT OF DREDGES

In the *Bulletin* of the Institution of Mining and Metallurgy for July C. A. Banks describes the methods employed in the air transport of dredge parts and supplies to an area in the interior of New Guinea. The author says that the island of New Guinea lies between north-eastern Australia and the Equator and it is credited as being the second largest island in the world. The eastern portion of the island is British, the south part of this eastern portion being Papua, with Moresby the capital; and the northern part being the Mandated Territory of New Guinea, with Rabaul the capital. The dredging property, as proved to the end of 1929, consisted of a stretch of 4½ miles of the Bulolo river-bed and flats, situated approximately 7° south of the Equator, at an elevation of 2,250 ft. above sea-level, and 35 miles, in a direct line, from the coast. The proved ground averaged about 2,000 ft. in width while the average depth of the gravel was 22 ft. The Bulolo River, which runs throughout the length of the property, is about 200 ft. wide, carries from 250 cu. ft. to 300 cu. ft. of water per second in the dry spells, and up to perhaps twice that amount at other times. The dredging ground was covered with heavy tropical jungle, and fortunately there existed a number of magnificent cedar trees, which later supplied excellent construction lumber.

The valuation of the property, based on drilling and shafting, set the volume of dredgeable ground at 40,000,000 cu. yd. and the average recoverable gold content at 50c. per cu. yd. This valuation included all the then-drilled ground which ran over the then estimated working and royalty costs of 15c. per yd. The gold, which is approximately 650 fine, is contained throughout the depth of the gravel with a concentration of values towards the bottom. These gold-bearing gravels are the erosion product of a gold quartz-vein area situated about 12 miles further up stream, and at several thousand feet higher elevation. The gravel was found to contain a number of fairly large boulders, particularly in the upper portion of the deposit, though nothing was encountered in the shafting that a dredge of 10 cu. ft. bucket capacity would be unable to handle. In spite of the presence of these boulders the gravel was considered as being particularly easy digging ground, and, further, remarkably free from clay. The bedrock consisted of soft blue clay giving a very satisfactory dredging bottom.

For the purpose of equipping the property with two all-steel bucket dredges, each of 10 cu. ft. bucket capacity, and of harnessing the Bulolo River, at the upper end of the property, for supplying electrical horse-power for driving these dredges, Placer Development, Ltd., formed, in the early part of 1930, an operating company named Bulolo Gold Dredging, Ltd. Recently Bulolo Gold Dredging, Ltd., absorbed an additional volume of approximately 60,000,000 yd. of gravel of an estimated gold content of roughly 30c. per yard, located on the Bulolo and Watut Rivers, immediately down-stream from the original Bulolo area. As no road whatever existed from the coast to the property, the all-important question of transport had to be settled. The construction of a road was carefully considered and trial surveys were made. It was found, however, that to cross an intervening range of mountains, the lowest pass through which was roughly 4,000 ft., the road would have been over 90 miles in length, would have taken from a year to a year and a half to build, and cost approximately a million dollars. Further, the building of a road, and the acquisition of suitable hauling equipment, would not necessarily have overcome the transport question, for road maintenance in a tropical country such as New Guinea, with its sudden heavy rainfalls, and its abundant tropical growth, was quite an unknown quantity.

During the testing of the ground, communication with the coast had been maintained by a local air-transport company, Guinea Airways, Ltd., and the whole of the equipment and the general supplies for the testing had been safely taken to the field by this company's aeroplanes, which carried up to 2,000 lb. per trip. The author conferred with Mr. Frank Griffin, of San Francisco, a co-director who was to be responsible for the design of the dredges, and obtained details of the critical parts, both as to weight and size, that would require to be air-transported to the field. The Junker Aeroplane Manufacturing Company considered that they could adapt their standard tri-motored G–31 passenger plane to provide a suitable sized cargo cabin or compartment, and, for the short distance over which it was wished to transport the machinery, to make it capable of carrying up to 7,000 lb. of freight. They also decided that a large hatch could be provided in the roof of the cargo cabin, so as to allow of the aeroplane being loaded by crane. A model of the cargo compartment was then made and models of all the critical parts which had to be carried were loaded into the model cargo compartment, particular care being taken to see that such pieces as approximated the capacity of the plane, such as the upper tumbler shaft, which weighed 7,000 lb., were capable of being loaded over the centre of gravity of the machine, which was located almost directly under the hatchway and about 6 ft. from the front of the cargo compartment. With a few alterations in the then contemplated design of the critical parts and some further slight alterations to the cargo compartment, it was apparent that the aeroplane could be made to suit the requirements. Further, it was soon realized that the cost of sectionalizing, and the extra cost of erection in the field, would not be excessive, and still further the risk of losing parts was really very slight.

In December, 1929, it was decided to abandon all idea of a road, and to air-transport the whole of the machinery and equipment from the coast to the site of erection in the field. The total weight of machinery and equipment to be carried for the two dredges and the hydro-electric plant was estimated at 2,400 short tons, and, in order not to delay construction, it was figured that 200 tons monthly would be required to be carried.

Two Junker G–31 aeroplanes were acquired, and transport of the machinery from the coast to the field commenced in April, 1931, and, for the twelve months to the end of March, 1932, a total of 2,500 short tons, comprising the whole of the above-mentioned equipment, had been safely transported by these two planes, and without a single accident. The tonnage was steadily built up from 35 tons in April, 1931, to 350 tons per month later on, when the staff became better organized and more accustomed to loading the machines, and as the weather conditions improved.

Junker aeroplanes were considered the most suitable as, first, being all metal in construction, they saved the very heavy cost of constructing hangars in New Guinea and, secondly, these machines were particularly suitable for heavy freighting for, being of the low-winged type, the heavy weights could be crane-loaded through a hatch directly on to the cabin floor, which was rendered particularly strong by the fact that the strong wing section ran underneath, and formed part of, this floor. The cargo compartment of the machine was 24 ft. long, 77 in. wide, and 69 in. high, while the hatchway was 142 in. in length by 60 in. wide. The hatch was provided with a concave cover, so as to give an additional 12 in. of head room below the hatchway, and directly over the centre of gravity, where the largest pieces were to be carried. The interior of the cargo compartment was free of obstructions, excepting two sets of stays, placed approximately 12 and 18 ft. from the front of the compartment. These stays, which reduced the floor width to 31 in., angled back to meet the sides of the compartment at their junction with the roof. A side door was provided close to the rear for loading small material, and as a means of entering the cabin.

The Junker G–31 aeroplane has a pay load of 5,800 lb., allowing for a crew of two, and sufficient petrol for 3½ hours' flight. The average flying time from the coast (Lae) to the dredging area and return being only 75 minutes, a reduction in the petrol load could be made to allow of the carrying, with two pilots, of 7,000 lb. of cargo, while at the same time retaining ample reserve of petrol. Sufficient power was provided, in order that the fully loaded aeroplanes could be sustained in flight with any two engines—in the test flights these planes, at an altitude up to 3,000 ft., actually climbed at the rate of 200 ft. per min. on two engines and under full load. This margin of power was a great insurance against forced landing and loss of life, material, and time. The reserve of power was also of great importance in our particular case as, with high mountains to cross, a fast rate of climb was important. Under normal working conditions, the aeroplanes would climb to 7,000 ft. in 35 minutes with three-quarter throttle. The average height attained in crossing the mountain was 6,000 ft., while the useful ceiling of the machine is approximately 12,000 ft.

The flying distance from the coast air port (Lae) to Bulolo and return is 100 miles and the average flying time for the return trip is 75 minutes. Over short distances such as this, speed is not very essential, though it would be a factor in greater distances. The landing speed of the planes is approximately 75 miles per hour. This is rather high and, while compressed-air brakes are fitted to check the run on landing, long aerodromes are required. The take-off distance of the planes is short on account of the reserve engine power. A quick take-off, and a low landing speed, greatly reduce the risk of accidents due to errors in judgment. An aerodrome 1,000 yd. by 1,000 yd. would be of sufficient size to allow of the landing of the planes in any direction. As a matter of fact, both the Lae and the Bulolo aerodromes, while each being upwards of 1,000 yd. in length, are not more than about 500 yd. in width. This, however, is quite satisfactory, for the planes are always landed against the wind, and quite 99% of the wind at Lae blows from either end of the aerodrome, while at Bulolo over 90% blows up and down the aerodrome.

At the outset it was a question as to whether the company should use the port of Salamoa, or that of Lae, for a flying base. Lae, which was already being used by Guinea Airways, was finally decided upon, and early in 1930 a commencement was made on its further development. Lae is more or less an open roadstead, but with care no difficulty is experienced in lightering cargo from the ocean vessels, which come to within about a quarter of a mile of the shore. A wharf was erected and a broad-gauge railway, three-quarters of a mile in length, was laid from the wharf to the existing Government aerodrome. Two 100-ton steel barges and a steam lighter were acquired for landing the cargo from the ship's side to the pier. A 10-ton locomotive crane transferred the equipment to trucks, and the same crane loaded it into the aeroplanes. The Government aerodrome at Lae was lengthened, and was generally made more suitable for the large aeroplanes which it would now have to serve, and store-houses, workshops, and white and native quarters were built to house the pilots, mechanics, and the native labour which was to be used for handling the equipment and servicing the aeroplanes. Further, a suitable concrete loading apron with gasolene pumps was built. Due to the fact that the Lae aerodrome had little or no grade, and also on account of the very heavy rainfall at the coast, this aerodrome has never been very satisfactory, and at times it has caused a good deal of anxiety. It is hoped that a system of deep drainage, which is now in hand, will improve matters and make the ground safe for the landing of the heavy freight planes at any season of the year.

The construction of a suitable aerodrome at Bulolo was a major undertaking and it involved many months of work with large gangs of natives under white foremen. A sandy gravel site was chosen at the down-stream end of the property and just off the dredging area. The dense tropical jungle, with trees up to 4 ft. in diameter, was cleared for a length of roughly 4,000 ft. by 1,500 ft. in width, and all trees were cleared away from the end boundaries for a distance of 500 yd. After the aerodrome area was cleared and all stumps removed, the ground was graded so as to make the surface as uniform as possible. Fortunately, the site had a natural and gentle slope to the

river and this, with a large drain which was run on the top side, kept the aerodrome free of surface water and generally well drained. While the surface of the aerodrome was bare, the reflected heat of the sun gave the pilots some difficulty in keeping their machines at the correct altitude when landing. To overcome this the whole area was planted with "couch" grass. This grass took well and very rapidly spread and grew into a compact carpet about 12 in. thick. Continual cutting will cause the grass to develop a deep root system and bind the surface very effectively. The Bulolo aerodrome took seven months to complete, and it cost approximately $30,000. It is an excellent aerodrome and, since its completion, the only maintenance has consisted of keeping the grass cut. The planes weigh approximately 19,000 lb. fully loaded, and the tyres are inflated to 65 lb. per square inch. The continual landing of these heavy planes at 75 miles per hour has had little or no cutting effect on the surface of the Bulolo aerodrome.

Drainage is of the greatest importance in the selection of an aerodrome site. The time of construction can, of course, be reduced according to the labour and equipment employed, but it is desirable to allow a period of three months to lapse, for sowing with grass and allowing fillings to set, before putting a new aerodrome into heavy service. With good aerodromes the wear and tear of the machines, from actual landing and taking-off, is very small.

The loading and unloading of heavy awkward parts of machinery need careful attention, but, in spite of all care, the hatchway, and the sides and floor of the cargo compartment, come in for an odd bump now and again and so, after a while, the cabin shows signs of wear. Should any part of the cabin be badly damaged it can, of course, be cut away and replaced with spare material which is always kept on hand for repairing the body of the plane. To the end of March, 1932, each of the aeroplanes had completed approximately 625 hours of flying and, in the absence of a total loss by accident, it is probable that they will each be good for a further, say, 3,000 hours flying. In an isolated country, such as New Guinea, a large stock of spare parts is an insurance against delay—the company carried two complete under-carriages and enough material to construct a further under-carriage. A spare nose-piece, and certain tail parts, were always carried, together with a large supply of landing wheels and tyres. After the planes had been in use for a short time, the landing wheels commenced to collapse. This was brought about by the heat which was generated by the brake operating on the rim of the wheel, expanding the rim until it burst. Luckily no serious damage was done. The result was usually a rather dangerous swing just before the machine was brought to a standstill, a worthless wheel, tyre, and tube. The design of the wheels was changed and since then no difficulty has been experienced.

The aeroplanes are each fitted with three 525 h.p. direct-drive, 9-cylinder, radial, air-cooled Hornet engines; making a total of 1,575 h.p. per plane. This gives a low-power loading of just over 12 lb. per horse-power, which accounts, in a measure, for the quick take-off and rapid climb of the machines. The company has experienced very little trouble with these machines and the maintenance cost has been comparatively low. Three spare engines were acquired and a liberal supply of engine spare parts. The engines are run for about 200 hours before being removed from the plane for overhauling. Though only a "top overhaul" is then required, complete overhauls have always been made, as the extra cost and time incurred is more than offset by removing as far as possible the chance of engine failure from mechanical cause. While the life of an engine can be figured at about 2,000 hours, it is then usually possible for the makers to recondition the engine with certain over- and under-size parts, and start off on a second 2,000 hours.

At the Lae aerodrome the concrete loading apron was fitted with platform scales for weighing the tail of the plane. The aeroplane taxis on to this platform, always from the same end so that it will be in the correct position as regards the scales and fuelling part, and the locomotive-type loading crane then moves into its position, just behind the wing, for loading. The cargo is always loaded and unloaded from the rear so that in case of accident the load falls on the back, and more easily repaired, part of the fuselage, in place of on the wing or front portion.

It was anticipated that there would be a considerable amount of difficulty in loading and in fastening the cargo into the cabin. This was not the case, however, and it is surprising how little real difficulty was experienced in this respect. A good deal of care was taken in the packing and the shipping of the equipment, in order to ensure that it would arrive at Lae in such shape as would present the least possible difficulty in loading into the planes. Many of the heavier parts of the machinery were shipped without any casing or crating. In other instances pieces were crated or entirely cased. Some awkwardly shaped pieces were bolted to wooden frames, in order to present a flat base suitable for placing directly on the floor of the cargo cabin. Narrow steel plates and girders were laid flat on the floor of the cabin, while wide plates were carried standing on edge, leaning against an inverted "V" shaped frame, built down the centre of the cabin. Long plates were bolted together at intervals along the edge so as to stiffen them and facilitate loading. The upper tumbler shaft, which was 12 ft. long and weighed 7,000 lb., was carried in four cradles set on the main transverse members of the floor of the cabin. With heavy concentrated loads, such as the above, rubber pads were introduced between the load and the wooden cradles, to absorb shock in landing and in taxi-ing. Some of the less heavy parts were difficult to fit into cradles, but by putting a layer of bags of rice (which were continually being carried for food) on the floor as a base, these parts were satisfactorily carried by resting them on the bags.

Heavy pieces of machinery were fastened in position by light steel cables attached at intervals to the floor along the sides and ends of the cabin. The piece of machinery was lashed both fore and aft as well as both sides, about ten lashings being used on a part, such as the second motion shaft, which weighed 4,400 lb. The cables were fastened around the piece of machinery with wire clips, and drawn tight with turnbuckles. No trouble through cargo shifting has been experienced.

While the machine is being loaded the tail rests on the weighbridge platform. If the cargo has been correctly loaded the weight of the tail should be between 1,800 and 2,200 lb. Should the weight

be found to be above or below this amount, part of the cargo is adjusted forward or backward until the tail weight is within the required limits. In the early stages, the distribution of the load caused a good deal of delay, so that sometimes over 40 minutes was required for loading. After a short while, however, the man directing this work could judge the necessary distribution fairly closely, so that the loading time was reduced to 20 minutes or less. The buckets were loaded very rapidly; 2 buckets and 2 bucket-pins made up a load, and in 10 minutes the machine was ready to start off again, at least so far as the cargo was concerned, though, as a rule, the refuelling of the machine had not been completed by that time.

Unloading at Bulolo was done by means of a hand-operated stiff-leg crane and the time taken was about half that of loading—the main reason for this is that the lashing down of the heavy pieces took much longer than the unlashing. Further, the "unloaders" could often make one sling load of the whole cargo, as when the load consists of plates or girders.

For the reason that the aeroplane was designed to carry long pieces, as well as heavy pieces, it is impossible to fly the machines empty, so that ballast has to be placed in the aft compartment so as to bring the tail weight up to the required 2,000 lb. or thereabouts, on the return journey from Bulolo to Lae. Water ballast could be satisfactorily used, but as gravel was handy at Bulolo, and was an asset around the loading platform at Lae, gravel in bags was used for this purpose.

When heavy machinery is packed in cases it should, if possible, be securely bolted to stout members laid lengthwise on the floor of the case. Heavy packing cases are necessary for ocean transport, but it is expensive to carry them by air and, with the machinery packed as above, the sides, ends, and top of the case can be stripped off, and the machine or piece of equipment, together with the floor of the case to which it has been bolted, can be lifted into the plane and set down on the floor of the cabin. All cases and crates should have the gross and net weight clearly marked on them, and all uncrated machinery should have the weight marked on each piece. Further, large pieces should have the centre of gravity marked on them so as to facilitate loading. An inventory of each load should be kept in order that a load can be replaced with the least possible delay in case of accident.

The two dredges which have now been air-transported are exact duplicates and, further, the hydro-electric machinery for the power plant consisted of two identical units, each of which was capable of supplying power for one dredge and the workshops. The second dredge and the second power-house unit were landed at Lae in time, so that, in the event of a critical part of the first dredge or power unit being lost in an aeroplane accident, it could have been replaced from the second dredge or power unit, without delaying the commencement of dredging.

Three pilots were used to operate the two planes, each pilot making two, and now and again three, trips daily. Two mechanics were also required for each machine for engine maintenance, and one for inspecting the engines after flights. A mechanic, usually a junior, accompanied the pilot on the flight, for the purpose of starting up the engines and for the maintenance of the planes at the Bulolo aerodrome between the flights. White mechanics were employed on all maintenance work on engines and aircraft. Native labour, with white overseers, was used for receiving the cargo at the ship's side, and for transferring it to the aerodrome and also for the maintenance of the aerodrome, and for painting, cleaning and, in fact, for all unskilled labour.

It seems to have been generally thought that aircraft would not perform as satisfactorily in tropical as in temperate zones. This has not been found to be the case, however, and the aeroplanes have carried up to the maximum load set by the makers, without any evidence of being overloaded. Further, the machines, which have at no time been under cover, do not seem to have deteriorated from the effects of rain and sun. They appear to be living up to the makers' claim, which is to the effect that they can remain in the open in the tropics for the term of their usefulness. An occasional re-paint seems to be all that is necessary. Waterproof canvas covers are provided for the engines, cockpit, and hatch.

The average load carried was 5,400 lb., but when the Lae aerodrome is better drained, and its surface generally improved, there is no reason why this should not be increased to around 6,000 lb., or even more. The greatest number of flights made in any one day, with one machine, was five. Under ideal weather conditions five trips per plane could be made daily from Lae to Bulolo; with an average load of 3 tons per trip, this would mean the transport of 900 short tons per 30-day month. To have made a single round trip by road from Lae to Bulolo would, no doubt, have taken a tractor at least a week—had a road existed.

Flying was not attempted when the weather conditions were at all unsatisfactory. In order to reduce as far as possible the weather hazard, two wireless telephone stations were established, one at Lae and the other at Bulolo. While, on account of the topography of the country and perhaps also the climate, this service was not entirely satisfactory, it aided the flying to a considerable extent. Pilots were able to leave Lae in the early morning, as soon as the Bulolo valley was reported by wireless as being clear of fog and, further, machines could be held at Bulolo should the weather conditions at Lae suddenly become unsettled. Throughout the transport of the whole 2,500 tons, necessitating approximately 1,000 trips, engine trouble developed during one flight only. On this occasion the centre engine failed, due to installation trouble, and the loaded plane finished the flight, without difficulty, on the remaining two engines.

The total capital cost of the two Junker G–31 aeroplanes assembled, duty paid (10%), at Lae, together with three spare engines, a liberal supply of spare engine and aeroplane parts, and including certain machine tools for repairing and servicing the planes, was approximately $400,000. The Bulolo aerodrome and the extensions and alterations to the Lae aerodrome, including store-houses and staff quarters at Lae, cost roughly another $150,000, so that the total capital outlay was approximately $550,000. The aeroplanes were operated for Bulolo Gold Dredging, Ltd., by Guinea Airways, Ltd., under a management contract of £5 (Australian) per short ton, which also covered certain facilities in addition to the actual management. Including the above, the total field costs for the air-transport of 2,500 tons, including all handling of cargo from ship's side to the aeroplanes, amounted to £52,000

(Australian). This, at an average exchange rate of $3\frac{1}{2}$ to the Australian pound, works out at $182,000 or $72·8 per ton of 2,000 lb., or 3·64c. per lb. The total capital outlay for the equipment and plant, plus the cost of operating the planes for the transportation of 2,500 short tons, but excluding amortization of equipment and plant, was roundly $550,000 plus $182,000, or $732,000. In comparing "air" with "road" transport, it is perhaps fair that to this figure of $732,000 the cost of sectionalizing the dredges, and the extra cost of field erection be added. Mr. Griffin estimates the total extra cost of sectionalizing the two dredges at $10,000, and the total extra cost of field erection at $20,000, making $30,000 dollars in all. This then increases the above cost to $762,000.

About the only part of the dredge machinery that required a radical alteration in design was the upper tumbler. In order to keep the weight of the tumbler down, cushion plates were fitted to the body, and the wearing plates were bolted to these cushion plates. Many other parts were altered slightly, for example, the main driving bull-wheels were cast with the spider in halves, and the rim in four pieces. The tread-ring of the screen was cast in two pieces, which were then bolted together and electrically welded in the field. The length of all structural parts was kept within 22 ft. 6 in. While the cost of sectionalizing and the additional cost of erection has been charged against the total cost of air transport, it is a question whether, for the comparatively small amount of $30,000, it would not have paid to have sectionalized the dredges in this manner, had the company been transporting by road instead of by air.

Comparing the cost of road transport with the above, the author is able to make only a rough guess at what would have been the position had they embarked on road transport. To the estimated cost of $1,000,000 for road construction has to be added, say, $75,000 for hauling equipment and road house accommodation, together with, say, $125,000 to cover the actual cost of transporting the equipment over the road, and of maintaining the road. This is a total outlay of, say, $1,200,000, as against, say, $762,000 which has been expended in connexion with the delivery of the equipment to Bulolo by air. There is still a further and very important benefit which has accrued from the air transport: at least one year has been saved in time and, with a tentative profit of something over $20,000,000 in the Bulolo area, including the additional yardage recently acquired, the saving in interest, at 5%, by the earlier winning of this profit, is more than sufficient to pay the entire cost of the aeroplanes and the landing of the whole of the equipment for four dredges, and the power plant, from the ship's side to the site of erection at Bulolo.

Experience has shown that the sectionalizing of the first two dredges was really carried too far and, in the further two dredges a great deal more riveting will be done before the material is shipped to Lae.

ANTIMONY SMELTING

The smelting of antimony in California is described by W. Brazenall in the *Chemical Engineering and Mining Review* of Melbourne for June 6. The author states that when the War began in 1914, the Western Metals Co. of California was formed to smelt and refine antimony exclusively. A site was purchased at Harbor City of five acres, and the first unit consisted of a blast furnace (water-jacket type), with one small reverberatory furnace for doubling and a six-hole crucible furnace for starring the metal. The blast furnace was 5 ft. by 20 in. at tuyeres with six tuyeres $1\frac{1}{8}$-in. diameter. The shaft of the furnace was 19 ft. high to the charging floor, where a hood was fitted and a flue pipe leading down to the flues underground which led to the bag-house, containing 25 bags 20-in. diameter by 20 ft. long suspended from beams at the top of the bag-house. When the bags became loaded with oxide it was necessary for them to be shaken in order to allow the gases to escape. This was done by a labourer going into the bag-house and shaking the bags by hand, a very disagreeable job. The writer afterwards devised a means of shaking them from outside of the bag-house. The bags were made of heavily woven woollen cloth made from natural wool with the yolk left in, the yolk in the wool protecting to some extent from the action of the sulphurous acid gas. An exhaust fan 54-in. diameter and 18-in. discharge, driven by 10-h.p. motor, was used to draw the gases and fume from the top of the blast furnace and discharge them in the lower tubes connecting to the bags.

A small unit of the Cottrell process was installed for experimenting with the object of collecting the escaping oxide. This consists of 20 vertical tubes 25 ft. high and 10-in. diameter connecting with the chambers top and bottom. Rods were suspended from the top of these tubes through which a current of 10,000 volts was passed, the current being taken from the high-tension line of the Pacific Electric lines running into the plant. The Cottrell process was partially successful at the time, but was discarded for the bag-house owing to the non-continuity of the electric magnetic current. This was caused by the accumulation of the oxide on the rods preventing the current from further action until it was shaken off, which was done after cutting off the current. This caused losses of oxide unless done frequently. This is now overcome mechanically.

The fume carried over from the blast furnace consisted of a sulphy-oxide of a dark red amorphous powder which contained from 10% to 15% sulphur, as the furnace was operated with a cold top. Advantage of the sulphur contents was taken to burn itself free by stacking the sulphy-oxide in kilns or brick walls, igniting the sulphur in it, and allowing it to slowly smoulder away, leaving it in the form of a comparatively clean oxide. This was charged in the reverberatories and reduced to metal.

Two electric power lines of high-tension wires, 10,000 volts, were brought in from the Pacific Electric main lines and a switch and track were laid on each side of the loading docks to enable all supplies to be brought right into the works and all metal loaded within the works for shipment out.

The power plant consisted of one 30-h.p. motor

fitted direct to an 8-in. Baker blower. This furnished blast for the blast furnace at a pressure of 3-in. mercury. A complete pumping unit consisting of 2-in. centrifugal pump for circulating water up on to a cooling tower and tank 15 ft. high from which the water circulated through the jackets of the furnace by gravitation, the overflows being brought to a point where they could be observed by the furnace men at a glance. An oil pumping unit supplied the crude oil, under a pressure of 25 lb. to the sq. in., to the burners of the reverberatories and crucible furnace. This oil was a very heavy crude from local wells, costing at the time 3 cents per gal. The pipes were passed under the reverberatory hearth which heated the oil prior to going into the burners. The blast for the burners was supplied by a 4-in. Roots blower, delivering air at 1½-in. mercury.

The ores were obtained chiefly from the company's own mines in the Mojave Desert, California, Mexico, Chili, and Alaska, and consisted mainly of silicious sulphides, although considerable oxide was obtained from Sonora, Mexico.

The charges of the blast furnace were elevated to the charging floor by an electric elevator, being weighed in iron wheel barrows and wheeled to the elevator. The charges consisted chiefly of sulphide ores and were as follows :—Coke, 350 lb. ; sulphide of antimony, 810 lb. ; tap cinder or metallic iron scrap, 350 lb. ; limestone, 550 lb. The aim was to produce a well-balanced slag in order to ensure efficient running of the furnace. The following was the average content of the slag that gave satisfactory results :—SiO_2, 41% ; FeO, 27·5% ; CaO, 28·2% ; Sb, 0·7%. The blast furnace treated approximately 18 tons of the silicious ores per 24 hours' shift. The metal obtained from this furnace consisted of singles, i.e. the metal containing approximately 5% to 7% iron.

Before lighting up the furnace for a campaign the fire was kept on the hearth for a few days to get the bottom well heated. Wood was then filled in for lighting and coke for the first 6 ft. ; then alternate layers of coke and slag from the previous charge were charged in sufficiently to fill the forehearth ; then the regular charge was carried on. The first lot of slag was used to fill the forehearth by allowing the furnace to fill up to the tuyeres with slag and then tapped into the forehearth every five minutes until it was full to overflowing, when the top was chilled by throwing water on the top to make a good crust, after which a hole was broken through it under the spout from the furnace and the overflow opened. When the furnace was tapped into the forehearth the metal settled out in the forehearth and the slag flowed out from the overflow spout. The antimony and matte settled inside the forehearth, and the slag flowing out was comparatively clean, although after testing it was found that prills of antimony were found in the pots. It was decided after experimenting that by tapping the slag from one pot to the other, the slag remaining in the form of a skull in the first slag pot contained about 3 per cent. antimony, while the slag tapped out into the second pot was comparatively clean. The skulls from the first pot was charged with the ordinary charge, a good flow of slag being necessary to ensure a good reduction of metal within the furnace. This blast furnace was run in campaigns of about two months, depending on the supply of ore, and then closed down when ore supplies ran out. The metal from this furnace was then smelted in a reverberatory and sufficient sulphide ore added to it to remove the iron in the metal. This process was termed doubling. It was then tapped into moulds on a truck on rails which were laid under the tap hole, and as they were filled moved along, the dross being skimmed off the surface, leaving the metal covered with crystals of antimony.

The starring of the metal consisted of breaking the double metal into 2-in. cubes and charging it in crucibles together with carbonate of potash slag, especially made and called flux. The crucibles were placed in the crucible furnace, especially built into the floor, which had six holes each holding one No. 30 crucible, with a capacity of 98 lb. of metal and 3 or 4 lb. of flux. The crucibles were heated by crude oil, the flame being arranged to pass around them and smelting the charge in about 45 minutes. It was then lifted out with tongs and placed in a bow made with handles for pouring the metal from the crucible similar to a ladle. The moulds were placed together in pairs so that two could be poured at once, each weighing about 45–46 lb. By placing a triangular piece on the joining edges of the moulds the stream of metal was divided equally between the two moulds, allowing the slag to cover the metal.

After the first year of the war the cost of crucibles became prohibitive and other methods had to be used to obviate the use of them, and considerable experimenting was done. Finally, the double metal was tapped in ladles together with sufficient flux that had been prepared in another furnace and then poured in the ordinary way. The metal was cleaned of slag by chipping with picks made for the purpose and also by washing, as the carbonate of potash slag was very deliquescent. It had to be cleaned thoroughly, otherwise it stained the metal, causing it to lose its bright appearance.

After two years of the above practice it was decided to change from the precipitating method to the volatilization method and a blast furnace working with a hot top was erected, the same size as the first blast furnace, only having 3-in. tuyeres and supplied with blast from a 10-in. Sturtevant blower of the fan type discharging blast at water pressure of 1½-in. As it was intended to volatilize all metal contents of the ore into oxide, a hot top was maintained throughout and the whole of the metal contents put into oxide. A large Sturtevant 100-in. exhaust fan with a 30-in. discharge was used to draw off the gases and fume and discharge them into the especially large bag-house erected for the furnace, containing 120 woollen bags 20 ft. long and 20-in. diameter and connected with large chambers beneath for collecting the oxide. These chambers were fitted with valves so that each chamber could be shut off to enable it to be cleaned out whilst the others were in operation. Much of this oxide was used in the manufacture of porcelain and had to be kept to a certain solubility test and had to be a good white colour, consequently great care had to be exercised in regulating the heat on the top of the furnace. Pyrometers were used in order to keep the temperature at the right degree to ensure good colour. This oxide was packed in barrels by machinery, each barrel holding from 800 to 900 lb.

After installing the volatilization process all ore was made into oxide and the carbon and soda added and then charged into the reverberatory and reduced to metal in the usual way. The works were closed down in 1919 after running continuously for nearly five years.

THE TENNESSEE COPPER BASIN

A description of mining in the Tennessee copper basin is given by E. P. Poste in *Industrial and Engineering Chemistry* for June. The author says that the copper basin is located in the extreme south-eastern corner of Tennessee, bounded east and west by two ranges of mountains approximately five miles apart. To the north is a lateral ridge, five miles south of which the Ocoee River cuts across the district. In the basin the formation is metamorphosed sedimentary material of Lower Cambrian origin, with some small igneous bodies. The ore deposits are enclosed in the sedimentary rocks as calcareous replacements, the source of the mineralizing solutions being unknown. They lie at an average angle of about 30° from the vertical.

The lodes contain three distinct zones of ore. The outcrops are typical gossans with hydrated iron compounds predominating to depths of 100 ft. Below this zone is a layer of secondary enrichment high in chalcocite, locally termed "black copper," containing from 20 to 40% copper. Some free metallic copper is also found in this portion. Below this is a body of "yellow" sulphide primary ore extending beyond depths of exploration. The copper content of this material ranges from 1 to 2·5%.

After dealing with the history of mining in the basin, the author goes on to say that although more than fifteen mines are on record, only three are now in active production. The Tennessee Copper Company operates the Burra Burra and Eureka mines, and the Ducktown Chemical and Iron Company is producing from the Isabella mine. A separate shaft, known as McPherson, is a second entrance to the Burra Burra lode. The largest producer is Burra Burra mine, from which the normal daily output is 1,400 tons. This mine is at the northern end of the district. In the McPherson shaft, workings are being carried on at the 2,000 ft. level, the deepest in the basin.

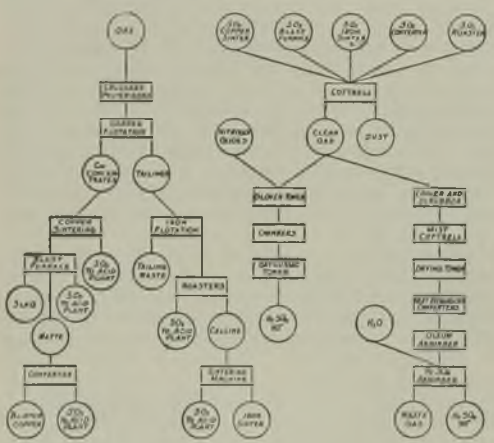
Eureka and Isabella mines are in the same deposit, on either side of the extensive limonite operations of the original gossan. These mines are relatively shallow, being worked at a maximum depth of 400 ft.

Ducktown Chemical and Iron Company.—All of the ores treated are reduced by two stages of crushing to a size of 0·5 inch and under, followed by wet-grinding in Hardinge mills to under 60 mesh. Fineness is controlled by a Dorr classifier. The pulp containing 35% solids passes through alkaline flotation cells, supplied with pine oil, creosote, and xanthate, for the separation of rougher copper concentrate containing from 6 to 8% copper. This material is further ground in rod-mills and passed through another alkaline flotation circuit to produce final copper concentrates (mainly chalcopyrite) containing from 15 to 17% copper. The tailings from the rough copper separation go through an acid flotation system for the recovery of iron concentrates (mainly pyrrhotite). The tailings from this operation pass a magnetic separator for the recovery of magnetite, which, with the pyrite tailings from the final copper flotation cells, is filtered to produce combined iron concentrates for roasting.

The copper concentrates are filtered out, sintered, and put through a blast furnace producing a 35% matte. This is reduced to blister copper in converters and sold to electrolytic refineries. The iron concentrates are treated in Herreshoff roasters, and the calcines are burned to iron sinter known as artificial iron ore, which finds a ready market at iron blast furnaces.

Sulphur gases from the copper sintering and blast furnaces and from the Herreshoff roasters go to the sulphuric acid plants. The gas contains from 6 to 7% sulphur dioxide and from 13 to 12% oxygen. Upon entering the acid plant, the gas passes through Cottrell precipitators operating at a voltage of 90,000 to 150,000. The recovered flue dust goes to the iron sintering furnace. A portion of the purified gas stream is conducted to the chamber plant, and the balance is further treated for the contact process.

The chamber plant consists essentially of one 24 by 24 ft. Glover tower, 40 ft. high, chambers totaling 1,000,000 cu. ft. in volume, and six Gay-Lussac towers. Nitrogen oxide gases are obtained by the oxidation of ammonia by one of two Chemical Construction Company units. Air is drawn through ammonia liquor, picking up the ammonia. The gas is then dried and heated by passing through a heat interchanger in going to the catalyst. The capacity of the chamber plant is 350 tons per day.



Ducktown Chemical and Iron Co. Flow-Sheet.

In further preparation for the contact plant, gases pass through coolers to remove excess humidity, followed by treatment in scrubbers through which 45° acid is circulated. To remove the "mist," the gas is drawn through another Cottrell separator, and then through a drying tower operating on 93% sulphuric acid. Then follows the blower which delivers the gas to the contact plant.

The contact units are three Selden heat interchanger converters installed by the Chemical Construction Company. Counterflow of incoming and outgoing gases effects thermal efficiency. Each converter contains 7,500 lb. of contact mass—6% vanadium pentoxide. Absorption is effected in 20% oleum to which pure water is added to produce 98% acid. The waste gases going to the atmosphere are free of sulphur trioxide. The rated capacity of the plant is 120 tons of 100% acid per day, and the conversion efficiency is between 97·5 and somewhat over 98%.

An elaborate system of control centres in a panel board on which are mounted Brown recorders

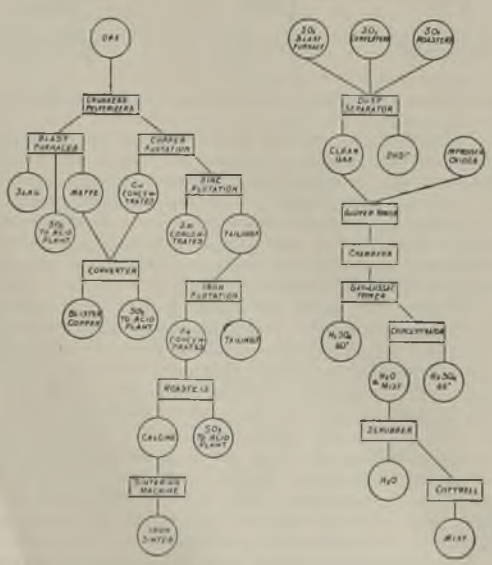
and indicators for temperature at various points in the converters, Englehard recorders for percentage of sulphur dioxide in gas entering the system, and Leeds and Northrup recorder for the strength of the finished acid which is held between 98·0 and 98·5%. It is possible to operate the plant at high efficiency at 50 to 150% of the rated capacity.

The contact mass has been in steady use since January 1, 1931, and shows no loss of efficiency. It is particularly free from the effect of any "poisons." Much of the pumping system is served with Meehanite equipment. This metal has been in steady use in pumps for 98% acid for 11 months, conditions fatal to cast iron in from 1 to 2 weeks. On 105% acid, parts show no serious effect after use for 9 months.

The products of the acid plants include the following grades of acid: 40% oleum, chiefly used in explosives; 20% oleum, under 0·002% iron content; 98·5% textile acid, largely used in oil refining and other chemical industries; 66° textile acid, made by cutting 98%; and 60° chamber acid (under 0·004% iron), for fertilizers, pickling, and other commercial uses. Both chamber and contact acids are free from arsenic. The finished acid storage tanks total 60,000 tons capacity.

Tennessee Copper Company.—The major portion of the ores from the Tennessee Copper Company's mines is separated by flotation, while a lesser amount is smelted by the direct or semi-pyritic process. Following the required crushing and grinding, the ores treated by flotation are processed in an alkaline pulp for the separation of copper sulphides, the tailings from which are further separated by flotation to produce zinc and iron concentrates. The zinc values are sold, while the copper and iron concentrates are further processed locally.

The smelting process is carried out in two stages. In the initial charge, silica and coke are included with the ore which is smelted in blast furnaces to make a matte containing about 14% copper. The melt is run into settlers from which the slag overflows, and the matte is drawn into ladles and, with the addition of silica, is ready for treatment in the converters. The matte from the blast furnaces and the copper concentrates from the flotation plant are processed in basic lined converters, and the resulting blister copper (99·4% pure) is cast into pigs and shipped to refineries in the north. The total output approximates 2,000,000 lb. per month. Some shot copper for the making of copper sulphate is also produced.



Tennessee Copper Co. Flow-Sheet.

The iron concentrate is treated in Wedge roasting furnaces, and the resulting oxidized iron calcine is sintered in a Greenawalt machine to form a 64% iron sinter which is sold to blast furnaces. This material is low in sulphur and phosphorus and, owing to its mechanical structure, is a very desirable raw material for the manufacture of pig-iron. The slag from the copper blast furnaces is crushed or granulated and marketed for ballast, road dressing, and concrete filler.

Gases from the blast furnaces and converters go direct to the acid plant, while those from the roasters are cleaned by means of Sirocco centrifugal separators. The sulphur dioxide content of the gas is about 7·5%. There are two separate acid plants with a combined output of 1,400 tons of chamber acid per day. The total chamber volume is well over 6,000,000 cu. ft., constituting the largest single sulphuric acid operation in the world.

Acid plant 1 was built in 1908–10 and plant 2 in 1916; the former is the larger. Nearly 8,000,000 lb. of lead were used in the construction. The two Glover towers are each 50 ft. high and 30 ft. in diameter. The gas flue from the Glovers to the cooling chambers is 10 by 20 ft. and is 120 ft. long. There are six cooling chambers, averaging 40 by 10 by 68 ft. The combined fan capacity is 150,000 cu ft. per minute. The subsequent chambers are as follows: twelve chambers are 50 by 50 by 70 ft.; six chambers are 50 by 50 by 75 ft.; and eight chambers are 23 by 50 by 80 ft.—a total volume of 4,000,000 cu. ft. There are ten Gay-Lussac towers: four are octagonal, 19 ft. in diameter, and 70 ft. high; four are round, 36 ft. in diameter, and 65 ft. high; one is round, 20 ft. in diameter, and 50 ft. high; and one is square (22 by 22 ft.) and 64 ft. high. The capacity of this plant is 930 tons per day.

The smaller plant 2 involves one Glover tower, 30 ft. in diameter and 50 ft. high; four horizontal chambers (236 by 59 ft.), 40 ft. high; and three Gay-Lussac towers in one block, equivalent to total dimensions of 64 by 72 ft. and 44 ft. high. The total chamber volume is over 2,000,000 cu. ft., and the capacity 470 tons per day.

Both plants are supplied with nitrogen oxide gases from an anhydrous ammonia oxidation installation of the Parsons type furnished by the du Pont company.

By means of a system of controlling the sulphur dioxide ratio between the chambers (devised by A. M. Fairlie), the plants are operated under varying conditions so as to maintain a constant sulphur dioxide percentage of 0·1% in the gases entering the Gay-Lussac towers, a conversion efficiency of 98·6%.

In addition to the chamber plants there are two large tower concentrators and one drum concentrator, heated by fuel oil. The water vapour and mist from the concentrators are passed through a scrubber for the removal of the former, following which the mist is removed by means of a Cottrell system operating at 75,000 volts. The capacity

of the concentrators is 180 tons per day. Two grades of concentrated acid are produced—a 66° commercial acid and a 66° textile clear product. The finished acid storage tanks have a total capacity of 30,000 tons.

Four grades of acid are marketed : 60° chamber, chiefly to the fertilizer trade ; 66° commercial concentrated, to oil refineries and other heavy chemical industries ; 66° textile ; and battery acids ranging from 1·225 to 1·835 in gravity.

THE LOAD TEST FOR REFRACTORIES

In the *Chemical Engineering and Mining Review* of Melbourne for June 6 H. Bittner discusses the testing of refractories under load and full extracts from his article are given here. The author says that the conditions to which a refractory material is subjected in various refractory-consuming industries differ greatly. There is no substance which combines all the desirable properties in itself. Many brands of refractories are on the market, but always to select the most suitable one for each individual use is not an easy task for the user. It is similarly difficult for the manufacturer to make some special stones or firebricks for the iron, ceramic, or glass industries. The simplest and surest way of finding out how a new material stands up in service is to build it in a furnace or kiln wall alongside an approved one and note what happens, but this method may prove expensive, when for some reason or other the material fails and the whole furnace or kiln has to go out for repairs involving cost and loss of production, and it may take a long time before results are available. This is the main reason why laboratory test methods have been devised. The results thus obtained give in most cases a fair indication as to the actual behaviour of the new material in service. In recent years the number of test methods have increased greatly, and they have been adopted in a definite form (which may vary in different countries) as a standard method. For Australia the committee for refractories has proposed to adopt the standard methods of U.S.A. as the standard methods for Australia.

Besides the chemical analysis, the porosity, the true, apparent, and bulk specific gravities, the compression, tensile and transverse strength at room temperature or at high temperatures, the impact strength, the cone melting point, the pyrometric cone equivalent, refractory materials are tested also for spalling and slagging, expansion and softening under load, and are examined in a thin section under a microscope for their mineralogical composition. To submit every new refractory body to all the above tests, the number of which could still be increased, would be a lengthy and difficult task. Manufacturers as well as the users will on the average be satisfied to carry out one, two, or at the most three tests only. They will have selected those of the above-mentioned methods which yield the most information. The writer considers as the most suitable the load test, whereby the movement at the height of the test piece is continuously recorded in relation to the rising temperature on a graph.

The first experiment to test refractories under load at high temperature dates back to 1905, but it was not until 1917 that this kind of testing became more fully developed. When reviewing the different methods for carrying out the load test now in use one can divide them into two main groups :—In the first group a static load, a fixed schedule of heating whereby the temperature increase does not want to be regular or uniform throughout the test, a fixed maximum temperature at which the test piece is kept for a definite period are main features. In this test big specimens such as full-sized bricks are used. The movement of the height of the test piece during the experiment is not registered. Here specimens are not tried until a complete failure occurs. After cooling down, the percentage of subsidence is measured and expressed in percentage of the original height. The principle of this method is based on some fallacies ; therefore this method has certain disadvantages as a standard test. These have been already fully discussed by Dale. Nevertheless, this type has become the standard method for testing of refractories under load in America since 1920, and was issued as a tentative in 1917.

A.S.T.M. Method.—Full size bricks of 9 by 4½ by 2½ = 228 by 114 by 64 mm. are placed in an 18-in. (457 mm.) tube furnace. Two bricks are tested at once. A load of 25 lb. per sq. in. is applied by a loading beam and transmitted on to the test bricks by means of two carborundum plungers. The heating is done with gaseous or oil fuel and compressed air. No less than two burners are used, which are located tangentially and so arranged that no flame can impinge upon the test specimens. The rate of heating, as well as the maximum temperature, is different for silicia and fireclay materials. The fireclay materials are distinguished in heavy duty, moderate duty and light duty materials.

The second group comprises all those methods where the test piece is tried until complete failure occurs or until it is compressed to at least four-fifths of its original height. A static load is applied, and the rise in temperature is constant during the whole period of testing. The movement of the height of the test piece is recorded on a graph in relation to the temperature. The apparatus may slightly differ in construction. Some workers have adopted methods of measuring the temperature of the test piece different from others. The temperature rise per minute may vary, but the principle is the same in all of them ; therefore it is proposed to describe briefly the atom machine for the load testing only as a representative of the second group.

The machine is designed to work at any loading required and will take a variety of forms of test pieces, but in order that the result shall be comparable a standard size should be used at all times. A cylindrical test piece of 50 mm. (= approximately 2 in.) in height and 2 in. in diameter is recommended. It shall be loaded with 1 or 2 kgm. per sq. cm. (= 14·2 lb. per sq. in. and 28·4 lb. per sq. in., respectively). The load of 14 2 lb. per sq. in. is also recommended because the load on the brickwork in modern furnace construction in the hottest part of the furnace hardly exceeds 14 lb. per sq. in.

The equipment consists of a carbon resistance furnace, the testing machine for applying the load and recording the expansions, the electrical control gear of the furnace and the pyrometrical equipment. The highly refractory middle tube

is 10 cm. (4 in.) inside diameter. The lower carbon anvil projects up centrally into the furnace. Upon this anvil the test piece is placed and the carbon disc is placed on top of it. Another carbon ram stands on top of the disc. The furnace is designed for a potential of 100 or 120 volts a.c. or d.c. current, and will take 12 to 15 kw. at 1,700° C. The rate of heating is 5° per minute, and uniform right throughout the test.

The load is applied vertically on top of the ram by a plate hinged on the free end of the loading beam. The loading beam has a fulcrum, the height of which can be adjusted by means of a hand wheel. The free end of the wheel is guided by a guide block which has a vertical movement in a guide bracket incorporating an adjustable stop—by means of another hand wheel. The guide block is suspended on a crank and operated by a lever. By this the loading beam can be raised to lift the plate clear of the carbon ram, thus taking off the load. The loading beam has suspended on it a loading pan to take the additional weights. The weight of the beam and the empty pan is such that it exerts a pressure of 20 kgm. upon the test piece, that is, 1 kgm. per sq. cm., if a cylindrical test piece of 50 mm. diameter is used. By placing additional weights upon the pan the load can be increased to any desired amount. The temperature of the top of the test piece is in this case measured through a hole in the plate and through the hollow upper carbon ram. A platinum thermocouple is used to 1,200° C., and afterwards an optical pyrometer. The recording gear consists of a lever arrangement with a pen which marks the movement of the test piece on a rotating drum in tenfold magnification.

When the test piece has squatted to approximately four-fifths of its original height the test is usually ended. The current is switched off, the load removed, and the upper carbon ram and the test piece are lifted out of the furnace. The practice adopted by Mellor and his co-workers is to use loads of 10 and 50 lb. per sq. in., but the German practice is only 1 or 2 kgm. per sq. cm. = 14·2 and 28·4 lb. per sq. in., respectively. Further, Mellor and his co-workers use rectangular test pieces 2 in. by 2 in. by 3½ in. height, and the rise is 10° C. per minute.

The resulting curve consists of a rising branch, which is followed by a descending one. The first is the result of the expansion of the test piece as well as that of the pressure rods and the anvil. The second branch is the result of the subsidence of the test piece minus the expansion of the ram and anvil. The point where the curve neither rises nor falls indicates the moment when the subsidence of the test piece just compensates the expansion of the ram and anvil. The corresponding temperature is wrongly described as the temperature of the beginning of softening. An apparatus whereby the expansion of all apparatus parts is automatically excluded and the real movement of the test piece alone recorded (the ideal way for testing) has not been constructed. Nevertheless the curves obtained by the present methods are well suited for comparing one material with another. Experiments whereby the furnace was heated up to 1,700° C. without a test piece and the upper and lower pressure rods rouching each other, yielded straight regular expansion curves. Every irregularity in the ascending as well as in the descending part of the curve is therefore due to structural changes in the test piece itself. The difference between the load test of refractoriness and the refractoriness determined by the ordinary cone melting point is especially marked with fireclay materials (alumina silicates). Fireclay test pieces start to subside comparatively early, but the range from the beginning of softening until the test piece collapses or its height has been compressed by 20% of its original value may stretch over several hundred degrees centigrade. The difference becomes more pronounced as the alumina content in the fireclay body increases. The same result is arrived at by increased pressure upon the test piece, but then we deviate from the rules laid down in the standard test. Nevertheless, experiments in this direction may, in some special cases, be of great value, when, for instance, a refractory has to stand a high load and high temperature at the same time. Fireclay material gradually shrinks with the height of the burning temperature and the length of the firing until the porosity has been reduced to approximately 2%. The first descending part of the load test curve is thus due to this after-shrinkage. The pressure accelerates the shrinking process similar to what a rise in temperature would have done; thus, a highly aluminous material with high porosity will, on load test, start to descend at a temperature far lower than it has been burnt to.

Here the author wishes to mention that this effect of pressure is helpful in burning refractories. If, for instance, a kiln of fire bricks is burnt, the weight of the overlying bricks by exerting pressure on the bottom courses of bricks where the temperature is always lower will make this bottom course of bricks reach a more advanced state of burning than the existing temperature here alone would have done. In this case the effect was unintended, but recently a patent has been taken out by Messrs. Salmang and Goeth which deals with burning refractories under pressure. In fireclay refractories the ascending part of the load test curve is generally a fairly even line unless the body is very heterogeneous, for instance containing large quartz grains. The descending part in some cases may show irregularities, when a short period of more or less sudden descending may follow a period of little or no subsidence (kinks). This can repeat itself. These kinks in the curve are likely to occur in highly-grogged and insufficiently-fired bodies. The longer and higher a refractory is burnt, the more the grains of grog and the matrix are interlocked by crystal growth (mullite, tridymite, etc., according to the composition of the matrix), the higher will be the temperature when the load test curve starts to descend and the shorter the range of subsidence. But the end temperature of any fireclay body is the same in nearly all cases. Only if the test fails through rupture (by lowering of its mechanical strength) or development of a sliding plane, the curve will end at a lower temperature. This failure of mechanical strength is more likely to occur with highly and coarsely grogged materials where vitreous grog is used. In this case the load test offers a criterion to select the right kind and amount of grog for special refractories. If experiments are done to compare the refractoriness under load of various clays it has been found necessary to prefire the test piece first to its sintering temperature and not as previously done to a fixed temperature of, say, 1,000 or 1,300° C. before starting the

load test. Then all kinks will disappear and the curve will be a smooth line in its ascending and descending part.

With silicious materials such as silica bricks the sudden volume changes of the various crystal forms of silica express themselves clearly in the rising part of the curve. So between 200 and 300° C. when beta cristobalite changes at 230° C. into alpha cristobalite, the volume change, here amounts to 5·6%. The volume change of tridymite which takes place between 100 and 150° C. of the curve is less pronounced, if at all. The change from gamma tridymite to beta tridymite occurs at 117° C. with a volume change of only 0·6%. If there is unconverted beta quartz present, a jump in the curve occurs between 560° C. to 600° C. (beta quartz 575° C. to alpha quartz volume increase 2·4%). This alpha quartz converts between 1,300° and 1,400° C. to alpha cristobalite with 17·4% increase in volume. The last two conversions are most pronounced in the load test curves of insufficiently burnt silica bricks which fail in service as a result of the sudden large expansions which weakens the bond between the silicate grains.

Silica bricks with a large tridymite content are identified by a more even expansion curve, as the volume changes from gamma to beta and alpha tridymite are comparatively small. When instead of 14·2 lb. per sq. in., as in the standard test, a higher pressure such as 50 to 75 lb. per sq. in. is applied the kinks indicating volume changes become very much less marked. Probably slight rupture in the grain itself occurs. Under higher pressure also silicious refractories fail earlier, though the influence of the pressure is here less marked as in the case of clay refractories. A special feature of silicious refractories is that of standing up to high temperature such as 1,600° C. and higher before subsidence begins. The range of subsidence is rather short, varying between 50° and 80° C., but in some special cases (tridymite bricks) ranges up to 150° C. have been observed. Failure through sudden rupture is far more frequent than with ordinary fireclay refractories. This may be explained partly by all silicia bricks closely resembling fireclay refractories highly grogged and the grog of a coarse vitreous nature where rupture also occurs frequently and partly by the bond, i.e., calcium silicate, being rigid up to high temperatures, but this becomes fluid in a short temperature interval. The influence of the atmosphere on the test has been studied by several workers. This is only marked when a refractory contains a considerable percentage of iron. Reducing atmospheres will convert all iron into the ferrous state, which is a many times severer flux than the ferric iron compounds are. As the atmosphere of the load test furnace is of a reducing nature, unless special precautions are taken the load test of iron containing refractories will show up less favourably.

GOLD TELLURIDES

In the *Canadian Mining and Metallurgical Bulletin* for July H. E. T. Haultain and W. E. Johnston give some account of the progress of research on the solubility of the gold in tellurides in cyanide. In opening their account of this work, the authors ask the question as to whether gold is soluble in cyanide and say that in the literature they can only find one attempt at a clear-cut answer. They say there are some descriptions of milling processes with figures showing that, after some preliminary process of roasting or reduction by hydrogen, good recovery may be made by cyanide from concentrates containing tellurides. There are some cases recorded where, by inference, at least some of the gold in tellurides is apparently dissolved by cyanide. This question has been a vitally important one for more than thirty years in many parts of the world. The great mining districts of West Australia, Cripple Creek, and later of Kirkland Lake, are noted for the small but rich content of telluride minerals and for the difficulties for their milling problems. How many millions of dollars have been spent on experimenting with these ores during the past thirty years in efforts to reduce the tailings losses? How many millions of dollars lie buried in the tailings heaps? Always the tellurides are the culprit, not by direct evidence, but by suggestion and inference. Everybody blames them but nobody has brought out sufficient evidence to convict. There is considerable literature on the milling methods of these camps, dealing with flow-sheets, machinery, grinding costs, special reagents such as bromo-cyanide and peroxides, roasting and reduction, but no information as to how much of the gold in raw tellurides is soluble in cyanide and little or no information as to tailings assays. Here, say the authors, the old adage may be safely considered as reversed. With tailings, no news is bad news.

From rich telluride specimens, they continue, the mineralogist has isolated several varieties, some containing gold, some silver, some gold and silver, some gold and base metals, and some base metals only, lead, bismuth, mercury, copper. He has analysed and named them and knows their hardness and specific gravity and crystal habit, but not a word about the thing that is really important. How much of the gold is soluble in cyanide? Why, in the face of the millions involved and the years in which the problem has been a live one, why this ignorance or this silence? The more the authors studied the literature, the more convinced they became that it was one of the strangest stories in all metallurgy. They have been able to find only one definite direct answer to the question from an authoritative source. In "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," by J. W. Mellor, on page 2, volume XI, they found this: "telluride ores do not give up their gold to mercury, to cyanide, or to chlorine." Kirkland Lake mill-men have some information which seems to contradict this, at least in part, for they find considerable tellurium in the matte above the bullion in their refining crucibles, and as much as 2% has been reported in the bullion itself. This tellurium must have been dissolved in the cyanide solution, and if tellurium, then presumably some of the gold that was associated with it was also dissolved. Yes—but how much? Is some of the gold in tellurides dissolved and some not? Does some yield to ordinary practice and some require special treatment, perhaps not yet discovered?

Some years ago the Department of Mining Engineering of the University of Toronto, aided

in part by the Nipissing Mining Company Research Fellowship endowment and by research funds provided by the University, commenced a study of certain of the fundamentals of gold milling. The progress was slow, as all fundamental research must be, and particularly so because the assistants were recent graduates, inexperienced in the necessary technique, who left for the field just as they were beginning to be useful. Working with the cyaniding of some Porcupine ores, the problems seemed comparatively simple. The main problem is to find the most economic percentage of recovery and is a field problem, not a laboratory one. In a laboratory, it was only a question of fine grinding and length of time of treatment to get as near to one hundred per cent extraction as our assaying could detect. The authors did produce some interesting information on the inhibiting effect of slimes and the importance of agitation in reducing the time of treatment, but then went on to other branches of the problem without publishing. With the Porcupine ores, neither extremely fine grinding nor great length of time was required to make a 99·5% extraction. When, however, they began work on Kirkland Lake ores, no matter what they did they could not reach these figures. They had five different lots of ore from four different mines. The results differed among the lots, but the best was considerably below the Porcupine results. All of which seemed to fit in with the general bad opinion of tellurides. Apparently, some of the gold was locked up in a chemical combination that cyanide would not break up. It was decided that it would be necessary to isolate these tellurides and bring them into contact with cyanide under conditions that would give results free from other disturbing conditions. With the aid of Dr. Ellis Thomson some polished surfaces of rich specimens were obtained and treated with various cyanide solutions. A steady stream of solution poured on the surface for more than a week failed to do more than produce a tarnish on some of the telluride surfaces and not even that on others. Later, the authors tackled in earnest the problem of separating telluride concentrates from the ore. They drew on everything in experience and devised new apparatus and developed new technique. They commenced experiments to obtain concentrates richer in these tellurides, but without any definite progress, chiefly on account of the difficulties of identifying the tellurides when in fine particles. Mr. Johnston spent some months simplifying the methods of tellurium analysis, but at best it was a slow process, a heart-breaking interruption to the other work. They consulted their microscopist friends and were told that if the concentrates were embedded in wax or bakelite and polished and etched with skilful hands and examined under the microscope by discerning eyes, they could be identified.

Fortunately, at this stage, there came to the authors the picture of the shovel and the blacksmith's forge, one of the earliest and most reliable tests for tellurides. They substituted a glass slide and Bunsen burner and a microscope. The particles of tellurides melted down into characteristic lakes with islands of gold beads, where they were gold-bearing tellurides and into empty lakes in the case of the base-metal tellurides. With this aid they rapidly developed new apparatus and technique and began to get small quantities, milligrams, of concentrates. The earlier tests with cyanide on these small quantities gave varying results and seemed to confirm the general opinion that, while some of the gold was fairly easily dissolved, some was not. The earlier samples contained considerable quantities of free gold, both as attached and detached particles. Some of this gold was extremely slow in dissolving.

Meanwhile, technique was improving and an attempt at quantity production was decided on, and, through the kindness of one of the managers, a quantity of ore from Kirkland Lake was obtained, and by long and laborious effort the authors succeeded in obtaining sufficient quantity of nearly pure telluride concentrates for a series of cyanide tests. The main difficulty was not in getting rid of pyrite and other sulphides but in freeing the tellurides from free gold. They had to work with very finely-ground material. Having obtained sufficient material, what they expected would be a lengthy campaign was commenced to determine the effect of varying quantities of cyanide, of lime, of time of treatment, of some special chemicals, such as bromo-cyanide and peroxides. At the outset it was found that cyanide and lime solution would dissolve over 99% of the gold in the telluride product in 48 hours of treatment! Repetition of the tests confirmed them. The authors had by no means made a complete recovery of the tellurides in the original ore, but their concentrates must have contained several different kinds of tellurides. Tests had shown that lead, bismuth, and mercury were present, and pyrex-glass slides showed lakes with different sized gold islands present and some that were silver in colour. Evidently there were a variety of tellurides in the product, and, as far as these tellurides were concerned, the answer to the question was clear and definite. The original lot of ore from which these tellurides were recovered was then cyanided and it was found that this ore was much more amenable to treatment than the first lots from Kirkland Lake. It approached much more nearly Porcupine results.

On heating the concentrates on quartz or pyrex glass to obtain the characteristic lakes with islands of gold, it was found that any pyrite present showed up as beautiful characteristic red particles, while chalcopyrite turned to a characteristic grey. As far as the authors can find out, this is an entirely new method of mineral determination. It has the advantages of extreme simplicity and rapidity. They consider that they have only started up the trail; it seems to have possibilities of development.

A number of photographs reproduced with the paper show the results of some of these tests on telluride particles.

West Nile and West Madi, Uganda.—In the annual report of the Geological Survey Department of Uganda for 1931, the director, Mr. E. J. Wayland, makes a short contribution on the mineral possibilities of the West Nile district and the Madi sub-district. Mr. Wayland says that in 1925 Mr. Simmons visited the West Nile district in order to obtain data for the International Geological Map of Africa, and during his rapid reconnaissance discovered an outcrop of asbestos. This occurrence did not apparently interest prospectors, who were informed of it, because their main object was gold. It was investigated by the writer in June, 1931. The asbestos, a remarkably long fibred but brittle material, was found to occur in what appears to be a raft or pendant of amphibole-rock surrounded

by more or less gneissose granite. The relationship of these two rocks was not, however, indubitably determined, for while the amphibole-rock appears to be floating in the granite, pegmatites piercing the former do not appear to enter the latter ; but this may possibly be due to differences in behaviour between the amphibole-rock and the granite (as manifested by shrinking and cracking) during the cooling of the latter. It has been elsewhere noted, for example, that dolerite dykes are more prevalent in granite than in the rocks which it intrudes. Most of the country rock of the asbestos veins, for there are several, is mono-mineralic, and medium grained. It consists of anthophyllite, but at least one band of biotite-magnetite rock is present. The asbestos is a fibrous anthophyllite, the fibres running, of course, at right angles to the length of the veins.

Small quantities of gold have been detected in the vicinity. Both West Nile and West Madi have in the past been subjected to much prospecting on the part of mining companies and private prospectors without encouraging results, but the writer, having examined the riverine deposits of a number of streams concluded that they, or at any rate some of them, are themselves derived from pre-existing deposits brought into being by a past drainage system which may, or may not, be related to the present channels. It is known that river-reversal has taken place over wide areas of Uganda, so that in some river valleys it would be necessary to look down-stream of gold occurrences in high-level placers and not in the present upstream direction for the source of the metal (in the Kafu Valley for example, *vide* Ann. Rept. 1926, p. 10) ; but so far as the West Nile streams are concerned it would seem that generally speaking neither upstream nor downstream search is likely to prove efficaceous (except by pure chance), and that what is required is the elucidation of the past drainage system, so that a fresh start may be made when this knowledge is obtained. With this end in view, an air survey has been made of part of the area. This will be followed by work on the ground. In consideration of the circumstances, the writer formed the opinion that auriferous deposits, at any rate rich enough for natives to work and thus ensure their poll tax irrespective of the fluctuations of the cotton market, might well be found, in spite of all the prospecting that had been done in the past, and as the Administrative Officer in charge of Madi was anxious to start, if possible, a gold winning industry in his district, he employed, after the writer's visit, a native prospector and thereby achieved results which well justified the hope. Indeed some of the finds are distinctly promising.

Another matter gone into was that of developing a local iron industry to be entirely in the hands of the natives (after the necessary preliminary supervision) from the winning of the ore to the marketing of the finished articles. This was started by the same Administrative Officer, and is being improved and carried on at present under his direction.

SHORT NOTICES

Open-Stope Mining.—The cost of open-stope mining is dealt with by M. J. Elsing in the *Engineering and Mining Journal* for July.

Incline Tipping.—In the *Journal* of the South African Institution of Engineers for June, G. W. Sharp deals with some important features of incline tipping.

Open-Pit Iron Mines.—M. H. Barber describes progress in the improvement of methods and equipment at open-pit iron mines on the Lake Superior iron ranges in Technical Publication No. 487 of the American Institute of Mining and Metallurgical Engineers.

Wire Ropes.—The selection, use, and discard of wire ropes for mines is discussed by C. D. Meals in the *Canadian Mining Journal* for July.

Mine Pumping.—C. W. Allen discusses the reduction of mine pumping expenses in the *Engineering and Mining Journal* for July.

Propeller-Type Fans.—In Technical Publication No. 484 of the American Institute of Mining and Metallurgical Engineers, A. S. Richardson describes a propeller-type fan at Moose shaft, Butte, Montana.

Natural Ventilation.—G. E. McElroy discusses natural ventilation in Michigan copper mines in Technical Paper 516 of the United States Bureau of Mines.

Placer Mining.—C. S. W. Barwell makes some observations on placer mining in the British Columbian *Miner* for July.

Sampling Alluvials.—The sampling of a gold placer deposit is described by D. L. Sawyer in the *Engineering and Mining Journal* for July.

Pipe-Lines.—In the *Journal* of the Institution of Petroleum Technologists for July, E. S. L. Beale and P. Docksey discuss flow in pipes in the critical region.

Tube-Milling. — F. Wartenweiler gives the results of investigations into the use of a composite grinding load in tube-milling on the Witwatersrand in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for May.

Gravity Concentration. — In the *Canadian Mining Journal* for July, E. F. Poncelet describes a new type of gravity concentrator, known as the vibro-settler.

Cement Copper.—Frank Ebbutt describes the recovery of copper from certain mine waters at Britannia in the British Columbian *Miner* for July.

Copper Determination.—B. Park describes the estimation of small amounts of iron in copper in *Industrial and Engineering Chemistry* (Analytical Edition) for July 15.

Sodium in Aluminium.—The chemical and spectroscopic methods of analysis of aluminium for determination of sodium are described by R. W. Bridges, M. F. Lee, and A. W. Petry in *Industrial and Engineering Chemistry* (Analytical Edition) for July 15.

Cadmium Impurities. — In *Industrial and Engineering Chemistry* (Analytical Edition) for July 15, H. G. Isbell describes the rapid determination of zinc and other impurities in cadmium.

Boron.—W. W. Scott and others describe a rapid method for the determination of boron in *Industrial and Engineering Chemistry* (Analytical Edition) for July 15.

Zinc Test.—Rinnmann's green test for zinc is described by A. A. Benedetti-Pichler in *Industrial and Engineering Chemistry* (Analytical Edition) for July 15.

Seismic Prospecting.—Reflection methods in seismic prospecting are discussed by H. M. Rutherford in Technical Publication No. 486 of the American Institute of Mining and Metallurgical Engineers.

Geothermal Gradient.—J. Fisher, L. R. Ingersoll, and H. Vivian describe recent geothermal measurements in the Michigan copper district in Technical Publication No. 481 of the American Institute of Mining and Metallurgical Engineers.

Magnetometers.—In Technical Publication No. 483 of the American Institute of Mining and Metallurgical Engineers, C. A. Heiland and W. E. Pugh discuss the theory and describe experiments with a new compensated magnetometer system.

Sea Level.—The use of mean sea level as a geophysical datum is discussed by H. A. Marner in the *American Journal of Science* for June.

Lead Ore Placers.—Dr. H. Bornitz describes lead ore placers in South Bolivia in *Metall und Erz* for July 1.

Mineral Resources of Asia.—The political and economic significance of mineral developments in northern Asia are discussed by Dr. J. Mackintosh Bell in the *Canadian Mining and Metallurgical Bulletin* for July.

Durban Geology.—In a paper read before the Geological Society of South Africa on April 25, L. J. Krige describes the geology of Durban.

Mount Isa.—The Mount Isa enterprise is described by J. M. Callow in the *Engineering and Mining Journal* for July.

French Indo-China.—Mining in French Indo-China is described by R. W. Karpinski in the *Engineering and Mining Journal* for July.

Cement Materials in Nyasaland.—The results of investigations in the properties of certain cement materials from Nyasaland are given in the *Bulletin* of the Imperial Institute for July (No. 2, vol. xxx).

Gold Mining Costs.—The cost of producing gold is discussed by S. D. Strauss in the *Engineering and Mining Journal* for July.

RECENT PATENTS PUBLISHED

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

4,872 of 1931 (373,217). A. S. Burman and I. Rennerfelt, Sweden. A hydrochloric acid extract of the ores of certain metals is mixed with alkaline or alkaline-earth chlorides and treated with sulphur oxides in a heated reaction chamber while the hydrochloric acid is removed, the process proving suitable for the preparation of chemical compounds and metals from refractory ores.

5,400 and 5,401 of 1931 (374,002-3). Precious Metals Developing Co., Inc., Newark, New Jersey. A thin coat of rhodium on silver surfaces, formed by electro-deposition from a solution of rhodium-ammonium-nitrite in dilute sulphuric acid, is found to preserve the natural appearance of the silver while rendering it untarnishable. In a modification of the process light coats of nickel, palladium, and rhodium are successively applied for the same purpose.

5,657 of 1931 (374,008). E. P. Dunn, Ferny Creek, Victoria. Molten slags are treated in a special apparatus in order to render them suitable for the manufacture of artificial stone, bricks, etc.

5,953, 5,954, 5,957, and 6,251 of 1931 (374,069-70-71-98). R. F. Bacon, New York. Ores or other metallurgical products containing sulphides of iron or other heavy metals are treated with a reagent such as chlorine, sulphuryl chloride, or sulphur chloride for the purpose of obtaining free sulphur and a concentrate of iron chloride.

6,323 of 1931 (373,298). E. G. T. Gustafsson, Stockholm. Ores are mixed with a suitable reducing agent and, if desired, a binding cement, made into briquettes, and treated in a suitable furnace for the production of metal sponge.

6,414 and 6,415 of 1931 (373,662-3). Minerals Separation, Ltd., London. Flotation process in which the ore pulp is agitated with a mono-thio organic acid or a derivative of a mono-thio organic acid in which the double-bonded oxygen and sulphur are attached to the same carbon atom.

6,505 of 1931 (373,667). Minerals Separation, Ltd., and S. Tucker, London. Froth flotation process for the concentration of oxidized minerals which is characterized by the conjoint employment, as reagents, of an organic sulphur-containing carbonic acid compound (such as a xanthate) and a sulphonated compound of a fatty acid or fatty oil (such as, for example, sulphonated oleic acid).

6,627 of 1931 (374,423). J. F. C. Friend, Newcastle-on-Tyne. The dry concentration of minerals is carried out in an apparatus characterized by the fact that the air or other gas blown into the material from below is periodically drawn downwards so as to cause stratification into layers of differing specific gravity.

6,680 of 1931 (374,486). H. Freeman, Shawinigan Falls, Quebec. Sulphide ores are burnt in a finely-divided form in suspension with a gaseous oxidizing agent, the temperature being maintained so high as to produce a fused black magnetic oxide, while the effluent gases are rapidly cooled in order to prevent the formation of SO_3.

8,251 of 1931 (374,900). Fried. Krupp Grusonwerk A.-G., Magdeburg-Buckau, Germany. Ores of zinc or of similar volatile metals are treated in a muffle built into a rotary furnace, the residue from the muffle being discharged into the rotary furnace, and there heated with reducing agents. In this way the heat of combustion provides the necessary heat for the muffles.

15,384 of 1931 (374,250). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Ores of molybdenum, tungsten, or vanadium are treated with chloride gases after admixture with carbonaceous material, at temperatures between 250 and 400° C., in order to convert the metals into volatile oxychlorides.

24,129 of 1931 (374,705). Beryllium Development Corporation, New York. Beryllium is recovered from silicate ores by treatment with a mixture of an alkali or alkaline-earth metal fluosilicate and fluoride and separating the reaction products.

33,844 of 1931 (374,376). C. W. W. Brown, Rugeley. Device for measuring heights.

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.

Gmelins Handbuch der anorganischen Chemie. System No. 59. Eisen, Teil B–Lief 5. Paper covers, pp. 873–1166. Subscription price, RM. 47·50; ordinary price, RM. 53·50. Berlin: Verlag Chemie.

Safety in Mines Research Board : Annual Report, 1931. Paper covers, 95 pages, illustrated. Price 2s. London : H.M. Stationery Office.

Transvaal Chamber of Mines : Annual Report, 1931. Cloth, 182 pages. Johannesburg : Hortors.

Uganda : Geological Survey Department Annual Report, 1931. Paper covers, folio size, 20 pages. Price, Shs. 2. London : Crown Agents for Colonies.

Lupa Goldfield, Tanganyika Territory. Bulletin No. 3, Geological Survey Department. By Dr. D. R. GRANTHAM. Paper covers, 34 pages, with map. Price, Shs. 5. London : Crown Agents for the Colonies.

Nyasaland : Geological Survey Department Annual Report, 1931. Paper covers, folio size, 12 pages, with two sketch maps. London : Crown Agents for the Colonies.

Sierra Leone : Geological and Mines Department Reports for 1930 and 1931. Paper covers, folio size, 28 pages. Price 2s. 6d. London : Crown Agents for the Colonies.

Oil and Gas in Eastern Canada. Canadian Geological Survey Economic Geology Series, No. 9. By G. S. HUME. Paper covers, 187 pages, illustrated. Price 30 cents. Ottawa : Department of Mines.

Gold Occurrences of Canada : Summary Account. Canadian Geological Survey Economic Geology Series, No. 10. By H. C. COOKE and W. A. JOHNSTON. Paper covers, 61 pages, illustrated. Price 20 cents. Ottawa : Department of Mines.

Canadian Geological Survey : Summary Report, 1931. Part A, 115 pages, illustrated. Part C, 93 pages, illustrated. Part D, 58 pages. Ottawa : Department of Mines.

British Columbia : Minister of Mines Annual Report, 1931. Paper covers, 254 pages, illustrated. London : Agent General for British Columbia.

Alleghany District, California : Gold Quartz Veins. United States Geological Survey Professional Paper 172. By H. G. FERGUSON and R. W. GANNETT. Paper covers, quarto size, illustrated, with maps. Price $2. Washington : Superintendent of Documents.

Pennsylvania : Geology and Coal, Oil, and Gas Resources of the New Kensington Quadrangle. United States Geological Survey Bulletin 829. By G. B. RICHARDSON. Paper covers, 102 pages, illustrated, with maps. Washington : Superintendent of Documents.

Theoretical Metallurgy : Contributions to the Data. 1. The Entropies of Inorganic Substances. United States Bureau of Mines Bulletin 350. By K. K. KELLEY. Paper covers, 63 pages. Washington : Superintendent of Documents.

Rock-Dust Barriers: Tests in the Experimental Mine. United States Bureau of Mines Bulletin 353. By G. S. RICE, H. P. GREENWALD, and A. C. HOWARTH. Paper covers, 81 pages, illustrated. Price 10 cents. Washington : Superintendent of Documents.

Ignition of Fire Damp by Explosives: A Study of the Process of Ignition by the Schlieren Method. United States Bureau of Mines Bulletin 354. By W. C. F. SHEPHERD. Paper covers, 89 pages, illustrated. Washington : Superintendent of Documents.

Sampling and Estimation of Ore Deposits. United States Bureau of Mines Bulletin 356. By C. F. JACKSON and J. B. KNAEBEL. Paper covers, 155 pages, illustrated. Price 15 cents. Washington : Superintendent of Documents.

Rubber-Sheathed Trailing Cables. United States Bureau of Mines Bulletin 358. By L. C. ILSLEY, A. B. HOOKER, and E. J. COGGESHALL. Paper covers, 53 pages, illustrated. Price 25 cents. Washington : Superintendent of Documents.

Prospecting and Exploration. By R. C. MATSON. Paper covers, quarto size, 45 pages typescript, illustrated. Price 60 cents. Michigan : Michigan College of Mining and Technology.

COMPANY REPORTS

Tanganyika Concessions.—This company was formed in 1899 and holds important interests in the Union Minière du Haut Katanga, the Benguela Railway, the Rhodesia-Katanga Company and other companies operating in Central Africa. The report for 1931 shows that the output of copper by the Union Minière was 120,000 tons of fine copper. Of this output 49,300 tons came from the Lubumbashi works, 29,700 tons from Panda, and 41,000 tons was produced by leaching and electrolysis at Chituru. The new ore developed during the year was approximately equivalent to that extracted, the reserves of copper metal being still in the neighbourhood of 5,000,000 tons, although this total does not allow for the results of recent work in South-East Katanga. The outputs of cobalt and radium were regulated so as to meet demand. As regards the company's other interests, a regular service from Lobito to the Congo and Northern Rhodesia has been established and although the present depressed condition of world affairs has seriously affected the traffic on the railway, the future is viewed with confidence. At Kansanshi, the Rhodesia-Katanga company's mine in Northern Rhodesia, work is at present confined to diamond drilling, while exploratory work at the Kilembe mine in Uganda, although giving good results, has been reduced to a minimum. The company has, in conjunction with its associates, taken an interest in the Eldoret Mining Syndicate, working on the recently developed goldfield in Kenya. The accounts for the year show a balance of profit of £294,103, which, added to the sum of £379,816 brought in, gave an available total of £673,919. Of this amount, £500,000 has been transferred to reserve and, after the payment of the preference dividend, there remained a balance of £171,280 to be carried forward.

Zambesia Exploring.—This company was formed in 1891 and it is closely associated with Tanganyika Concessions, Ltd., which company it floated in 1899. The accounts for 1931 show a debit balance of £18,612, reducing the credit brought in to £50,610.

Angola Diamond.—This company was formed in 1917 in Portugal and works diamondiferous deposits in Angola. The report for 1931 shows that 397,526 cu. metres of gravel was treated, as against 341,708 cu. metres in 1930, the production of diamonds rising from 329,824 carats to 351,495 carats. New workable deposits were discovered in the Lunda district, which are estimated to contain about 865,000 carats. The accounts for the year show a profit of £105,949, the balance available, after making various allowances and adding the amount brought in, being £108,428. Of this amount, £100,000 was distributed as a dividend, the balance of £8,438 being carried forward.

Rhodesia Broken Hill.—Formed in 1910, this company is working on lead-zinc-vanadium deposits

in Northern Rhodesia. The report for 1931 shows that the output amounted to 6,927 tons of zinc and 268 tons of fused vanadium oxide. In addition, 705 tons of vanadium concentrates was produced. The Mulungushi power plant operated successfully during the year. The accounts show an operating profit of £7,853, against a loss of £38,485 in the previous year, but, after making various allowances, there remained a debit to profit and loss of £17,927.

Ex-Lands Nigeria.—Formed in 1912, this company operates alluvial tin property in Northern Nigeria. The report for 1931 shows an output of 592 tons of tin concentrates, as compared with 495 tons in the previous year. The average price per ton realized was £78 7s., against £88 12s. 9d., the net costs rising from £52 10s. 1d. to £56 5s. 1d. The net profit for the year was £1,539, which, added to the sum of £27,101 brought in, gave a balance of £28,640, which was carried forward. The ore reserves at the end of the year were estimated to be 6,987 tons, of which 3,253 tons were proved and 3,734 tons partly proved.

Juga Valley.—Formed in 1927, this company works alluvial tin properties in Northern Nigeria. The report for the year to February 29 last shows that 88 tons of concentrates was produced, the output being reduced by 65·5 tons to conform with restriction conditions. The accounts show a working profit of £2,753, but, after making necessary allowances, this resulted in a loss of £11,809, which has been carried forward. The whole of the output for the year under review was obtained by hand labour at a cost of £60 16s. 8d. per ton f.o.r.

Junction Tin.—This company was formed in 1923 to operate alluvial tin properties in Northern Nigeria. The accounts for 1931 show a loss of £5,561, after allowing £3,857 for depreciation of plant, etc. The mine has now been closed down, the company having disposed of its quota allowance for what is stated to be a satisfactory consideration.

Boulder Perseverance.—This company was formed in 1923 and works a gold-mining property at Kalgoorlie, Western Australia. The report for 1931 shows that 84,108 tons of ore was treated, of a realized value of £205,744, sundry receipts bringing the total revenue up to £223,094. The total expenditure for the year was £185,087, leaving a net profit of £38,007. After deducting the debit balance of £2,104 brought in, there was available a sum of £35,903, of which £24,959 was distributed as a dividend, equal to 20%, the balance of £10,944 being carried forward. New plant is now in operation at the mine, the amount necessary for its completion having been met out of the enhanced price of gold.

Blackwater Mines.—This company, formed in 1906, works gold mining property in the Reefton district, New Zealand. The report for 1931 shows that 43,815 tons of ore was treated for gold realizing £97,957, sundry rents received bringing the total revenue to £98,459. Expenditure amounted to £61,169, leaving a balance of £37,290. After making allowances for depreciation, income tax, etc., the balance remaining was £21,985, which, added to the sum of £6,758 brought in from the last account, gave an available total of £28,743. Of this amount, £18,749 has been distributed as a dividend, equal to 1s. 6d. per share, leaving a balance of £9,994 to be carried forward. The ore reserves at the end of the year were estimated to be 84,046 tons, of an average value of 9·71 dwt.

Consolidated Gold Fields of New Zealand.—Formed in 1896, this company holds large interests in Blackwater Mines, Ltd., and in the Progress Mines of New Zealand. The accounts for 1931 show a loss of £337, reducing the credit balance brought in to £13,385.

Kent (F.M.S.) Tin.—Formed in 1926, this company works alluvial tin property in the State of Selangor, F.M.S. The report for 1931 shows that 1,556,270 cu. yd. of ground was treated, the yield of tin concentrates amounting to 306·42 tons, the company's output being restricted in accordance with conditions. The working profit at the mine amounted to £883, but after allowing for all expenditure, there was a loss of £800, reducing the credit balance brought in to £3,779.

Kramat Pulai.—This company was formed in 1907 and works scheelite and alluvial tin on its property in the State of Perak, F.M.S. The report for 1931 shows that 149 tons of tin ore was produced, as compared with 100 tons in the previous year, while scheelite ore sold during the year realized £28,750. The profit for the year, after making depreciation allowances, was £11,511, which, added to the sum of £6,226 brought in, gave an available total of £17,737. Of this amount, £10,000 was distributed as a dividend, equal to 10%, the balance of £7,737 being carried forward.

DIVIDENDS DECLARED

Blackwater Mines.—1s. 6d., free of tax.

Boulder Perseverance.—2·4d., less tax, payable August 3.

Consolidated African Selection Trust.—6d., less tax, payable August 4.

Consolidated Gold Fields of New Zealand.—9d., free of tax.

Golden Horse Shoe.—1s. (return of capital), payable September 16.

Henderson's Transvaal Estates.—5%, less tax, payable August 4.

Johannesburg Consolidated.—1s. 6d., less tax, payable September 22.

Kramat Tin.—6d., less tax, payable August 30.

Petaling Tin.—4%, less tax, payable August 6.

Rawang Concessions.—6d., less tax, payable July 30.

Wankie Colliery.—6d., less tax, payable August 3.

NEW COMPANIES REGISTERED

Kay Tin Mines (Kinta).—Registered as a public company. Capital: £100 in 1s. shares. Objects: To acquire Kay Yew (Kinta Valley) Tin Mines. Directors: C. A. Bolton, F. S. Hooker, D. B. W. Markham, and W. B. Harris.

Southern Kampar Tin Dredging.—Incorporated in Federated Malay States January 6. Capital: £300,000 in £1 shares. Objects: To acquire concessions, grants, claims, and licences, and to carry on the business of miners, etc. Directors: L. T. Williams, J. H. B. Will, G. H. Hutton, W. H. Edwards, and Sir William D. Henry. London Office: 55–61, Moorgate, E.C. 2.

Uralpa.—Registered as a public company. Capital: £10,000 in 2s. shares. Objects: To acquire concessions and search for petroleum and other mineral substances. Directors: M. McGuinness and C. Campbell. Office: 20, Copthall Avenue, E.C. 2.