The Mining Magazine

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EDITORIAL

THREE of the annual awards of the Geological Society of London will interest mining men. The Murchison medal and fund goes to Dr. A. L. du Toit, whose work in South Africa is widely known, while the Bigsby medal has been awarded to Mr. E. J. Wayland in recognition of his activities in Uganda and elsewhere. In addition a moiety of the Lyell Fund is to be presented to Mr. A. B. Broughton Edge in recognition of the value of his geophysical work in its application to geological problems.

IN the last issue of the MAGAZINE it was announced that the Anglo-Persian dispute would come before the Council of the League of Nations on January 23. After a statement of their case by the British and Persian Governments, both parties were persuaded to meet, M. Benesh being appointed *rapporteur*. Under his offices an acceptable formula was found, which, it is hoped, will lead to a satisfactory solution. The respective Governments have agreed to suspend proceedings before the Council until May and meanwhile the company will open negotiations with the Persian authorities for a new concession, its normal operations being continued during the progress of discussion.

THE new president of the Institution of Mining and Metallurgy—for the period 1933–34—is Mr. G. W. Gray, who, it is interesting to note, graduated from the Royal School of Mines in mining in 1899, the same year as his predecessor. He immediately proceeded to his first professional appointment as assistant manager of the Panuco Copper Co., Mexico, where he spent about a year, subsequently going to the Mountain Copper Co., California. In 1902 Mr. Gray was appointed mine and mill superintendent of the Loemar Mining Co., Dutch West Borneo, but four years later saw his return to Mexico as manager of mines for the Refugio Syndicate, and in 1908 he went to Russia as mine manager of the Kyshtim Corporation, only to return to America in about three years to become manager of the Pyrites Co., Virginia, which began his association with the group he has since been almost continuously identified with. His work in Spain commenced in 1913 on his appointment as chief mining engineer and deputy technical manager to the Rio Tinto Co. and except for an intervening period in consulting practice from 1921–27—when he was in partnership with Mr. William Selkirk—Mr. Gray has remained with them ever since, having been technical director since 1929. The president-elect became a member of the Institution in 1922 and was president of the Royal School of Mines (Old Students) Association in 1931.

Tropical Hygiene and Malaria Control

There was a good number of members at the January meeting of the Institution to hear the address by Sir Malcolm Watson, Director of Tropical Hygiene in the Ross Institute and Hospital for Tropical Diseases, on "Tropical Hygiene and Malaria Control on Mines at Various Elevations." The death of Sir Ronald Ross must be fresh in the minds of all and it is now widely realized how great an effect his researches had on the furtherance of engineering projects in the tropics, while the work carried on in London at the institute bearing his name has received welcome publicity by reason of the prominence given to its achievement in clearing the copper mines in Northern Rhodesia of malaria and coincident diseases. In addition many members have availed themselves of the courses of instruction in malarial control that are held at the Ross Institute each year and the practical advice given by those in charge has been readily acknowledged, a recent letter in these pages undoubtedly reflecting the general opinion. Mining men realize what may, perhaps, be best expressed in the lecturer's own words, that "the time is past when any business concern should force its way into the tropics, build its houses on the wrong site, lose a large percentage of its men, and then begin to 'tak' a thought and mend"; nevertheless, ever eager for further guidance, they formed an attentive audience on this occasion.

The education of the layman in matters connected with malarial control is of supreme importance, for, as Sir Malcolm pointed out, it is upon him that the burden ultimately falls. One of the most striking points arising out of the lecture and one which serves to emphasize the need for more general instruction in tropical hygiene seems to be that if malaria is present efficiency is also lost from other diseases, inasmuch as the malady

tends to lower the vitality of its victims and open the way to attack by other germs, the statistics collected during control work in Malaya affording a striking demonstration of this. In the course of the evening other important facts—almost disconcerting in their negation of preconceived ideas—emerged. For instance, tropical swamps are not regarded as necessarily malarial, the rice-fields of India, Malaya, Siam, and other places being, for example, singularly free from the disease, while the same is said to be true of artificial swamps containing mine tailings. The reason for this is apparently that those mosquitoes which carry malaria breed, as a rule, in clean water and water pollution—by the addition of mine tailings or decomposing vegetable matter—tends to lessen the risk of infection. Again, if it is impossible to kill the infected insects, it is possible to move away from the danger zone and sites at a distance of only half a mile from infected running streams have been found to be safe dwelling places. These three points seem to emerge from Sir Malcolm's discourse, which was concerned, as the title of his paper indicates, with an examination of work conducted on mining properties at varying altitudes, which has taken him far afield, to Malaya, India, Africa, and other parts of the infected tropics. The importance of a suitable site for headquarters is the plain lesson for those selecting a mine camp, while the prospector in new countries is warned not to camp near a stream and also well away from the nearest native village—practical lessons that have already been learnt by those who have had experience in the tropics.

The discussion was opened by Mr. R. E. Palmer, whose particular experience with malaria has been in southern Spain. His questions to the lecturer were pertinent, particularly when he referred to the natural instinct of the explorer to camp near running water. To all with tropical experience this must seem by far the most difficult mistake to eradicate, for, at the end of a tiring trek, a clearing near running water is irresistible to prospector and carriers alike. Following Mr. Palmer was Mr. A. D. Storke, who pointed out that malaria was a serious matter at the commencement of operations at the Roan Antelope mine and that great improvement resulted immediately the Ross Institute expedition took over the work of control, blackwater fever being a thing of the past in the Northern Rhodesian camps. The cost of the work at Roan Antelope is interesting, the capital outlay having been £25,000, a small amount in relation to the capitalization of the company and small indeed when reckoned against the resultant gain in the efficiency and happiness of the mine staff. Dr. Ramsey, whose work in India had been referred to by the lecturer, followed and his remarks served to show clearly the need for further research, for, as he stated, the problem is how to deal with a type of anopheles mosquito that breeds in clear water in exposed places and to find a plant to grow beside the streams in order to shade them. Other speakers included Mr. E. T. McCarthy, Dr. J. A. L. Henderson, and Mr. S. H. de la Mare, all of whom have had extensive experience in the tropics and whose questions and remarks added to the interest of the discussion. Sir Malcolm Watson, in his reply, showed that there were always difficulties peculiar to new sites and that co-operation between the medical man and the layman in control is the most important factor in overcoming the ravages of disease and promoting healthy and efficient work in tropical places.

The Rand and the Gold Premium

When South Africa left the gold standard the first step was taken which led to increased attention being directed to Rand gold-mining shares and at a meeting of the Transvaal Chamber of Mines last month Mr. John Martin, the president, made an important statement on the policy of the gold-mining industry consequent on the newly-created position. Mr. Martin pointed out that the uncertain exchange situation had created many difficulties likely now to be removed, but recommended that the adoption of a sterling basis should be the objective of the Union's monetary policy. He expressed the belief that those in charge of South African affairs had never been sufficiently impressed by the startling progressive decline in the industry that would have been inevitable under the old conditions, even though the recommendations of the Low Grade Ore Commission and the estimates of the Government Mining Engineer were fresh in all men's minds. The increased price now obtainable for the produce of the industry did much, in Mr. Martin's opinion, to improve its prospects, the question of bringing lower-grade ore and ore from greater depths into production having been an outstanding problem in the economy of gold, and he was

confident that under the different conditions something in the nature of a new mining policy would be evolved, in which full advantage would be taken to lower pay limits, to increase the ore reserves, to accelerate the development of ore-bodies at present being worked, and to forward the exploration of new reefs previously regarded as unpayable. At the same time Mr. Martin foresaw that the increased price of gold would ensure a substantially higher scale of working profits, so that to the detached observer there seems something contradictory in his review, which makes the position worthy of closer examination.

The mining of ore of lower grade or, in other words, increasing reserves by the addition of ground hitherto regarded as unpayable can hardly make for enlarged profits, for the treatment plants at the properties are not elastic and are in most cases already being worked to their full capacity. An increased scale of profits is only possible if the industry continues to treat ore of, let us say, 1932 grade and this could only mean that full advantage was not being taken of the new conditions to extend the lives of the mines. The industry cannot have it both ways and to obtain increased profits while mining lower-grade ore would only be possible by plant extensions such as hardly seem warrantable, unless it is felt that the present conditions are only likely to be of short duration. With regard to certain of the lower-grade properties—properties on the border line of profit and loss—conditions are, of course, greatly improved and in such cases an increase in the capacity of the treatment plant may be justified and the profits are likely to improve. A sane view would seem to be that the main effect of the departure of the Union from the gold standard should be to prolong the life of the industry rather than to provide an increased return to the shareholders, much of which has been discounted by enhanced price levels. It would seem that good profits over a longer period are better than increased profits over a short one, especially as the intentions of the Union Government with respect to new taxation and the attitude of labour to the present wage levels are quite unknown.

There is another aspect of the present situation that seems worthy of notice. It has often been stated that shortage of gold is largely responsible for the present world situation and we have been reminded that in some providential way depression has in the past been countered by the opportune discovery of new fields. Some observers consider any extension of the life of the Rand equivalent to such a discovery, but it is difficult to follow their reasoning. The points previously reviewed serve clearly to show how mistaken is such a notion, for present conditions can hardly contrive to stimulate production on the Rand—they may even have the reverse effect, for it must be realized that last year's profits can be maintained by a lower output. One is, therefore, forced to return to the sane view and to assume that the gold premium is unlikely to increase the annual output of the Rand, but should serve to prolong the life of the most important industry of the Union.

Gold in Kenya

Speaking at a luncheon held last month in his honour, Sir Albert Kitson, who has recently returned from Kenya on the conclusion of his work of inaugurating a geological survey and mines department for the colony, reviewed the prospects of the Kakamega goldfield, where he spent a good portion of his time. In the course of his remarks, he pointed out that the field was gradually changing from a purely alluvial state to one in which the reefs must be explored in depth and that the future of the field depends on the downward and lateral extension of the reefs, many of which have proved to be highly auriferous. That the gold is there is amply proved by the returns recently published, the output for the ten months to October, 1932, being estimated at 8,112 oz., as compared with 2,450 oz. for the same period of 1931. The increase is mainly from the new Kakamega field and comes almost entirely from the alluvial diggings. Apart from the function referred to, further reference to this field is called for in view of the publication of the main conclusions of Sir Albert's second report on the field, in which he deals particularly with the application of Tanganyika Concessions, Ltd., for an exclusive prospecting licence over an area of 5,900 square miles surrounding the field itself.

The Kakamega goldfield, as at present open to general prospecting, lies in the east of Central Kavirondo, the area applied for by the company mentioned running into Northern and Southern Kavirondo, in the latter down to the Tanganyika border. The

intense opposition felt in Kenya itself to the granting of this licence has already been referred to in these columns and it may be said at once that Sir Albert is in agreement with the opposition and would advise that the application, as it stands, be not approved. The offer of Tanganyika Concessions apparently proposed that a staff of 11 men—nine of whom would have been prospectors—should be entrusted with the work of exploration and it was estimated that this would mean, in addition, the employment of 330 natives. The minimum expenditure involved in the work was estimated at £20,700, spread over a period of two years. Sir Albert Kitson considers the proposed staff totally inadequate for a proper exploration of the area and he has formulated a scheme under which he considers the work would be more thoroughly carried out. He recommends the division of Kavirondo into five sections—First, part of North-West Kavirondo (1,550 square miles), extending north of the present field ; secondly, the area westward and south-westward of the extension of the Kakamega field and lying mainly in Central Kavirondo (approximately 1,000 square miles) ; thirdly, southern Central Kavirondo and northern and eastern South Kavirondo (approximately 1,720 square miles) ; fourthly, western South Kavirondo (approximately 1,140 square miles), and, fifthly, the Gori goldfield, in South Kavirondo (approximately 485 square miles). Of these areas Sir Albert advises that the second and fifth should be thrown open for general prospecting, as it is already known that gold occurs within them, while the other three should remain for the present closed, but that Tanganyika Concessions should be informed that the Governor is prepared to grant an option over one of them and to receive applications from that company, from other companies, or from individuals for portions of the remaining two. In the event of the company concerned refusing the option, then applications should be receivable for all three for exclusive prospecting licences over one or two year periods at an annual rental of 2s. per square mile.

It is evident from this summary of his report that Sir Albert Kitson is most critical of the offer of Tanganyika Concessions. He contrasts the expenditure proposed by the company with that likely to be spent by Kenya miners if the areas he recommends are thrown open to general prospecting. In such a case he foresees the activities of 200 men employing approximately 3,000 natives, which would mean, of course, an annual expenditure, actually within the colony, of, say, three times that proposed by the company, while the Kenya miners are now sufficiently experienced in local conditions adequately to prospect the ground thrown open and they have, in addition, a greater incentive to thorough work, as their only reward will be the fruit of their own endeavour. Such a course of action would seem to be of actual benefit to more powerful interests, for their prospecting would, in a sense, be done for them and they would be in a position to choose which discoveries are worthy of further investigation. With respect to the conditions under which new exclusive licences are granted, Sir Albert insists that these should include a considerably increased minimum expenditure, the employment of far more native labourers, and a definite detailed programme, rather than indications of a proposed course. It is evident, therefore, that Sir Albert does not intend that the new mines department of the colony should be ignored and considers that the superintendence of the results of carefully-planned work would occupy its time fully.

The publication of this new report—to which, as is stated in a prefatory note, the Kenya Government attaches the greatest importance—is likely to enlarge considerably the areas of native land affected by the gold discoveries and, if the authorities decide to throw open the new areas, they are likely to accentuate the controversy that has arisen over the temporary dispossession of the natives in the reserve. The reservation of mineral rights to the Government in order that they may be worked to the best advantage to the community has never been questioned, so that it is difficult to see how those who on anthropological and humanitarian grounds fear for the native can complain at the examination of the surface of areas where mineral is known to exist. The eagerness of the natives in the reserve to accept the new employment offered to the younger men seems a sufficient answer to the trepidations of those who fear the worst and who talk openly of the likelihood of native unrest. Before more country is thrown open to prospecting certain critics insufficiently acquainted with Central African conditions have asked for further deliberation. It might be as well to let them have it, for it would show them that their fears are unwarranted.

REVIEW OF MINING

Introduction.—The increased activity in South African gold-mining shares, consequent on the departure of the Union from the gold standard, has been an outstanding feature of the past month, but matters at the time of writing appear to be settling down to an appreciation of the real position. In the base-metal industry the outlook of tin has been distinctly improved by the January statistics, which reveal a diminution of 1,500 tons in the world visible supply, while that of zinc has been adversely affected by uncertainty as to the renewal of the International Cartel.

Transvaal.—The output of gold on the Rand for January was 919,125 oz. and in outside districts 48,332 oz., making a total of 967,457 oz., as compared with 980,618 oz. in December. The number of natives employed in the gold mines at the end of January totalled 222,005, as compared with 221,008 at the end of December.

Shareholders of Randfontein Estates have been informed that as the higher price being obtained for gold has made profitable an additional large tonnage of ore it has been decided to enlarge the reduction plant, bringing its capacity up to 10,000 tons a day. The estimated cost of the work is £210,000, while other equipment and work incidental to the larger scale of operations will involve a total capital expenditure of about £700,000, spread over two years. It is expected that the plant extensions will be completed by January, 1934.

As usual the quarterly reports of the Rand mining companies disclose several items of interest, especially as regards the ore-reserve position, as figures are calculated on the 1932 basis. In the Anglo American group Springs' reserves show an increase of 385,500 tons as compared with the previous year, while those at Daggafontein have been increased by 99,000 tons, although the grade in this case is a little lower. The ore reserves of West Rand Consolidated at the end of 1931 were estimated to be 5,028,000 tons, averaging 5·3 dwt., an increase of 10,000 tons in amount and 0·1 dwt. in value as compared with a year ago. The South Shaft at this mine intersected the Main Reef at 3,613 ft. and during December last reached 3,776 ft., at which No. 36 level station, the lowest level contemplated, was being cut. The report of the New Kleinfontein for the three months ended December 31 last discloses interesting developments in the Apex section, especially the finding of three more pay-shoots on the 10th and 12th levels, in view of which additional equipment is to be installed that will permit 3,000 ft. of development per month to be carried out instead of 2,000 ft. In the Gold Fields group the report of the Sub Nigel shows an increase in the reserves of 160,000 tons and it has been decided to increase the reduction plant to a capacity of approximately 41,000 tons a month, the construction work to start immediately.

The report of Crown Mines for the three months to December 31 last states that an application has been made for the undermining rights of an area equal to approximately 829 claims adjoining the company's southern boundary. It is stated that the company contemplates extending its treatment plant and increasing development.

The acquisition by Luipaards Vlei of the block of claims formerly worked by the French Rand and Tudor companies is expected greatly to extend the life of the mine and it is anticipated that efforts will be made to extend the scale of operations.

It is stated that arrangements have been completed between the South African Land Company and the Anglo American Corporation that will provide the funds necessary for prospecting the farm Witpoort by the Brakpan and West Springs companies.

The accounts of the Tweefontein Colliery, Ltd., for 1932 show a profit of £20,200, which, added to the sum brought in, gave an available total of £61,840. Of this sum £7,500 was absorbed in the payment of a dividend and bonus for 1931, while £7,500 went in preference dividends, leaving a balance of £46,840. From this amount it is proposed to pay dividends at the same rate as last year, absorbing £10,500, while £6,000 will be placed to a dividend equalization reserve, leaving £30,340 to be carried forward. The total coal sold by Tweefontein United Collieries amounted to 654,756 tons, against 725,977 tons for the previous year.

Southern Rhodesia.—The output of gold from Southern Rhodesia during December was 52,096 oz., as compared with 48,082 oz. for the previous month and 50,034 oz. for December, 1931. Other outputs for December were: Silver, 8,559 oz.; coal, 33,840 tons; chrome ore, 941 tons; asbestos, 1,944 tons.

Shareholders of Rezende Mines, Ltd., were informed last month that the reduction of capital having been sanctioned by the English Court, the date of repayment of 6s. 6d. per share had been fixed for January 31 last.

It was announced last month that a cross-cut on the Motor No. 27 level of the Cam and Motor mine had at 311 ft. encountered ore averaging 79s. per ton over a width of 16 in., while at 335 ft. a split portion of the Central Reef was found which assayed 387s. 6d. per ton over 24 in.

Northern Rhodesia. — Shareholders of the Roan Antelope company have been informed that it is proposed to discontinue the publication of monthly output returns, which will, however, continue to be included in the quarterly reports.

Gold Coast.— The report of the Ashanti Goldfields Corporation, Ltd., for the year to September 30 last shows a profit of £689,299, which, with the sum brought in, gave an available total of £775,440. Out of this sum two interim dividends, each of 25%, had been paid, absorbing £250,000, while a final distribution of 25% and a cash bonus of 2s. per share absorbed £375,000. In addition £100,000 has been placed to dividend equalization reserve and, after making other allowances, £26,484 carried forward. The ore treated during the year totalled 158,330 tons, yielding 175,063 oz. of gold and 10,717 oz. of silver. The ore reserves at September 30 last were estimated to be 642,100 tons, averaging 23·6 dwt. per ton, as compared with 667,400 tons, averaging 23·1 dwt., at the end of the previous year.

In a progress report issued to shareholders of Bibiani (1927), Ltd., last month it was stated that the erection of the new power plant had been completed and that treatment plant construction was progressing satisfactorily.

At the annual general meeting of the Ashanti Goldfields Corporation held last month it was announced that a pooling arrangement had been entered into by the Consolidated Gold Fields of South Africa, Ltd., the Anglo American Corporation of South Africa, Ltd., the Ashanti Goldfields Corporation, Ltd., and the Gold Coast Selection Trust, Ltd., for the formation of a development syndicate to operate in Gold Coast Colony. The last-named company offered its shareholders 300,000 unissued 5s. shares at par on January 26. It has engaged Mr. O. A. L. Whitelaw, late geologist to the Gold Coast Geological Survey, whose services will be placed at the disposal of the new syndicate.

Australia.—Reports of the Mount Isa company for the year ended June 30 last were available in time for the general meeting held in Sydney in December, but the presentation of a balance sheet has been deferred until the present year. The report of the general manager shows that 454,604 tons of ore was mined, consisting of 345,656 tons of carbonate ore, 97,690 tons of sulphide ore, and 11,258 tons of pyrite, and that 453,145 tons was delivered to the mill storage bins and 1,459 tons to the smelter. The mill, which started work in May, 1931, was not operating properly until June, but up to June 30 last 453,997 tons of ore, having an average value of 10·7% lead, 4·1% zinc, and 5·5 oz. silver per ton, was treated, producing 87,500 tons of concentrates averaging 44·4% lead, 5·5% zinc, and 21·9 oz. silver per ton. The output of the smelter was 38,008 tons of lead bullion, of which 36,310 tons was shipped to England for refining. The ore reserves at the end of the year were estimated to be 19,027,000 tons, mostly in the Black Star lode.

Interesting developments were reported in January by both the Great Boulder and Boulder Perseverance companies. At the Great Boulder a diamond-drill hole from Robertson's Shaft depressed at 45° struck no fewer than five lodes at vertical depths of 270 ft., 470 ft., 515 ft., 535 ft., and 550 ft., the last-named point being 15 ft. west of the east boundary. Assay values ranged from 8 dwt. to 184 dwt. per ton over widths of 72 in. to 9 in. At the Boulder Perseverance the 1,100-ft. level north drive had been extended 63 ft. north of the winze at the beginning of February, the ore at the end of the drive assaying 36 dwt. over a width of 13 ft.

The report of the Wiluna Gold Corporation, Ltd., for December last states that two further instalments of £25,000 each have been repaid on the issue of £300,000 6% seven-year notes guaranteed by the Australian Government, reducing the amount outstanding to £225,000. In view of the satisfactory progress made with plant extensions it is expected that the monthly tonnage treated will gradually be increased to 40,000.

Shareholders of South Kalgurli Consolidated, Ltd., were informed last month that while baling water on January 22 the

tank fell down the shaft, damaging the timbers below the 500-ft. level and causing a suspension of production. It was expected that repairs would be completed early this month.

New Zealand.—It was announced last month that the New Zealand authorities had granted to a group of British and New Zealand concessionaires the right to dredge for gold over nearly 20 miles of the Molyneux River between Cromwell and Alexandra and over approximately seven and a half square miles of the adjacent flats for a period of 40 years.

New Guinea.—An announcement made this month by New Guinea Goldfields reports the discovery of two new dredging areas near Bulolo. The first of these covers an alluvial flat 8 miles long by 1,500 ft. wide, while the second is 10 miles by 3,000 ft. The areas are at present being drilled.

Malaya.—At an extraordinary meeting of the Penawat (Malaya) Tin Dredging Co., Ltd., to be held this month, it will be proposed that the capital of the company be reduced from $5,000,000 in $1 shares to $2,500,000 in 50 cent shares by cancelling capital to the extent of 50 cents per share. The directors consider this method the best way of countering the fall in value of the company's assets and of placing it upon a dividend-paying basis as soon as possible.

Shareholders of the London Tin Corporation have been informed that the directors have decided to exercise the option they hold over 150,504 shares in Southern Kampar Tin Dredging, Ltd., which are held by Lower Perak Tin Dredging, Ltd., and to offer 150,000 of these to shareholders in the Corporation at 21s. per share. By this means the capitalization of the Southern Kampar Company will be completed and it will be possible to redeem the £150,000 of 7% debentures privately placed when the company was formed.

Siam.—At the beginning of February the directors of Kamra Tin Dredging gave particulars of a scheme by which it will be possible to redeem the 8% debenture stock outstanding, provided fully-paid shares are accepted in payment of half the holdings. If the scheme is approved, the necessary cash is to be provided by increasing the capital to £270,000 by the creation of 280,000 new 5s. shares and issuing 114,000 of the new shares at par.

Panama.—It has been announced by the Panama Corporation (Canada), Ltd., that the Margaja property has been leased to a Canadian mining group, which hopes to start crushing in about 12 months' time. As to the Remance mine, it is stated that this has been leased to an English company, which hopes to resume milling operations before the end of the year.

Bolivia.—The directors of Frontino Gold Mines, Ltd., have announced that the recent issue of 36,610 ordinary shares was oversubscribed.

Yugoslavia.—The report of Trepca Mines, Ltd., for the three months to December 31 last states that an agreement has been concluded with Belasica Mines, Ltd., for the acquisition of that company's undertakings, the purchase price to be satisfied by the issue of 59,667 shares in Trepca Mines, credited as fully paid. The Belasica company owns exclusive prospecting rights over 358 square miles of country adjoining that held by Trepca. The mill at Trepca treated 136,704 metric tons of ore during the period under review, producing 15,254 tons of lead concentrates and 22,270 tons of zinc concentrates.

Cornwall.—Interesting developments at the East Pool mine have been reported during the past month. A cross-cut north from the Moreing lode drive at 1,600 ft. encountered ore at 680 ft. on the North Pool sett, the cross-cut passing through 4½ ft. of ground assaying 35 lb. per ton black tin. After another 8 ft. of mineralized ground a further lode was encountered, of which the first 4½ ft. went 23 lb. per ton and the last 2 ft. 80 lb., the whole 6½ ft. averaging about 40 lb. per ton. After another break of 24 ft. a third lode, 3 ft. wide, was cut, the ore averaging 30 lb. per ton. Driving E. and W. has been started on the second lode and 5 ft. in each direction has been completed, the ore at the face going 85 lb. per ton over a drive width of 8 to 9 ft.

Anglo-Continental Mines.—The report of Anglo-Continental Mines, Ltd., for 1932 shows realized losses amounting to £19,395, which have been met from reserve, reducing that account to £36,354. The company is at present investigating a block of 28 claims in the Kakamega area, Kenya, in conjunction with the Fanti Consolidated Investment Co., Ltd.

Venture Trust.—The accounts of the Venture Trust, Ltd., for 1932 show a profit of £28,011, from which a dividend equal to 6d. per share free of tax is to be paid, leaving £15,700 to be carried forward.

THE CARDOX PROCESS

By A. IGNATIEFF, A.R.S.M., B.Sc.

The author gives a description of the principles, construction, and application of this blasting method to the mining of coal.

The Cardox cartridge involves an action differing in principle from the action of an explosive. A descriptive account of the principles, construction, and application to coal mining of this cartridge should, therefore, be of general interest to those who follow the progress of modernization in the coal-mining industry.

Broadly, the action of an explosive when detonated produces a sudden change of a chemical compound from the solid to the gaseous state. This change involves both chemical and physical reactions and is accompanied by great temperature and pressure rises which are suddenly applied; these are exposed to the coal in the bore or shot-hole and may be a source of danger in fiery mines. Again, the result of any explosive shot is influenced by factors that are dependent to some extent on the skill and experience of the person in charge of blasting—e.g., the amount of explosive charged into the shot-hole, the air-tightness of the complete charge, or the individual explosive cartridges, etc. It will be readily seen, therefore, that the breaking pressure of an explosive charge cannot be definitely regulated.

In the case of Cardox the action is purely physical, taking place within an indestructible cylindrical container or cartridge filled with a liquefied gas. The gas, in the form of liquid and vapour, is heated within the cartridge and the pressure is raised until a steel disc at one end of the cartridge is ruptured. The pressure of the discharge of gas is mechanically, and therefore accurately, regulated. Although all the stages of this action are swift, taking about 1/20th of a second in time, the ultimate discharge of gas has no shock-giving properties and breaks the coal along its natural cleavages without shattering. With explosives, however, the breaking is effected largely by the hammer-blow of the detonation. The gas originally contained in the cartridge in a greatly increased volume after the discharge spreads along the natural cleavages in the coal strata as a wave or gaseous wedge. The discharge pressure, accurately controlled by the strength of the disc, gives impetus to the large volume to perform its heaving work on the coal strata in expanding to atmospheric pressure. With a well-placed shot-hole the gaseous wedge will spread until the entire volume and pressure have been dissipated as energy in breaking the coal.

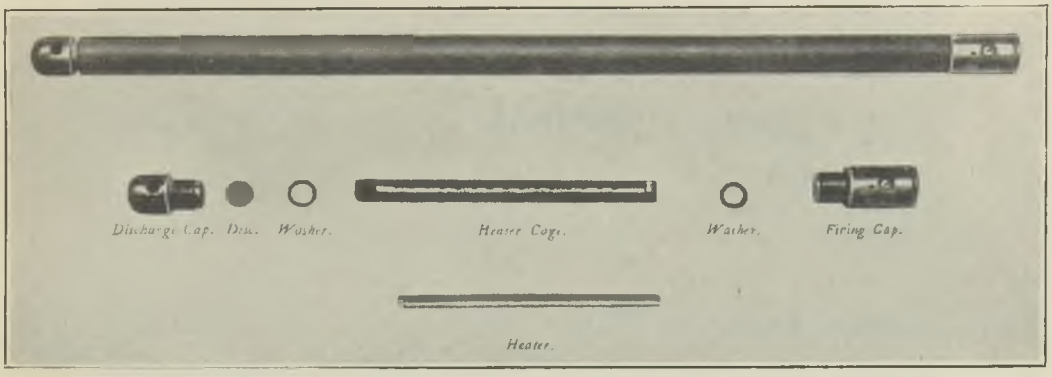

FIG. 1.—STANDARD CARDOX CARTRIDGE AND COMPONENT PARTS.

PRINCIPLES OF CONSTRUCTION. — The Cardox cartridge in its basic principle is analogous to the action of a boiler, with the exception of the disc—the safety-valve of the cartridge, which releases the pressure almost instantaneously and not gradually as in the case of the safety-valve of a boiler. The original design of the early cartridge in principle is similar to the old air-bomb, except that the inner or bore-hole end of the cartridge is fitted with a rupturable disc and the cartridge is made of indestructible material. The early cartridge was placed in

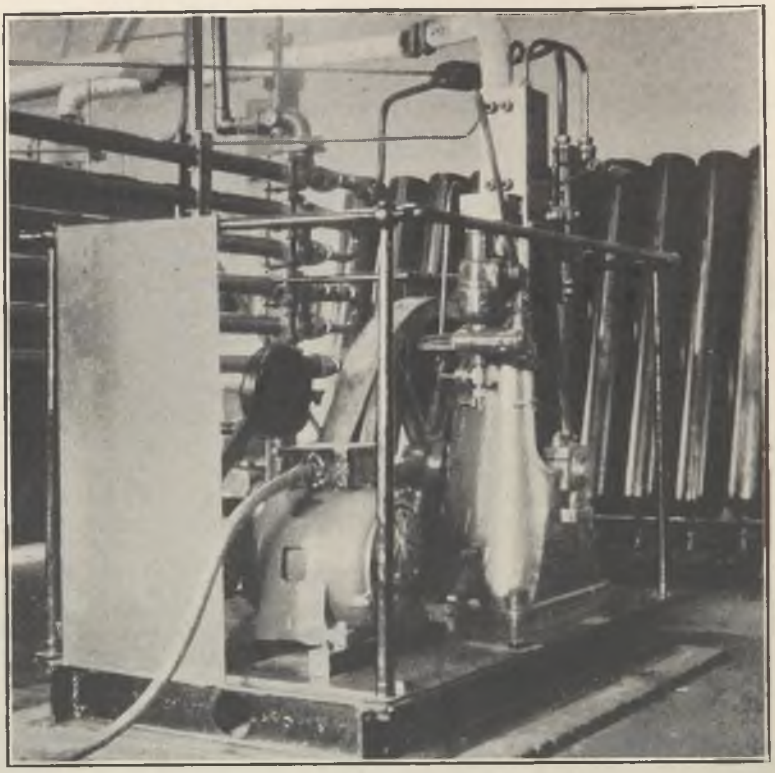

FIG. 2.—COMPRESSOR FOR CHARGING CARDOX CARTRIDGES—CO_2 FLASKS IN BACKGROUND.

the bore-hole and then filled with compressed air or carbon dioxide until sufficient pressure was generated to rupture the disc.

Carbon dioxide has a number of physical properties which are advantageously utilized in the functioning principle of the Cardox cartridge—

(1) Carbon dioxide is easily liquefiable at moderate pressures and temperatures.

(2) Liquid carbon dioxide has a low latent heat.

(3) The critical temperature of carbon dioxide is low. Other gases could be used, but carbon dioxide lends itself particularly well for the purpose for which this cartridge is designed.

All early work in connexion with the development of the cartridge was carried out in the United States, but further improvements in design have been made here for the particular conditions and requirements in this country. There have been several types of cartridges evolved for various charges of liquefied carbon dioxide, the first type being known as the "A" cartridge. This model measured 39 in. long and had an outside diameter of $3\frac{1}{16}$ in. and a liquefied carbon dioxide capacity of about 4 lb. The diameters of the cartridges have been gradually reduced, resulting in a substantial reduction in weight, together with a reduction in capacity of liquefied CO_2.

The four types of cartridges which have been submitted to tests at the Safety in Mines Research Station, at Buxton, and authorized by the Mines Department are—

	Approx. Weight.
3 in. or G80 type, CO_2 capacity 48 oz., 31 in. long	40 lb.
$2\frac{1}{2}$ in. or C74 type, CO_2 capacity 44 oz., 40 in. long	$32\frac{1}{2}$ lb.
$1\frac{3}{4}$ in. or B37 type, CO_2 capacity 22 oz., 42 in. long	18 lb.
$1\frac{3}{4}$ in. or B20 type, CO_2 capacity 12 oz., 25 in. long	$11\frac{1}{2}$ lb.

The choice of any type of cartridge for use in coal depends, of course, on the particular characteristics of a given seam and to a smaller extent on the method of mining. Broadly speaking, the size of cartridge required for a given seam is proportional to the thickness of the seam, but often in a seam of only moderate thickness, if the coal is heterogeneous, a larger-capacity

cartridge is preferable to a smaller-capacity cartridge, which would be advantageously used in a seam of the same thickness, but with the coal of a more homogeneous nature. In the United States the practice is to use the largest possible capacity cartridge where deep undercuts are prevalent, as it is obvious that the larger the volume the greater the spread of CO_2 in the coal strata.

In this country the B37 $1\frac{3}{4}$ in.-cartridge is used almost exclusively, as this type has been found to give the best results in the seams of medium thicknesses and the prevailing depths of undercut.

The purpose of the discharge cap is to permit the release of the gaseous CO_2 from the cartridge into the coal. The cap is screwed into the cartridge against a steel disc. When the deflagration of the heating element is completed and the pressure of the gasified CO_2 is raised sufficiently to rupture the steel disc the gaseous contents issue through axial holes in the discharge cap and commence their breaking action on the coal. Fig. 1 shows the component parts of the $1\frac{3}{4}$-in. diameter B37-type cartridge.

The composition of the heating element as approved by the British authorities is

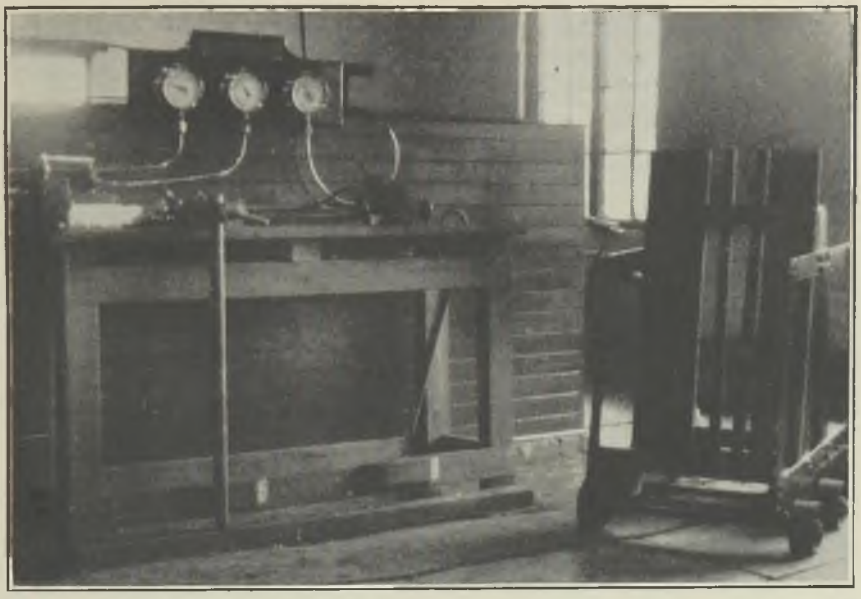

FIG. 3.—CHARGING BENCH; THE INSULATING HOUSING OF THE COOLER CAN BE SEEN IN THE BACKGROUND.

The Cardox cartridge consists essentially of a tube and three main component parts known as the firing cap, discharge cap, and heater cage. The ends of the tube are screwed internally to receive the firing cap and discharge cap. When the cartridge is placed into position in the bore-hole the firing cap is at the outer end and the discharge cap is at the inner end or bottom of the bore-hole. The heater cage is a small perforated steel container for carrying the heating element or heater within the cartridge.

The function of the firing cap is—

(*a*) to fill the cartridge with liquid CO_2 and

(*b*) to complete the necessary electric circuit between the firing battery and the electric fuse of the heater.

insensitive to impact and friction and the heating element with a low-tension electric fuse is contained in a Kraft-paper tube, one end of which carries the electric contacts to the firing cap. The firing cap has two transverse holes, which are used for attaching the shot-firing cable to the cartridge by means of two tubular inserts fitting into these holes. These electric contact ports or holes are of positive and negative polarity respectively. The centre, or positive, hole connects to the heater internally through a central spindle or electrode, while the eccentric hole carries the negative return through the steel body of the cartridge.

When assembling the cartridge for charging with liquid carbon dioxide the heater is placed into the heater cage, which is plugged

at one end and threaded at the other to engage into the internally-threaded end of the firing cap. When the heater cage is screwed into the firing cap the electrical circuit is automatically complete. The firing cap and heater cage when assembled is screwed into one end of the cartridge against a sealing shoulder, while the discharge cap is similarly screwed into the other end of the cartridge against a sealing shoulder, on which is previously placed a gasket and a shear disc. The cartridge is then ready for filling with liquid carbon dioxide and this is done through the side port of the firing cap, of the first charge will gasify and thereby cool the cartridge and it is usual to blow off this expanded gas to lower the temperature of the cartridge, so that a denser volume of CO_2 may be admitted into the cartridge.

A more rapid and uniform charging operation is obtained by a small compressor plant, working on the principle of self-refrigeration. The CO_2 from the cylinders or flasks placed in an inverted position on a rack is passed through a calcium chloride dryer to extract any moisture in the liquid and then into the system through the "cooler." This is an assembly of double concentric pipes and in

Fig. 4.—Inserting the Cardox Shell in Hole.

a corresponding socket being provided at the opposite side of the firing cap for use in clamping to the charging head for filling.

The cartridge body and component parts are made of special steel to resist wear and corrosion, making the assembly robust so that replacements are not often required.

Charging of Cartridges. — The liquid carbon dioxide is supplied in flasks or cylinders containing 28 or 40 lb. of liquid CO_2 at a pressure of about 600 lb. per square inch. The cartridges can be easily filled by directly connecting them to the cylinders or flasks supplied by means of piping and suitable charging clamp fitted on to the cartridge. A charge of liquid CO_2 will flow into the cartridge by reason of the difference in pressure and it is usual to aid this flow by inverting the cylinders. A large proportion a refrigerating plant would be termed an evaporator. Expansion of the liquid CO_2 takes place at the entry into the outer pipes, thereby cooling the higher pressure liquid (used for filling) which flows in the inner pipes. The temperature is controlled by regulating the expansion valve. The expanded gas is drawn through the 5 h.p. compressor, which raises its pressure to 800–900 lb. per sq. inch and the gas is condensed in a water condenser, where the heat of compression is removed. Through the outer pipes flows the water that cools the hot compressed gas flowing in the inner pipes and the gas condenses towards the bottom of the condenser and flows into a receiver and is drawn off again through the cooler or evaporator for filling. The pressure of the liquid is controlled by the amount

Fig. 5.—Position of the Cardox Shell after Discharge: Note the lump coal heaved outwards.

admitted to the system and the temperature of condenser water. It is usual to maintain the pressure of the high-pressure liquid for filling at about 67–70 atmospheres and its temperature at -5 to $+5°$ F. Cartridges can be filled in one half to one minute. Any of the expanded gas can be returned to the suction side of the compressor through a separate connexion from the charging clamp. The layout is very flexible and little supervision is required for the running of this plant. (Fig. 2 shows the compressor in the foreground and the CO_2 flasks can be seen in the background. The condenser

Fig. 6.—Face Shot by Cardox in a Thick Seam.

is to the left. Fig. 3 shows the charging bench and in the background the insulating housing of the cooler.)

Application of Cardox in Coal Mining.—The greatest claim Cardox has over explosives in coal mining is that its use brings about an appreciable increase in lump coal. Cardox can be used anywhere where coal has to be broken by explosives or mechanical means and is applicable to any and all systems of winning coal. In recent years, with the introduction of conveyor loading in progressive mines, a means of reducing the quantity of slack obtained from breakage in transit by conveyors has been sought for and this has been fulfilled by Cardox. It is found that fewer shot-holes are required for breaking a given face or working with Cardox than in the case of explosives and these shot-holes can be placed in such a way as to give maximum work for the cartridge to perform without unduly overloading it. When undercutting is carried out a deep undercut is often advantageous, as the gas has more area to spread into the coal before commencing its wedging action from the solid coal.

In hard and thick seams it is often necessary in the case of explosives to increase the charge to its permitted limit and this entails undue shattering of the coal due to the localized detonation of the heavy charge, whereas with Cardox the shot-holes may be placed at shorter distances apart to obtain the desired results without any shattering taking place.

The method of underground handling of Cardox is similar to that of explosives. No great skill is required to operate this device, as the method of discharging the cartridge is similar to that of electric shot-firing. There is, however, added safety in the absence of a detonator and explosive charge. The cartridges may be taken underground in tubs or wagons allotted for the purpose to each district or section as required.

Fig. 7.—Loading Cardox-Shot Coal into Tubs at Gate-End Loader.

The shot-holes drilled for Cardox may be by hand or power. Some excellent rotary compressed-air or electric machines have been developed by well-known drill manufacturers. The drill steel usually consists of the auger type, with a special cutting bit attached to the end of the drill. The bits can be conveniently detached from time to time and resharpened. These power machines are hand-breast models and are very convenient for use on longwall faces. Stand or platform machines are also used, chiefly in development headings or thick seams. In the hand-drilling machine, which may be either of the breast or stand type, an ordinary twist drill steel is used.

The method of connecting the cartridge to the shot-firing battery is by means of

a cable and two short lengths of cotton-covered, tinned-iron wire connected to the two leads of the cable at one end and to the two tubular inserts at the other for fitting into the transverse holes in the firing cap already described. When ready for shooting the cartridge is placed in the shot-hole in the usual way with the aid of a rammer stick and stemmed with ordinary semi-dry clay. The cartridge is discharged in the ordinary way with the low-tension single-shot approved-type exploder.

Fig. 8.—Tubs of Cardox-Shot Coal at Pit Bottom.

The advantages claimed by Cardox over explosives may be summarized as follows :—

(1) The pressure of the discharge of a cartridge is much lower than the pressure of detonation of an ordinary explosive, even black powder. The breaking of the coal is effected by a large spreading volume instead of a localized, hammer-blow action. The discharge from a Cardox cartridge has not a shattering effect, such as that produced during detonation of an explosive. The coal broken is, therefore, structurally stronger and in larger lumps, which resist disintegration from transport or weathering. Comparing the power of Cardox with explosives, it is found that proportionally more coal is broken by the "blowing" action of Cardox than with a known charge of explosive which may give an equivalently greater swing in the ballistic pendulum (the means of comparing relative strengths of explosives).

(2) The roof of the working is not disturbed by the mild action of the discharge of a Cardox cartridge, as the expanding gas travels no farther than the defined parting between coal and roof. This is a great advantage in seams where the roof is tender, as the shattering of the roof often entails a waste of time in dressing and timbering the disturbed part.

(3) The coal is broken cleanly to the back of the undercut and to the roof.

(4) The use of Cardox is a distinct step forward in the general safety of shot-firing operations. In the true Cardox action the whole of the heater must be consumed to raise the pressure of the gas within the cartridge in order to rupture the disc. Carbon dioxide does not support combustion and is a bad conductor of heat.

(5) There are no noxious fumes from the discharge of a cartridge and consequently the operations in a working need not be suspended, as in the case of explosives, with which it is often necessary to wait for the clearance of smoke and fumes.

Although this process has not long been established in this country, a number of

progressive mines have adopted this method of breaking coal and have found that, apart from the added safety, it is highly remunerative. Cardox increases the proportion of lump coal in the output of the mine and lump coal, as is well known, is marketed at a higher price than small or slack coal. Thus the average selling value of the output is substantially raised and, therefore, the net profits are increased.

The author is indebted to Cardox (Great Britain) Limited for permission to publish this article.

LIGHTNING.—IV

By JOHN F. SHIPLEY, M.I.E.E.

In this, the last of a series of four articles, the author discusses the nature and causes of breakdowns of electrical plant due to lightning.

There is a great deal of uncertainty in the minds of engineers—electrical engineers included—as to the nature and cause of breakdowns on electrical appliances due to lightning. During the last few years scientific investigation has been unremitting and much information has been published. All this the author has carefully followed and he admits that it is bulky and very indigestible. He has, therefore, tried to extract the truth, checking it against his own experience and bringing it down to the level of medium and small installations, which are not thought much of across the Atlantic, but which exist in number elsewhere.

The effect of a lightning flash on a transmission line is to make the insulators flash-over or puncture. Often the insulators are shattered; the author has known every insulator of a mile of telephone line down owing to this cause. This fact gave some measure of the voltage of the stroke, for the flashover values and puncturing values of the insulators are known and can be checked.

By providing special measuring devices akin to an insulator—such as a spark gap of definite length—and recording the voltage across them by means now available, a great deal can be learnt. For instance, we now know that direct strokes on to a conductor are not as rare as they were thought to be, that direct strokes on to line towers and earth wires are fairly frequent, and that where earth wires are used the rises in voltage caused by such flashes to towers or to the earth within a few miles of the line rarely exceed 500,000 volts. A 40-ft. pole line, carrying three 33,000-volt conductors without an earth wire, may be struck and the top conductor may be raised suddenly (within 10 millionths of a second) to the voltage of that proportion of the lightning flash which corresponds to the pole height, about 40 by 100,000 volts—i.e., four million volts. This is about the maximum and the average may be much less, but if an earth wire be raised above the conductors the chance of a direct stroke is largely eliminated and the maximum voltages that reach a conductor are much less and the averages still lower, so that by using an earth wire the maximum voltage rise is limited to, say, one million instead of four million volts.

With these voltages standard 33-k.v. pin insulators will probably puncture near the striking point, flashing over farther away as the wave of voltage weakens in intensity and flattens out. Now a punctured insulator is a great nuisance, because it is difficult to find and often requires much time to replace, or it may become a repeated cause of power arcing to the earth, or it may drop the conductor on the metalwork of the pole and cause a short circuit. Therefore insulators that puncture should not be used. On the other hand flashovers do very little damage owing to the brief element of time they last. Such insulators can be obtained, are reasonably cheap, and are of the very greatest use.

There is, however, the equipment at each end of the line to consider. What happens when the splash of voltage reaches the end of the line? If one drops a marble into a narrow trough of water a splash or pressure wave is caused, which at once begins to travel to each end. When it reaches the end the wave reflects back and this reflection goes on until the wave tires itself out. If there is a slight water way at one end the incoming wave will proceed or act as a new source and again the disturbance will be propagated onward, but with reduced energy.

Similar effects take place in the electrical circuit. A transmission line that ends in a block (or an "open" switch) will reflect

at its end any wave disturbance that may reach it, but if the switch be closed and the current path continuous the disturbance will pass through as a whole ; or if there be some restriction (such as resistance) the wave will still be propagated onward, but with reduced energy. To prevent such lightning waves, direct or indirect, from either reflecting or passing on, some sort of safety valve or absorber must be provided, which will, when called upon to do so, (*a*) act within a few millionths of a second, (*b*) get rid of the excess voltage, (*c*) carry a current up to 100,000 ampères and dissipate the energy, and (*d*) then be fully ready for immediate action again—all, of course, without any attention, time after time, for months on end.

A whole host of contrivances has been put upon the market during the last 30 years, but until just recently no one has really known whether they carried out their function or not. Sparking gaps of all descriptions, open, protected, and in a vacuum, and with or without horns, have been tried. These gaps are set to spark over to earth when the voltage has risen to dangerous values. They are catalogued with and without magnetic blowout, with resistance in series, and with resistance in parallel—in fact, the whole gamut has been tried.

Naturally air, insects, birds, and blobs of metal affected the gap and the tendency arose to eliminate this variable by putting it in a vacuum. Such a device is of great use on telephone circuits and has proved its worth, but there are limits to its size. In fact, all these gap devices are effective to a certain degree, but they lack perfection by a great deal. Moreover, the hot-air path of the spark often allowed the power voltage to pass a current and to continue to pass it, so that damage was done and the system for a time rendered inoperative, or the equipment fuses were blown. Also these " follow-on " power currents cause their own voltage rises when they are extinguished suddenly, which may have awkward results, and therefore they must be avoided if possible.

Electrical condensers have been used, from a short length of cable to a large-sized condenser. These are also useful, as they do absorb a certain amount of an excess pressure wave. Then use was made of the water jet, which was built up of isolated drops normally, but which coalesced to form a solid column of water when electrified by excess pressure. This water column connected the system to earth during the discharge and then reverted to its original form. Naturally this could only be used where water and skilled attention were always available and exceedingly cheap—as, for instance, in Central Europe.

Gradually, however, engineers began to reason that one gap only was not the correct solution, but that a multiplicity of gaps was more desirable. Devices of this type ranged from two gaps in series to the multitudinous tiny gaps of the carbon granule resistance invented by Brazil. Then the real safety-valve action was sought for, resulting in the invention of the aluminium electrolytic arrester, in which a series of dishes coated with aluminium hydroxide immersed in aluminium borate is provided. This has been a substantial step forward, but it has the disadvantage of requiring to be reformed daily. Its discharge capacity is also limited. Later it was found that lead peroxide had a similar property, with the additional advantage that it sealed up again as soon as the pressure disappeared. It was, therefore, a great advance and arresters employing it, termed " oxide film " arresters, are in use with substantial success all over the world.

The latest type is modelled on Brazil's original idea that a multiplicity of tiny gaps should be used and is the direct result of scientific search. It consists of a solid block of a material consisting of conducting particles of metallic oxide diffused in a baked clay which is microscopically porous. This material is similar to porcelain in texture and mechanical strength and normally has almost infinite resistance. As soon as the electrical pressure across a block of it rises above normal its resistance decreases in a much greater proportion than the rise of voltage. In fact, every time the voltage is doubled the current it will pass increases over 12 times. It responds equally quickly to the rise of voltage and it reverts to its original form immediately the voltage drops and ceases. It does not shatter even with the heaviest energy discharges and appears to be indestructible. This material is called " Thyrite " or " Ocelit." These qualities are permanent and the fact that it is an artificial product and that its properties can be accurately controlled indicate that here at last we seem to have the ideal safety valve or arrester. It has been on the market two years, but the writer cannot yet obtain

any overwhelming proof of improved results obtained over the protection secured by other forms of arrester gear. The usual assurances come from the makers, but these must be substantiated by independent experience before a definite opinion can be given.

A protection device much in vogue on the Continent, called the Petersen Coil, is based on the following simple principle: When a commercial power transmission system is first energized two opposing types of current —(*a*) condenser current and (*b*) inductive current—flow into it. These two currents, if equal, will cancel each other out. They represent the energy necessary to form (*a*) the condenser field and (*b*) the magnetic field of the whole system.

Anyone who has handled a wireless condenser and accidentally discharged it will appreciate that an electric field can exist inside it and that a current can flow out of it. The process is somewhat akin to blowing up a balloon, which is useless until it is stretched with a quantity of gas, which is released in a current when the balloon is punctured. The magnetism of the system, including that of transformers and other equipment, has similarly to be provided by a current representing energy.

Now, if one conductor of our electric transmission system (whether actually transmitting power or not) is earthed by a punctured insulator, or by other means, the voltage of that conductor drops to zero and the voltage of the other two phases jumps to double normal. The voltage thus redistributes the electric or condenser field and the current which flows through the fault to "charge" the new electric fields of the other two lines is a charging or "condenser" current. Petersen arranges that this current flows through the windings of a large choking coil, of such a size that it exactly neutralizes the condenser current. The Petersen coil thus causes the arcing earth at the fault to die out instantly and without any damage to the coil.

Although this system has been given a thorough trial in a region of lightning activity reports are divided as to its success, but are in the main favourable. Extensions to the system must be taken care of by adjusting or even increasing the size of the coil, so that the condenser current of the fault remains balanced by the inductive current required by the coil.

Another contrivance adopted on the Continent is to short-circuit the flashover through an automatic oil switch, which is caused to close by the fault current. This wipes out the arc, as it reduces the voltage across it to zero, but initially it has to deal with the fault current.

A British maker has brought out a novel type of arrester, which is known as a "surge absorber," and, as usual, the widest claims are made for it by the makers, but there is still insufficient practical experience of it to write with certainty that here is another solution. Whereas an arrester discharges the energy of the lightning flash to the earth, this new device is said to absorb it, turning it into heat and wasting it in the air. It consists of a choking coil surrounded by an earthed iron shield. When a steep wave caused by lightning discharge reaches it the choking coil acts as the primary winding, while the iron shield acts as a secondary one-turn winding and the heavy current which occurs in the latter is wasted. The absorber is stated to act as a buffer against the steep voltage waves, while its condenser action distributes the electrical stress and flattens out the effect of the wave. These surge absorbers are substantial affairs and in many cases are so heavy as to need special supports, while naturally they are expensive, especially for large primary currents.

The writer's experience with the surge absorber is in connexion with a case in which the absorber is connected at the end of a 22-k.v. 12½-mile line between existing electrolytic arresters and the power plant. Its effect so far is to make the existing arresters operate more frequently, which would indicate reflection rather than absorption. It is impossible to say more until a few lightning seasons have passed. The author feels, however, that a modern transformer ought to embody the properties of a surge absorber in itself and as transformers for many years past have been rightly credited with considerable freedom from breakdown he feels that complete immunity is not far off.

Choking coils are another palliative. The makers of the oxide film and Thyrite arresters were believers in choking coils until recently, when recorded tests with an artificial lightning generator apparently suddenly convinced them that choking coils were ineffective and in some cases aggravative and they advised their customers, equally suddenly, to discard them all. The author is not convinced by these statements. Choking coils are certainly partially effective,

as he has seen them spark over from coil to coil frequently during a storm, but he admits that some surges get through.

What arrester to choose and how much should be spent on protection against lightning involve many problems which should be correlated. Each protection problem which the writer has been called upon to solve has been different and has needed individual attention. The relative cost of a breakdown ; the type of service given ; the presence of other clients on the system ; the design of plant, transmission line, and insulators ; the age of the installation ; the meteorological conditions ; the character of the country for many miles work and expense were caused, with possible large loss of property and damage to equipment.

The first step taken was to insulate the neutral of the electrical system. Earth faults caused by punctured insulators then became of less importance—i.e., it became possible to operate the system with faults on one line, although a shutdown occurred with the next fault on one of the other two conductors. This relieved the system, but did not prevent the faults, so a very careful record was kept of the date, duration, position, and character of all breakdowns. It was thus found that almost all the breakdowns were punctures and that they occurred

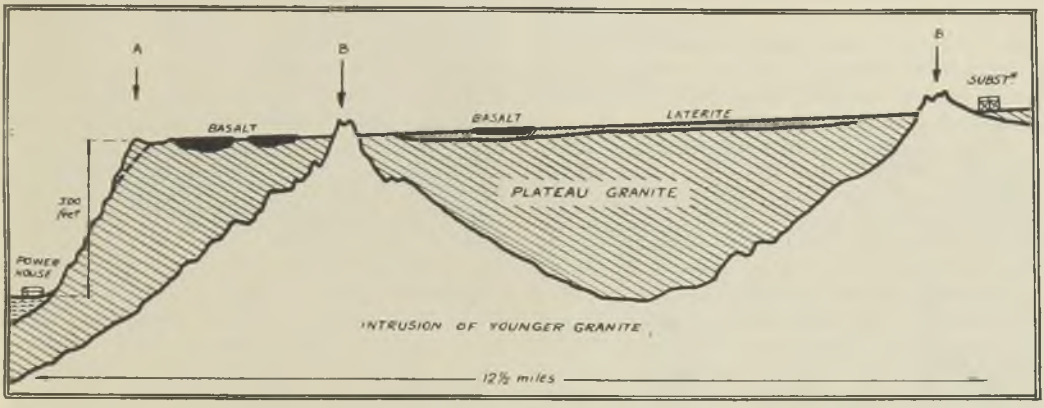

Fig. 13.—Section of Nigerian Plateau, to Show Correlation of Lightning Severity with the Physical Characteristics.

around, and the operating personnel have all to be considered. The money available or to be spent is usually the toughest problem, in spite of the cost of a stoppage.

With a view to clinching these remarks an actual case will greatly help. The installation is in Nigeria and consists of a power house feeding a main substation via a single line at 22 k.v. Thence radiate various main and distribution lines to the consuming points. From the start it was realized that the conditions would be very severe, as lightning was present throughout the rainy season of six months and the line was on top of an abruptly-edged plateau. Exact knowledge of the severity and frequency was lacking and the excellent arrangements at first available soon proved to be insufficient. For the first season complete shutdowns occurred frequently, sometimes two or three times a day, and were very costly, as the valuable output of the mine was held up, involving a direct loss, while much extra

most often at three spots which were definitely associated with the physical contour of the ground. Fig. 13 illustrates this better than words can describe it. These three points were chosen for protection by means of oxide-film arresters and the continuous earth wire was earthed at many more points than was originally done, and, in addition, these earths were maintained properly with salt and water at reasonably low resistances. At the same time it was decided to prevent punctures in the future by installing insulators which would only flash over. This was done as soon as possible, but, in fact, a year elapsed before it could be completed. The effect, however, was immediately noticeable and the facts showing the progress have been recorded in Fig. 14.

The results for 1928 to 1932 are so consistent that it is felt little more can be accomplished unless much more money is spent. Moreover, the present times do not allow of this being done, nor is the need so

great as it was when interruptions were costlier.

It is interesting to note that breakdowns due to lightning have been gradually shifted from the line to the terminals. The small amount of time lost is due to this fact, as faults no longer call for a lengthy patrol of the transmission line.

The cost of protecting an equipment against lightning is a very variable amount and cannot be expressed in general terms, but the table given (Table 1) is based on the cost of a protective system for an installation provided in an intense lightning area. The capital of the mining company was £420,000 and its maximum gross income was £495,000 a year. Every stoppage then represents a direct loss in revenue of £56 for every hour the electrical plant supply was interrupted. The indirect losses, however, would be very much higher, probably making a total of not less than £150 per hour.

This installation deals with tropical lightning on, roughly, 100 days per year and the annual time lost owing to lightning does not exceed two hours. If it were possible

TABLE 1

Value of electrical plant only	£50,000
Cost of transmission lines only	33,000
	£83,000
Extra cost of special insulators	980
Extra cost of earth wire and earthing	350
Complete oxide film arrester equipment	1,960
Total	£86,290

to do without the devices mentioned above the mine would probably not be working for periods corresponding to a total of 25 days lost per annum, involving a direct loss of revenue of £34,800. Such frequent shutdowns would probably involve serious damage to or possibly complete loss of both machinery and such works as are liable to damage from flooding. The risk of being unable to pump storm water during and after a tropical lightning storm is no light one. Hence the indirect loss might be very much greater. It is naturally impossible to prove these last statements, but the figures are given in good faith as a result

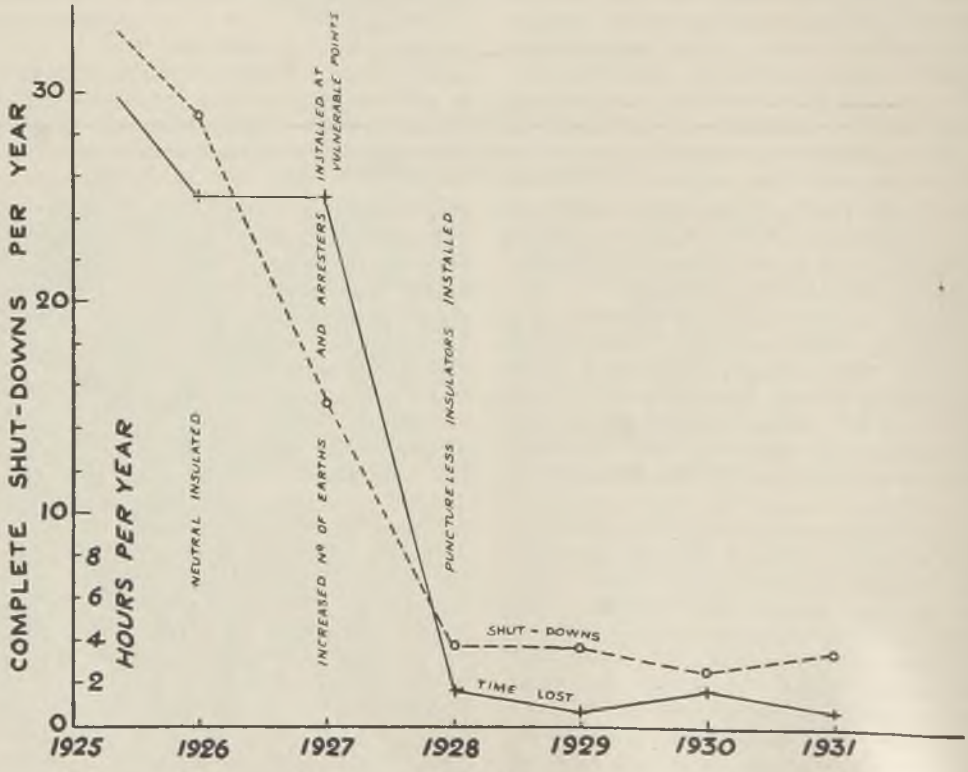

FIG. 14.

of long experience. The cost of efficient protection against damage from lightning should, therefore, be considered as an insurance premium, and not as useless expenditure.

The lead peroxide (oxide film or autovalve) arrester equipment used cost, roughly, £2,000. If the newer Thyrite or Ocelit arresters were to be substituted about £3,000 would be needed, if surge absorbers were used exclusively the cost would work out at about £7,000, while a Petersen coil equipment would probably involve the expenditure of £4,000.

The results to be expected from these different methods of protection are difficult to foresee and to assess without more experience and an intimate knowledge of the many aspects involved, as has already been pointed out. Time will certainly show improvement in the performance and possibly reduction of price of some of the types of arresters touched upon. Meanwhile, the author hopes that his remarks will have been found useful to all those who have taken an interest in this subject. He would warmly welcome any news or photographs of phenomena pertaining to lightning or atmospheric electricity, accompanied, if possible, with meteorological information and a description of the physical contour of the country.

ALLUVIAL SAMPLING

By A. J. PETERSON

The author reviews some of the difficulties standing in the way of standardization of alluvial sampling methods.

Recent pronouncements on the sampling of alluvial deposits have tended to create a feeling that an attempt is being made to say the final word on a subject which long discussion has proved to be still experimental and controversial. There are many difficult problems arising during the testing of such deposits which have heretofore either not been mentioned or have been hastily dismissed and it is not surprising, therefore, that in some cases the purpose of the examination is lost by too close attention to the mode of procedure. Some engineers seem to be of the opinion that most of the field work—such as the direction of the main traverse and the orientation of borehole symmetry—can be planned beforehand in the office, when often an examination of the site with map in hand will reveal insuperable difficulties in the way of any such prepared scheme. In the following article the author endeavours to show what is the main purpose of alluvial testing and in what manner conditions may affect procedure, his remarks being illustrated by Malayan practice.

The purpose of the examination of any deposit is, of course, valuation and the uppermost thought during the consideration of, say, a tin area suitable for dredging should surely be how quickly it is possible to determine the minimum yardage conjointly with value which will warrant the installation of a dredge and also the continuance of sampling.

The usual practice is to subdivide the main area by three or four rows of holes, the results of which quickly decide abandonment or give encouragement for continuance. Let us suppose it is the latter and that an area has been marked for systematic sampling. If judgment has been used there is already the framework of a predetermined symmetry of the system, which may lead even to the "2 by 2" chain square, considered by so many engineers to be the only criterion of efficiency. Is not this practical procedure as certain as and much less costly than a persistent extension by eight-chain spacing to maintain from the beginning to the end a square symmetry? Moreover, although it is not often recognized, there are—or soon will be to the mathematically minded—rows and columns of results offering themselves in a number of ways to alternate averaging and comparison of divergences. Why, it may be asked, choose a "definite area," which, from a mathematical appreciation of irregularity, is no guide, when the whole area to be systematically sampled offers a means of determination of requisite spacing and sufficiency of holes? Does it not follow that if it is logical to accept the decision of divergence of, say, perhaps 2% or 3% from alternate averaging on completion that the pleasing information may be given that the sampling has been checked, or in other words that the safety factor is at least 2?

The author does not propose to attempt itemized criticism of boring practice as it

has been described by others, but he feels that many explanations have been given that are contradictory, many statements made which need qualifying, and that many considerations of importance have not been mentioned. There has, for example, been some discussion of "factoring." It may at once be said that "factoring" has an ill repute in Malaya, where the use of a figure expressing the relationship of sampling result to the estimation of extraction by dredging has been widely held to be a suspicious practice. This attitude of the ignorant is, perhaps, understandable, but it is incomprehensible that many engineers should be blind to the true meaning of the relationship, for a factor won from the experience of both sampling and dredge extraction is essential. To obviate the use of an openly-expressed figure measuring boxes of special dimensions, giving volume or expansion allowances automatically, are widely used. These allowances are of the order of 133⅓% to 150%.

Several methods of bore-hole sampling have been used in Malaya, each one of which under efficient supervision has proved itself capable of affording a surprisingly precise result. The results from the several methods are widely different. An engineer not knowing dredging operation would be astounded to see results obtained by great care of manipulation and computation and expressed often to three places of decimals multiplied by high factors of such latitude. It should be remembered that at best the operation of dredging is crude. Undug ground, spillage from buckets, screen losses, and jig or table losses are all serious. Nor can the total loss be determined except after a period of several years. The only alternative is very intensive sampling—both ahead and, later, astern of the dredge—the result from which would only apply to the very small volume examined. This may explain the rather indefinite factors employed, for under such circumstances of comparison a very considerable margin is necessary. It does not, however, explain the fact that the tin-dredging industry is almost unique in requiring a factor of multiplication and not of division in estimating extraction.

A comparison of the several methods used in bore-hole sampling would be advantageous. It may be accepted that these agree in complying with the mathematical considerations involved in computing volume and average value per cubic yard from the previously-determined volume value of the holes. It is in this determination that the methods employed are very different. Samples obtained in boring with a Banka drill are invariably wet and more or less disintegrated. The materials consist of soil, clay, sand, and gravel (and perhaps tin oxide), sometimes alone, but very frequently so mixed that the previous relationship in situ seems indeterminable. The physical characters of these materials are very different and each requires special consideration.

Some years ago the proportioning of aggregate for the purpose of making concrete was determined almost entirely in reference to void filling. Very many determinations of voids in sand and gravel unmixed and mixed artificially and from banks have been published. Although these figures naturally refer mostly to loose and dry-packed material, there are a number of determinations of void percentages after wet packing to be compared. From these it would seem that wet-packed gravel from a bank contains on an average about 40% voids. This figure was tested many times by the writer in Malaya in determining void percentage in wash and results showed a close agreement. Sand also, of an irregular size and wet packed, gives approximately the same percentage. Sand of a uniform size contains, of course, a lower percentage. Clays also have voids. In the natural state of consolidation the void percentage is, roughly, 35% to 40%. When wetted there is considerable swelling owing to the increase in size of the water films separating particles. When puddled and settled the void percentage increases to 60% to 80%. This represents an increase in volume of at least 50%.

The formation of an alluvial deposit is well understood. A bed of gravel is formed by the accumulation of pebbles and rock fragments which have been rolled forward by moving water. Settlement is due to obstacles—other pebbles—blocking advance rather than to a selective choice of permanent seats and to the lowering of velocity of the water carrier. Sand more or less concurrently settles with the gravel. It likewise is carried along by moving water and a change of water velocity will, perhaps, be sufficient to cause it to sink to near the bottom, where velocity is still less, and it settles into crevices or interspaces in the gravel. Later, when conditions have much changed, the area may, perhaps, be a backwater and almost quiescent—a slow deposition of clay occurs, gradually filling the voids of the

previous deposit. This filling may continue slowly long after the deposition of the clay has ceased. Rarely does the filling persist to the bottom of the gravel. Almost invariably in boring an inrush of water occurs soon after penetration of wash. It is obvious that voids can never be more than filled and consequently gravel, or sand if gravel be absent, determines the volume. Compactness of ground in a rather indeterminable way increases with depth and pressure which, at least for the depths under consideration, is insufficient to cause crushing and fracture of particles.

From the foregoing considerations it may be expected that not one particular manner of measuring volume will satisfactorily meet all the conditions of sampling, yet this is attempted—such as by pipe-volume measurement, box measurement, water-displacement measurement, dry weighing, wet weighing, etc. The pipe-volume measurement would seem the simplest, but in Banka-drill practice it has only been partly successful. Intermittent operation and irregularity (in gravel the pump must be forced ahead of the casing) render the volumes won most inconstant in relation to depth bored. Only for clay or a clay mixture (sand and gravel percentage low) can any reliable relationship be established. The water-displacement measurement of sand and gravel determines the volumes of solids, leaving the voids unmeasured. The error may be as high as 40%. Clay drained overnight has swollen, perhaps, 20% or 30% before measurement next morning.

Box measurement provides nearly an exact measurement (there is, perhaps, even more slippage of pebbles than in the original settlement) of clear sand and gravel and also of a sand-gravel-clay mixture after washing, provided the clay is infilling only and not all or part extraneous—that is, from above or below the layer of wash. Dry weighing and wet weighing are not used a great deal and very little information is available.

In more than one way each appears unsatisfactory. However, it is a saving feature that tin oxide is generally deposited along with the sand and gravel and not with the clay. With this appreciation it seems wise to accept the measuring box as the best means of measuring sand and gravel volumes and this can be extended to include measurement of sand-gravel-clay mixture, when it is evident that the clay represents void filling. Although in good boring practice samples are broken immediately change in the character of material is recognized, samples frequently contain extraneous clay from above or below, or if a thin bed of wash from both above and below. In deciding the upper and lower limits of a bed of wash an empirical sand percentage based on voids and clay consistency is sometimes indicative or useful, or, better, a close examination of successive tin weighings and sand percentages made later and comparison with those of neighbouring holes will help in deciding lines of demarcation. The lower limit is particularly important. Sand and gravel and, of course, tin oxide are frequently carried down several feet by the jump before complete acceptance. Though the depths may be fixed the sand and gravel volumes to be attached are not quite truly representative. However, the error introduced is certainly very much less than in a determination depending on box measurement of clay.

In speaking of measurements the author recalls that three or four years ago many of the considerations that have been outlined here were discussed with Mr. L. T. Willan in Malaya. Mr. Willan had at that time made considerable advance in pipe volume measurement and from his collection of data—box measurements, granular analyses, clay densities, etc.—had been able to derive formulae, which he was using in determining volume values relative to the actual occurrence of materials as considered in situ.

If this review succeeds in showing some of the many complex problems arising in alluvial valuation work the author will feel that it has served a good purpose. The valuation of an alluvial area is generally a much more difficult undertaking than the valuation of a lode mine. In the latter the actual relationship of materials can always be seen and definite and accurate measurements can be taken. In addition there are shafts and winzes, levels and cross-cuts open for inspection and sampling. It should be realized that to report on either requires special qualities and special knowledge. The author finds it disturbing that the Institution of Mining and Metallurgy proposes, in the form of recommendations, that reports of valuation of alluvial areas should be presented in a specified manner as indicating a prescribed procedure. Preservation of the status of the alluvial members of the profession and the possible great harm to the investing public is pleaded as justification for this action. It is felt that neither mechanical methods nor

mechanical observance in presentation, which the least efficient may perform with the appearance of the highly skilled, can enhance and maintain prestige and it should be realized that fundamental scientific principles may be grossly outraged even in complying with such a scheme. A much-quoted saying has been handed down : " Style is the man himself." May it not be said with the same truth and with even more force that the report is the man himself, his ability, his knowledge, and his honour. It is to be hoped that the proposal will receive further consideration.

The I.M.M. Benevolent Fund

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

	£	s.	d.
Nundydroog Mines, Ltd.	10	10	0
A. J. Bensusan	5	5	0
J. D. Hasleden	5	5	0
C. M. P. Wright	5	5	0
J. G. Lawn	5	0	0
H. G. Scott	5	0	0
C. R. Pinder	4	4	0
T. Pryor	3	3	0
G. Rigg	3	3	0
G. W. E. Turner	3	3	0
V. L. Aspland	2	2	0
Sir Harold Carpenter	2	2	0
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K. E. Bensusan	1	1	0
P. C. C. Cayley	1	1	0
F. G. Cornish	1	1	0
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W. J. C. Scrutton	1	0	0
J. H. Ellis		17	0
C. Pengilly		17	0
C. Brackenbury		10	6
Previously acknowledged	1,275	10	9
Total	£1,375	14	3

LETTER TO THE EDITOR

" Gold Mining in Russia "

SIR,—Since you have summarized in your issue of October last an article by Mr. L. Schlounde, published in the *Far Eastern Review* for July, allow me to state there are a number of inaccuracies therein. As the result of a somewhat lengthy experience in Russia I have no hesitation in saying the article was full of geological, geographical, and statistical misstatements, the enumeration of which would occupy much greater space than you would be willing to accord me.

G. T. EVE.

London, E.C.
January 11.

BOOK REVIEWS

Man and Metals : A History of Mining in Relation to the Development of Civilization. 2 vols. By Dr. T. A. RICKARD. Cloth, octavo, 1,068 pages, illustrated. Price 50s. New York : McGraw Hill Publishing Co.

The sub-title of these two volumes is " A History of Mining in Relation to the Development of Civilization." In his preface the author tells us that the writing of this book was prompted by the reading of the " Outline of History." He and Mr. H. G. Wells were fellow students under Thomas Henry Huxley some 47 years ago. He considered that Mr. Wells failed in the above book to pay proper regard to the part which mining had played in the development of civilization. He has now repaired the omission. The method adopted by him has been to present a study of the origin and development of mining and metallurgy as far as they can be ascertained in a series of chapters each of which has been submitted to

two or more of his friends for their " critical reading." A list of references to authorities is given at the end of each chapter. The book is dedicated to " the Librarians whose kindness and courtesy the author desires to acknowledge gratefully."

In his Introductory chapter the author traces the origin and development of the words Mining, Metal, and Civilization. It appears that our word mine comes from " mineor," an old French verb that in the earliest instance meant to excavate. It contained the idea of sapping and of military engineering. He surmises that the French word probably came from the medieval Latin " mina," which, however, apparently did not signify an excavation from which mineral substances were drawn ; the word was not used in an industrial sense. It means a point, something which projects, and therefore threatens. From this the word minae, a threat, is derived, and later in medieval Latin " minari " occurs, meaning to drive by threats, to threaten, a meaning which survives in our English word " minatory." In this way " mine " came to mean an excavation made in warfare and had a military significance long before it acquired an industrial meaning. This earlier meaning also survives in " mines," used in naval warfare. It appears that the Romans did not use " mina " to designate an underground passage. Their word for this was cuniculus, the primary meaning of which was rabbit, because their undermining operations suggested a rabbit warren. In the modern industrial sense mining is " The act, which if done skilfully is an art, of removing rock, hard or soft, loose or compact, from its place in the crust of the earth." It consists in the exploitation of ore deposits, the word ore meaning rock or mineral which can be exploited to economic advantage.

The word " Metal " comes to us from the Latin metallum, which, however, connoted not only metal but mine, mining operations, mineral, and ore. The Latin word was derived from the Greek metallon, which it appears was also comprehensive rather than specific in its meaning. " At one time metallon was supposed to mean ore in the sense of a complex substance, derived from meta with, and allos another ; the more acceptable derivation, however, is from the verb metallan, to seek after, which suggests prospecting." " Civilization " is more difficult to define than mining because its meaning rests largely on preconceptions that are subjective. The word signifies the state or condition of the civis or citizen, which connotes, therefore, an organized community which itself represents a comparatively advanced stage of human progress. This word is only two centuries old. It cannot be regarded objectively. To us it is " a state of living that suits our taste, and taste is an appreciation of what is fitting."

The next chapter is entitled " The Ages without Metal." If the view be accepted that the earliest representatives of mankind lived at least 500,000 years ago, that homo sapiens is believed to have entered Europe 30,000 years ago, and that the age of metals began in Europe about 5,000 years ago it would follow that it represents only 1% of human existence. Accordingly the author has rightly devoted a long chapter to the pre-metal age. As is generally agreed, civilization did not begin until metals became the materials of tools, implements, and machines. By their aid man emerged from savagery. The author mentions that when Captain James Cook first visited the Islands of the Pacific he found the natives using only stone, bones, coral, shell, and wood. Their chisels were formed from the upper bone of the human arm, but they appreciated the value of iron, having obtained a little of it from driftwood and from previous voyagers. He purchased several pigs for a sixpenny nail while on the coast of New Zealand in 1778. Then follows a chapter on " The early use of the Metals," which is based on the paper presented by the author to the Institute of Metals in 1930. He takes up a very sound position when he argues that the development of metal culture in any given region was at first dependent on the mineral resources of that region, although the development might be modified later, when, by means of trade, the indigenous products were bartered for those obtained from foreign lands. As he further argues—

> The idea of a world-wide succession of definite ages is due, not only to the early concentration of archæologic study on the Eastern Mediterranean, but also to a failure to ascertain by chemical analysis the composition of the metallic relics that constitute the evidence for any accurate knowledge of the prehistoric use of metals. The failure to test the oldest pieces of iron for the purpose of determining whether they are meteoric or not has completely befogged the study of iron in antiquity. Even the accounts recently given in books are open to this criticism. Celestial iron can be distinguished from man-made iron by its nickel content, which averages about 8%. . . . Another cause of confusion arises from the hasty assumption that every green-stained piece of old metal must be bronze. Many of

the key antiquities of Egypt and Hissarlik that were promptly labelled bronze when discovered are known now to consist of copper. Further, everything composed of copper is assumed to be made of smelted copper, although the evidence of the use of copper by primitive man ought to warn the prehistorian that the oldest copper is likely to be native metal.

Dr. Rickard's general conclusion is as follows—

> The industrial history of mankind may be divided into two major epochs, a Stone age and a Metal age. . . . Between the two main epochs comes a transitional period or twilight zone, during which the metals, as found in their native state, were used as stone. This intermediate era, which may well be termed "chalcolithic," lasted probably for two or three millenniums; and then came the melting of copper, the use of which as melted metal may have lasted for another millennium, before either copper or any other metal was reduced from its ores. Bronze is to copper what steel is to iron; they represent sequent phases of metal culture. The critical event, one of the most portentous in the history of man, was the first smelting of metal out of stone. That in the light of evidence now available appears to have happened in 4000 to 3000 B.C.

Chapters then follow on "The Gold and Copper Mines of Ancient Egypt," "The Phœnician Metal Merchants," "The Cassiterides or Tin Islands," "The Athenians and their Silver Mines," "The Mines of the Romans in Spain and Italy," and "The Lead Mines of the Romans in Britain." These comprise the first volume.

The second volume opens with chapters on "Mining in Medieval Times" and "The Law of Mines and the Freedom of the Miner." They are succeeded by one on "The Conquistadores," from which the reviewer extracts the following—

> The lurid descriptions of their deeds sent home by the Spanish adventurers and the absurd exaggerations of the countries they despoiled have created a glamour in which the truth has been obscured. A historian speaks of Peru as one of the most extensive empires on the face of the earth. To talk of Mexico and Peru as great Empires is nonsense. Spanish writers applied the grand terminology of feudalism to the coarse barbarism of the American aborigines. Cortez and Pizarro posed as conquerors of mighty and civilized nations, though, as a matter of fact, their opponents Montezuma and Atahualpa were the chiefs of native tribes living in mud hovels; they were so far from being civilized that they were in a rudimentary state of human culture in which cannibalism survived.

The next chapter, entitled "The Later Argonauts," is based on a paper communicated to the Institution of Mining and Metallurgy in 1926 and describes the discoveries and exploitation of the western goldfields of the United States and of Australia. It is fitting that the mining of fuel and, in particular, of coal should be included in the author's survey, since the digging of coal constitutes one of the principal phases of mining, and this fuel is a prime requisite in metallurgy.

The succeeding chapter is entitled "The Use of Iron" and opens with the following sentence—

> The most portentous event in the development of human industry was the discovery of iron, i.e. the purposeful production of the metal from its ore. The use of the other common metals—copper, lead, and tin—was restricted by the relative scarcity of the ore deposits from which they were obtainable, whereas supplies of iron have always been abundant in many parts of the world. Next to aluminium, iron is the most plentiful of the metals in the crust of the earth, the average content being 4½%; but to be of economic value as an ore iron must be in a six-fold state of concentration. The use of this metal is the prime factor in our civilization.

The author's general conclusion from the evidence available, which he discusses with shrewdness and acumen, is that the original home of metallurgy in the ancient world was neither the valley of the Nile nor that of the Euphrates, for neither of these was a mining region. He says—

> The original home of metallurgy in the ancient world appears to have been the mountainous country between the Caspian Sea and the Black Sea. The myths retailed by the Greeks point that way; so does the Hebrew tradition as exemplified by the tale of Tubal the Smith. The Dactyls, the Chalybes, the Phrygians, the Amorites, and the Hittites are links in the story of prehistoric metal culture. The first metal founders were men of the mountains; the Assyrians drew their metals from the Caucasus; the Hittites brought iron into Syria; Armenia and Cappadocia were the cradles of the metallurgic art; the Philistines brought it into Palestine; and it is there in the Biblical land that the oldest man-made iron has been discovered recently by that honoured veteran Sir Flinders Petrie. In a mine at Gerar, about 9 miles from Gaza, in 1927 he found iron-smelting furnaces together with agricultural implements, all of which had been made on this spot. These have been dated by the means of contemporaneous scarabs and amulets of Egyptian origin. . . . The most significant evidence is that of a real beginning of the smelting of iron for the fabrication of useful tools such as hoes, sickles, and plough-points in 1200 B.C. The first production of iron appears to be linked with the Anatolian era and the use of it industrially is connected with the extension of the Hittite power into the Syrian lowlands after 1400 B.C.

The remaining chapters are entitled "Iron in Human Industry," "The Miner in South Africa," and "The Romance of Modern Mining," and the book closes with a short Epilogue, at the conclusion of which, as also in certain other parts of these volumes, the author gives rein to his faculty of human

insight and scientific imagination. His final summary is as follows—

In the great work of opening the dark places of the earth and of introducing civilization among the black peoples, the miner has been a prime agent. When he opens the door, he leaves the latch-string loose ; he is hospitable ; he is co-operative. That is why his pioneering has helped mankind forthwith. The others that went ahead covered their tracks, they did not blaze their trail, they were secret in their coming and going, because they wished to be let alone. Such were the Phœnician traders and the Spanish freebooters. The Arab slave-dealers that penetrated Africa desired no interference with their nefarious commerce ; the English hunters that sought the ivory tusks of the elephant cared for no trespass on their preserves ; even the Scottish missionaries were jealous of each other and of the trader that weakened their hold on the ignorant native. So Africa remained the dark continent until the miner's pick broke through the wall of mystery. Likewise on the American continent, the French voyageurs that pushed their way along the rivers preferred to play a lone hand, in their own way ; the British fur-traders of the North-west obstructed development ; the agents of the Hudson's Bay Company wanted to retain their exclusive dealings with the Indians ; all of these kept the prospector out of their domain as long as they could ; they ignored the mineral wealth of the country, being aware that any public knowledge of it would spoil their monopoly of the peltry business. Their trails followed the lakes and rivers, avoiding the ridges and ranges where ore was more likely to be found. They walked over gold mines unwittingly. The vast expanse of northern Ontario, now one of the chief gold-producing regions of the world, remained a dreary solitude and an unproductive wilderness until the miner's hammer rang a reveille. The prairies between the Mississippi and the Rocky Mountains, the sagebrush plains and the alkaline deserts beyond them, were traversed by hunters and traders, by soldiers and artisans, even to the shores of the Pacific, but theirs was an empty conquest and a vain annexation until the miner spoke the word that unloosed the springs of human industry. He was not only the pioneer, but he left marks to show the way, he blazed the trail for civilization. He has done it with geological exuberance and equatorial amplitude ; from " the stark and sullen solitudes that sentinel the Pole " to the " steaming stillness of the orchid-scented glade " in the tropics he has left his mark, as the herald of empire and the pioneer of industry. Trade follows the flag, but the flag follows the pick.

It has been impossible within the limits of a single review to give anything like an adequate idea of the scope and magnitude of Dr. Rickard's work and it has seemed best to the reviewer to draw attention to certain of its salient features mainly by way of quoting extracts so that the appetite of potential readers might be thereby whetted. This is a book that everybody ought to read who is interested in man's development from savagery through barbarism to civilization. The reviewer has read it with great interest and profit to himself and now feels that for the first time he possesses some idea of the important part that metals have played in the civilization of the human race. Dr. Rickard has laid us under a deep obligation to him, for the labour involved in its preparation must have been immense. Anyone who reads it will understand why he has dedicated it to the Librarians, for it is in their treasure houses that he has obtained his subject matter. He has used it with insight, imagination, and power, and it appears to the reviewer, at any rate, that his main conclusions are well and truly established. For the first time the technical evidence which is available to a skilled miner and metallurgist has been properly assembled, compared, and utilized. As the author has so clearly shown, the metal smith preceded the metal melter and the latter the metal smelter. The raw materials of the first two were the native metals and these were all that were required, but the supply of them was limited and had the third discovery never been made mankind would still be in a primitive stage of civilization. The outstanding discovery which has rendered our present civilization possible was *the smelting of a metal from a stone*, for this made available to subsequent generations the vast supplies of ores from which the metals and alloys of to-day are smelted, refined, and fabricated. The importance of this discovery comes in the same category as the first method of producing fire artificially.

H. C. H. Carpenter.

A Textbook of Geology. Part I—Physical Geology. By C. R. Longwell, A. Knopf, and R. F. Flint. Cloth, octavo, 514 pages, illustrated. Price 23s. New York : John Wiley & Sons. London : Chapman and Hall.

This volume is the " avowed successor " to Part I of Pirsson and Schuchert's " Textbook of Geology," of which the tenth edition appeared as recently as 1929. The changes made are not very considerable, although the order and method of treatment are somewhat modified. The first chapter gives a general view of the earth and indicates the scope and method of geology. Succeeding chapters deal with the various agents of erosion and deposition, sedimentary and igneous rocks, vulcanicity, folding and faulting, earthquakes, metamorphism, the earth's interior, and mountain structure. A penultimate chapter on " Land Forms " enables the more complex aspects of the

erosion cycle to be discussed in the light of geological phenomena previously described. The last chapter deals briefly, but interestingly, with coal, oil, and ore deposits. There are useful appendices on the more important minerals and rocks and on topographic maps. The omission of discussion on climate and weather and on the mechanics of glacier motion has enabled the treatment of more pertinent subjects to be expanded and brought up to date without much increasing the length of the book as compared with its forerunner. A short statement in the chapter on glaciation of the ideas developed by one of the authors on the effects of stagnant ice provides a feature probably new to geological textbooks. It is, perhaps, a matter for surprise that the chapters on igneous rocks and vulcanicity contain no reference to the very significant results of work in the Tertiary igneous province of Scotland. The attempts at elementary treatment of the more recondite subjects have not always escaped the pitfall of superficiality, notably in the case of Alpine structure. The illustrations are good, although some of the diagrams are not as clear as the corresponding ones in the final edition of " Pirsson," and the photographic illustrations are hardly as well reproduced. Numerous block diagrams greatly assist in elucidation, but it is perhaps a mistake to use these to the almost entire exclusion of maps, for the importance of accustoming a student to extract geological information from topographical maps can hardly be over estimated. The book has a useful index and can be recommended as well-conceived and clearly written.

T. H. WHITEHEAD.

Handbuch der Geophysik.—Edited by Professor Dr. B. GUTENBERG. (i) Vol. II, Part 2. " The Geological Structure of the Earth," by Professor A. BORN. Paper covers, 303 pp., illustrated. Price 69 R.M., subscription price 46 R.M. (ii) Vol. IV, Part 3. " Earthquake Geography," by Professor Dr. A. SIEBERG. Paper covers, 319 pp., illustrated. Price 84 R.M., subscription price 56 R.M. (iii) Vol. IX, Part I. " The Structure of the Atmosphere," by Professor Dr. B. GUTENBERG. Paper covers, 171 pp., illustrated. Price 36 R.M., subscription price 24 R.M. Berlin : Gebrüder Borntraeger.

The first part of the book now under review forms the second portion of Volume II of this comprehensive work, which deals with the structure of the earth. The chemical and physical aspects of this subject have been reviewed in the previous portion of the volume and the geological viewpoint is here considered. The author divides the surface of the globe into nine distinct regions, in each of which he considers the structural features with that wealth of detail which is characteristic of this extensive treatise. The second of the three books under consideration, entitled " Earthquake Geography," is an authoritative account of this branch of seismology by Sieberg, who has contributed extensively to the literature on the subject. In this case the treatment is almost completely analogous to that of Born on " The Geological Structure of the Earth." The earth's surface is divided into corresponding areas, which are studied individually in considerable detail. From a critical examination of the data available in the various regions, valuable information concerning the structure of the earth is rendered available.

Volumes VIII and IX of this " Handbuch " are to be devoted to " The Structure of the Atmosphere " and the first part of this treatise to appear forms the last of the books now under review. This is divided into three sections, the first of which, from the pen of Gutenberg, deals with " The Structure of the Atmosphere." The author considers the composition of the air at different levels in the troposphere and stratosphere and discusses the variation of temperature and wind direction with height. Then follows a theoretical account of the structure of the atmosphere, in which the theories of Jeans, Chapman, Milne, and Linke are compared with the Lindemann-Dobson observations. In the next section the same author considers the propagation of sound in the atmosphere, from both the theoretical and instrumental standpoints, and discusses the results of observations on gun-firing and large-scale explosions. A short section on the thermal properties of the stratosphere follows, in which the recent valuable work of Simpson receives special consideration.

All the parts are copiously supplied with valuable references and well maintain the high standard of thoroughness which has been set by the previous parts of this excellent work.

H. SHAW.

The Form and Properties of Crystals. By A. B. Dale. Cloth, octavo, 186 pages, illustrated. Price 6s. Cambridge University Press.

This small book is a commendable introduction to the study of crystals and minerals and the use of the petrological microscope. The opening chapters deal with the nature and classification of crystals, including their morphological properties and method of representation. Special attention is paid to the stereographic projection of crystal forms, stereograms of the various crystal systems and classes being depicted, and a section devoted to practical examples in this mode of projection. Undoubtedly this is the most useful projection for advanced work, but for the general geology student some means of representation which shows the actual appearance of the crystals seems to be more suitable. The chapter on classification suffers from an insufficiency of crystal drawings and a too summary account of some of the crystal systems.

After devoting a small chapter to the internal structure of crystals the remaining half of the book describes the general physical properties of minerals and the elements of optical mineralogy in a most attractive style. References for wider reading are given in an appended bibliography. The book is marked throughout by a clarity of exposition which will be welcome to all students of mineralogy and crystallography.

David Williams.

The Scientific Principles of Petroleum Technology. By L. Gurwitsch and H. Moore. Second edition. Cloth, octavo, 584 pages. Price 30s. London: Chapman and Hall.

The first edition of the translation of Dr. Gurwitsch's book was published in this country in 1926 and is so well known that this revised edition needs little description, but only further commendation. As was the case with the first edition, the new is mainly an admirable treatise on the chemistry of petroleum and its components and products, and it has been considerably improved by the addition by Mr. Moore of material totalling about 100 pages on the more technical side of the subject. The book follows the scheme adopted in the first edition and is divided into five main sections:

(1) The constituents of petroleum and the action of chemical reagents upon them.
(2) The physical properties of the constituents of petroleum.
(3) The distillation of petroleum.
(4) The refining of petroleum products.
(5) The properties of the refined products.

The new edition is a marked advance on the first and can be confidently recommended.

Murray Stuart.

Stratigraphy of the Plains of Southern Alberta. Donaldson Bogart Dowling Memorial Symposium. Cloth, octavo, 160 pages, illustrated. Price $3·00. America: The American Association of Petroleum Geologists, Tulsa, Oklahoma. London: T. Murby and Co.

This little book is composed of fourteen papers by members of the Alberta Society of Petroleum Geologists and the American Association of Petroleum Geologists reprinted from the Bulletin of the American Association of Petroleum Geologists, Volume 15, Number 10, October, 1931. It thus brings together in one small volume the present-day knowledge of the stratigraphy of that part of the world. Few, if any, of the papers appear in the same form in which they were originally presented. During the discussions following the reading of the original papers many points were criticized in great detail and agreement was reached on such questionable points before the final draft of the papers was made. Consequently the symposium may be regarded as the work of the Alberta Society of Petroleum Geologists as a whole and as carrying the approval of that body. In addition to verbal discussions that were later incorporated in the papers the symposium has been edited by a committee to ensure uniformity of nomenclature and to harmonize conflicting statements in different papers touching on the same problems. The result is that the book is a valuable exposition of the subject matter embraced by the title.

Murray Stuart.

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

NEWS LETTERS

JOHANNESBURG

January 5.

Gold Premium.—South Africa has abandoned the gold standard and the Witwatersrand mines are now enjoying the benefit of the gold premium. Mines which have been operating at a loss or a very precarious margin of profit may now be able to make some return to shareholders. The lives of all the gold mines will be prolonged, a large amount of additional money will be circulated, and many millions of capital will soon begin to flow back into the country. Mines which were closed down owing to the handicap imposed by the exchange will be reopened. It has been pointed out that there is no reason to suppose that the South African currency cost of working a ton of Witwatersrand ore, which cost was in November 18s. 11d., will rise to any important extent or to any extent comparable with the improved money value of the mine product. The effect of a devaluation of, say, 25% would be to bring down the working cost expressed in terms of the product, gold, from 18s. 11d. to 14s. 2d. According to evidence submitted to the Low Grade Ore Commission by the Chamber of Mines, the effect on the industry of a reduction of 4s. per ton would be to more than double its life. This would result from the fact that the mines contain large tonnages of low-grade ore and, if a smaller proportion of the gold produced be absorbed in working costs, it is obvious that ore of lower grade can be worked. It is expected that the New Year will witness important developments on the Eastern and Western sections of the Witwatersrand—extensive drilling operations, shaft sinking to open up deep levels, and possibly the prospecting of certain gold-bearing farms by means of drives from adjoining properties.

Rhodesian Mineral Production.—It is estimated that Southern Rhodesia's gold output for 1932 is, in round figures, £3,000,000, the highest for the past fifteen years and the fifth highest in the history of the colony. The peak figure of £3,800,000 was reached in 1915, when several big mines were operating which have since been exhausted. The number of properties now producing in the colony constitutes a record. An important factor in the past year's results has been the enhanced price of gold, but a more significant and encouraging feature is that a number of new and highly-promising mines have been opened up. This is a direct result of the stimulus given to mining enterprise by the gold premium. Last year's output brings the total from the gold mines in the colony since the British occupation up to over £80,000,000. A more optimistic view is taken of the base mineral prospects, in particular asbestos, while it is hoped that a recovery of the copper market and of activities on the northern copper belt may lead to the resumption of normal work on the Wankie coalfields. Northern Rhodesia's mineral returns for the eleven months of the year are more than double those for the January–November period of 1931, the figures being respectively £2,345,000 and £1,063,063.

Diamond Industry.—Sir Ernest Oppenheimer, chairman of De Beers Consolidated Mines, pointed out in the course of his review at the annual meeting of the company that, while some fall in the price of diamonds was unavoidable, it had been but a fraction of the drop in other commodities and diamonds would start, therefore, with a much better price level when a recovery came about. "Diamond production in South Africa," he added, "has either ceased or been materially reduced and this has effected the small improvement in the diamond market which has been evident for the past three months." Although the past year would always be remembered as one of exceptional distress, he was confident that it would ultimately be looked back upon as having seen the turn of the tide in the diamond industry. In no year in the past had such stupendous efforts been made to put the industry on a firm basis and through the co-operation of the outside and Conference producers the Diamond Corporation was in a position to offer goods for sale only as the market required them and steadily to pursue a policy of maintaining prices.

New Coalfield.—It is reported that large coal seams have been discovered in the Alexandria district, not far from Port Elizabeth. Apparently the discovery has no connexion with the once-prosperous coal areas of Stormberg and Molteno, which are several hundred miles distant and which, on account of the poor quality of their product, have almost ceased to operate. Until the Union the mines on these areas used to turn out around 200,000 tons annually, but to-day

the returns are so small, through the competition of the superior Transvaal and Natal coal, that they no longer are specified in the statistics. Dutch money is principally involved in opening up the Alexandria occurrence. At Mimosa station, south of where the new coalfield has been located, Professor E. H. L. Schwartz some years ago identified a large prehistoric volcano. He stated in his report that limestone on top of chalk deposits no less than 500 ft. thick were the characteristic features of the landscape.

Aerial Survey of Mines.—The services of the Aircraft Operating Company have been in increasing demand lately. The company has surveyed the Far Western Rand farms which are to be developed by the new company, West Witwatersrand Areas, and is now busy on the Far East Rand. Later on, it is understood, the mountainous country of the Pilgrim's Rest district, Northern Transvaal, will be examined by the company's experts.

Diamonds in Rhodesia.—Of the seven pipes or fissures filled with kimberlite known in Southern Rhodesia only two have been shown to contain diamonds and these, though thoroughly tested, did not prove payable. The total output declared to August, 1932—15,781 carats, valued at £75,253—has come from the Somabula and Ngamo alluvial workings, situated near Willoughby's Siding, 12 miles south-west of Gwelo. The diamond-bearing wash might be correctly described as a "deep lead," since it is covered by sandstones and mudstones containing fossil plants, which prove the wash to be of Stromberg (Upper Karroo) age and, therefore, older than the pipes, which are later than the Karroo system. The increasing thickness of this overburden makes the deposit more and more costly to work and it does not seem likely that any large output can be expected from this field in the future. The Somabula diamonds have not been traced to their original source. The gemstones found with them are chiefly chrysoberyl and topaz, but sapphire, ruby, and aquamarine, as well as staurolite, tourmaline, and garnet, also occur. The assemblage is remarkably similar to that found with the diamonds in the Kasai fields in the Congo and Angola.

Asbestos.—During the boom of four years ago over 100,000 claims were taken up in the asbestos belt of the Pietersburg district, Northern Transvaal, and 16 propositions were working. To-day only one mine is operating and the number of claims held has fallen to less than 25,000.

BRISBANE

December 27.

Mount Isa's Position.—At the annual meeting of the Mount Isa Mines, Ltd., held in Sydney the other day, a question was raised by a shareholder, on a motion to confirm the action of the directors in borrowing £62,500 from the American Smelting and Refining Company, as to whether the company was not assuming the form of "a sort of bottomless pit," because of frequent borrowing. In reply the chairman and other directors pointed out that the Mount Isa venture is a big scale proposition, aiming at the production of 6,000 tons of lead a month, and that to reach that stage a temporary expenditure in excess of income is necessary. Mr. McRea added that the directors were watching with the greatest care the outlay of money. At the same time they were of opinion that, despite the low price of lead, the company must be kept going and the only way out of their trouble is to borrow. Another of the directors (Mr. F. Hambridge), confirming what Mr. Leslie Urquhart had predicted a couple of years ago, asserted that Mount Isa could produce lead at a lower cost than any other mine in the world, adding that if the output continued it is almost certain that it would capture the lead market. Mr. Hambridge also said it is the hope of the directors, who are struggling to keep the mine going, that they will not have to borrow more money.

Mount Isa Work and Production.—The mining and milling plants of the Mount Isa Company were started in May, 1931, and the smelting plant in the following month. The present general manager, in his report to the annual meeting, shows that since the beginning of production to the end of the company's last financial year the output of ore had been 450,604 dry tons, of which 453,145 tons was delivered to the mill storage bins and 1,459 tons sent to the smelters. The ore was composed of a mixture of sulphides and carbonates, with an average metal content of 5·5 oz. of silver to the ton, 10·7% of lead, and 4·1% of zinc. The average monthly production for the period was 37,884 tons, while in addition there remained in the shrinkage stopes 84,401 tons of ore broken and ready for extraction. The total diamond and churn drilling for exploration purposes

was 51,208 ft. The drilling in the Rio Grande section had revealed ore of a good average value. The quantity of ore treated at the mill during November, 1932, was 62,966 tons and the resulting concentrates 12,168 tons. The bullion recovered contained 5,213 tons of lead, worth £63,772, and 244,125 oz. of silver, valued at £19,835, the total value of the month's output thus being £83,607. Development work in the same month continued to proceed satisfactorily, particularly in the Black Star section, where extensive preparations are being made for a stoping campaign on a large scale. The new smelter is running smoothly and gives promise of being able to turn out 100 tons of lead daily under normal conditions. The installation of the May jigs in the mill has been progressing steadily and these will soon be in commission. Diamond drilling has been continued underground and I. 38 vertical hole was completed at 137 ft. 6 in., proving that the rich streaks encountered in G. 37 cross-cut persisted in depth and that the ore of lower grade was replaced by pyritic material.

The New Cracow Field. — A comprehensive report on the new Cracow goldfield, in Central Queensland, by a State Government geologist (Mr. A. K. Denmead) has just been issued, accompanied by notes thereon by the Chief Geologist. From these it is gathered that a large amount of prospecting, both surface and underground, is required before the potentialities of the field can be gauged and before reliable estimates can be made of the amount of milling ore available. The more important finds comprise the original high-grade shoots of the Golden Mile quartzose formation and the rich and large, but not as yet fully delimited, kaolin orebody of the Golden Plateau. The Golden Plateau, which has developed the largest reserves of ore, is, at any rate, expected to be a producer for a number of years. All of the large bodies of quartz are now being tested and this work will probably occupy about six months. Although a large area in the vicinity of Cracow has already been prospected, further discoveries of payable gold, Mr. Denmead says, are "within the range of possibility." On this field there are undoubtedly high-grade ores, as well as some of a very low grade, the latter perhaps not treatable at a profit, but as yet it is too early to make a reliable forecast of what will be its future.

Mount Morgan, Ltd.—The acting chairman, at the annual meeting of Mount Morgan, Ltd., held in Sydney last week, told the shareholders that, based on the present price of gold, a profit of £2,500 a week, or £130,000 annually, is expected by the end of April next, when the plant will be handling 3,000 tons of ore weekly. Even at the normal price of gold the estimated profit is £40,000 a year. The profit by the end of April, it was added, will be in the vicinity of £17,000. The present company is no longer treating dumps, as it has been doing since its formation, but is now dealing with the ore that is being mined. With the successful demonstration of selective flotation, Mr. Campbell said, the company is energetically attacking the main ore-body, consisting of 8,000,000 tons of ore, estimated to contain 1,153,600 oz. of gold, at 85s. an ounce (£54,092,800), and 123,840 tons of copper, at £40 a ton (£4,953,600). It is pointed out that, had the science of metallurgy reached its present stage of development when the old company decided to wind up, the mine would never have been closed down and that as a consequence Australia would have been several million pounds richer. The chairman also affirmed that the records of the old company (Mount Morgan Gold Mining Company, Ltd.) showed indisputably that there exist in the mine known reserves of more than 8,000,000 tons of ore, assaying 4·37 dwt. of gold and 1·7% of copper.

Mount Wandoo Gold Mine.— Mr. Alexander Macdonald, the holder of the Mount Wandoo lease, near Chillagoe, North Queensland, has furnished to the mining warden for the district a report on operations at the mine up to the end of November. At that time the main shaft had been sunk to 187 ft., but scarcity of water had not only caused first the curtailment and then the suspension of work for a time in the shaft, but also had prevented the starting of the battery and treatment plant, which is now ready for use and which Mr. Macdonald considers to be equal to any of its kind in Queensland. He likewise states that the ore in the bottom of the shaft has shown no signs of diminution in values and that the last assay gave a return of 8 oz. of gold from the crude ore and 12 oz. in the concentrates. An east level, which has been put in at the 125-ft. mark and extended to 85 ft., was driven for the last 50 ft. on an ore-body averaging in width fully 6 ft. and bulking over 1 oz. of fine gold per ton in the crude. In Mr. Macdonald's opinion the indications were that the level was entering an ore zone of greater width than any previously, the

width in the face being 8 ft. A west level at the same depth has also been extended 20 ft., making the total distance from face to face 141 ft. A concrete dam has been constructed in a gully near the battery. It is at present empty, but it is estimated that when full it will conserve upwards of 2,000,000 gallons of water.

Central Australia.—In spite of geologists' reports condemnatory of the Granites goldfield, Central Australia, the company which has taken over the mine of Mr. C. H. Chapman is still keeping at work and appears to have confidence in ultimate success. Early this month a message from Melbourne, where the company has its headquarters, was received in Brisbane stating that Mr. Chapman had advised that the two-head stamp-battery on the company's lease had produced 62 oz. of gold—the result of one week's work with three shifts a day. It is understood that the quantity of ore crushed for the yield was from 8 to 10 tons. Mr. William Hatfield, the Australian author, who has lately completed a motor tour of 10,000 miles from Melbourne, by way of Western Queensland, through the desert country of Central Australia to Broome, in Western Australia, down to Perth, has given it as his opinion that the country has been overstocked, is hopeless for pastoral purposes, and is becoming worse. He says, however, that there is gold in the region, because mining men have been making a living year after year, but that there is a possibility in future that the less spectacular metals will be developed. About 70 miles east of Alice Springs there is a deposit of mica which is said to be the biggest in the world. In two years, Mr. Hatfield thinks, this will dominate the world's mica market. There are also huge deposits of ochre and red oxide.

Mount Lyell Company.—The annual meeting of the Mount Lyell Mining and Railway Company, Ltd. (Tasmania), the only large mining concern that has continued to produce copper in Australia during the time of depression and low metal prices, was held in Melbourne on December 16. At this meeting Mr. C. Templeton, the chairman, admitted that, with copper and the exchange on the present basis, there is no margin of profit and said it is impossible to forecast the probable course of the market for the metal. Dealing with mining operations for the year, Mr. Templeton said that he had again to record a substantial addition to the tonnage of ore treated and a decline in the average copper contents of the ore. The company's future depended on the ability to treat large tonnages of low-grade ore. So far, he added, this policy had met with considerable success.

TORONTO

January 19.

Mineral Production of Canada in 1932.—The value of Canada's mineral production in 1932 is estimated at $182,701,000, as compared with $228,029,018 in 1931. Metals as a group totalled $103,133,000, as compared with $118,524,439 in 1931. The drop in demand and in prices is reflected in the decreased production of the base metals, but on the other hand in no previous year has the Dominion produced so much gold as in 1932, the output from all sources amounting in 1932 to 3,055,168 fine ounces, valued at $63,155,000, an increase of 13% over the production of last year. In addition the gold mining companies also received premiums to the amount of $6,103,000 in view of the exchange situation.

Gold Production of Ontario.—A report of the Ontario Department of Mines of the gold production of the Province gives the total output for 1932 at $46,773,154, as compared with $42,737,276 for 1931, an increase of approximately 9·4%. Production during December at $4,135,336 showed a satisfactory improvement over the November output of $3,906,467. The Porcupine area produced $2,067,215 from the treatment of 287,150 tons of ore. The Kirkland Lake Mines yielded $1,921,146 from 154,229 tons of ore and the mines of North-Western Ontario produced $147,175 from 35,246 tons of ore.

Sudbury.—The International Nickel Company has resumed the operation of the Oxford process plant at Copper Cliff, which has been closed down for six months. Sufficient blister copper will be produced to meet the requirements of the Ontario Refinery Company, Ltd., which is transferring consignments of electrolytic copper to Britain to meet the demands of the British consumers. The working force consists of 300 men, who were formerly laid off. It is expected that the plant will be kept in operation for several months to meet present copper requirements. The Falconbridge Nickel has declared an initial dividend of 10 cents per share, which will involve an outlay of approximately $320,000.

For the nine months ended September last the company showed net earnings after all deductions of $523,427. The company entered the year 1932 with inventories of nickel totalling 2,888,466 lb., but the opening up of new markets enabled the company to dispose of these large stocks and it became necessary to increase production to take care of the growing demand for nickel. The recently completed addition to its plant is in steady operation and other units will be opened early this year. In the Swayze gold area the Kirkland Hudson Bay Mines will conduct a diamond-drilling campaign on the Darragh group of claims, on which some rich showings have been disclosed. The Halcrow Swayze Mines has uncovered four promising veins showing free gold. The Kenty, which has been sinking a shaft by hand steel, is now installing equipment preparatory to carrying out an extensive programme of development.

Porcupine.—The Hollinger gold mine is assured of a continuous supply of ore for many years to come, according to the report of Dr. L. C. Graton, Professor of Mining Geology of Harvard University, who made an exhaustive examination of the geological conditions of the property. He was convinced of the continuity of the deposits to a considerable depth below present workings and pronounced the Hollinger one of the greatest gold mines of the times. Dome Mines, Ltd., reports bullion production in December valued at $322,284, a slight gain over the $321,089 for the previous month. Ore tonnage treated and the average grade show little change from November's rate, when 45,650 tons of the average grade of $7·02 was milled. During the year the bullion output reached a value of $4,030,296, an increase of approximately $556,000 over the $3,474,000 for 1931. During the past year new high-grade sections were opened up, which materially increased the average grade of ore treated. Development on the lower levels of the McIntyre is proceeding with satisfactory results, production is being well maintained, and the directors felt warranted in declaring the usual extra dividend of 12½ cents. Good progress has been made in the sinking of the winze from the 3,750-ft. level on the McIntyre to open up 19 new levels below that horizon. The plant being installed at the 3,750-ft. level for the second stage of mining is similar to that on the surface, although the hoist is a little smaller. Vipond Consolidated for the quarter ending December 31 produced bullion to the value of $125,900 from 27,719 tons of ore milled, as compared with $103,157 from the treatment of 27,096 tons of ore. Gross production for the year totalled $472,474 from 87,200 tons, with an average recovery of $5·42 per ton. South Keora Mines has resumed operations on its property. A diamond-drilling campaign is now being carried out to confirm the results obtained in earlier work, when drill cores returned high values in gold over considerable widths.

Kirkland Lake.—The Lake Shore reports bullion production of $3,110,000 from 205,187 tons of ore milled for the three months ended December, as compared with $3,032,000 from 204,645 tons for the previous quarter. The recovery was at the rate of $15·15 per ton, as against $14·81. For the year the mine's output of bullion was of the value of $12,495,076, an increase of $1,422,382 over the total of $11,073,694 in 1931. The company is maintaining an extensive programme of mine development and it is stated that the ore values and tonnages are increasing as work proceeds downwards. At the Wright-Hargreaves the No. 3 shaft is down to 3,900 ft. and No. 4 shaft to 3,710 ft. and it is expected that both will be completed to 4,000 ft. by February, when extensive lateral work will be undertaken to develop the ore-bodies intercepted by diamond drilling. On the 3,000-ft. horizon considerable development work has been completed and sections are stated to have returned rich assays. It is estimated that the company has ore reserves in excess of 1,000,000 tons, of the average grade of $14 per ton. The Teck-Hughes has encountered mineralization in a diamond-drilling campaign undertaken to tap a vein coming in from the Lake Shore, but no assays are yet available. Work on the lower levels is meeting with encouraging results, ore of a good grade having been opened up below the lean sections. The Sylvanite will enlarge the scope of its operations. The shaft will be continued down from the 3,000-ft. to the 3,500-ft. level and four new levels opened up. It is also planned to continue the programme of underground exploration. On the 3,000-ft. level the north vein has been drifted on for 400 ft. and shows average values of $10 a ton. Work is also being pushed on the 2,500-ft. horizon, where rich ore sections were located a short time ago. The Miller Independence, in the Boston Creek area, has acquired the adjoining property of the Allied Gold Mines. A calavorite vein on the company's property

has been traced into the Allied ground and the old shaft is being dewatered in preparation for a resumption of operations. The Barry-Hollinger has let a contract for 1,500 ft. of diamond drilling below the bottom level. At the Masassa work is proceeding on the new level above the drive and some good ore has been encountered. A new raise is going up to open up a mineralized section.

Other Ontario Goldfields. — In the Matachewan area the Ashley is now on a regular gold shipping basis. The workings are being carried to lower depths, a winze having been put down to the 750-ft. level. The new ore which is being opened up shows an improvement in grade, mill heads during December averaging $18·76 per ton. The Bloom Lake Consolidated Mines has three groups of claims which will be thoroughly tested by diamond drilling to a depth of 1,000 ft. The Moss Mine in the Thunder Bay district, which recently entered the production stage, is milling ore at the rate of 150 tons per day. Good progress is being made in development work and a new high-grade section has been opened up on the 625-ft. level. Preparations are under way for the development of the Cole property, in the Red Lake area of the Patricia district. A mining plant sufficient to sink a shaft 1,000 ft. has been taken in. Surface showings are continuous and extensive, carrying good values. The Bathurst, operating in the Woman Lake area, has made its first shipment of gold, valued at $7,500. The shaft has been put down to the 250-ft. level and much lateral work done.

North-Western Quebec.—The Noranda has increased the capacity of its concentrator from 1,000 to 2,000 tons daily, giving the mine a total capacity of about 4,000 tons daily. The objective of the management in increasing concentrator capacity is to enable them to treat more ore of lower copper and higher gold content. There are large bodies of ore high in copper, which are being held in reserve until the conditions in the copper market are improved. The Siscoe during December produced bullion to the value of $87,398 from the treatment of 5,563 tons of ore of the average grade of $16·09 per ton. For the year 1932 the company's production was in excess of $1,000,000. The company is now engaged in a programme of mill enlargement, which will bring the rated capacity up to 225 tons per day, as compared with the present rate of 175 tons. The new Hadsel mill of the Granada, which recently went into operation, is working satisfactorily and will bring the mill capacity up to 150 tons daily. Good results are being obtained from the deep development programme. The continuation of No. 3 vein has been encountered in a cross-cut on the 1,225-ft. level. Mill heads are averaging around $14 per ton. At the Pandora, in the Cadillac area, good values have been encountered on the 250-ft. level. The grade of the ore shows some improvement with depth. The Beattie has nearly completed the construction of its mill and operations are scheduled to begin in March. The shaft is now down to 300 ft. and in the course of sinking ore was encountered stated to average $9 per ton. Ventures, Ltd., has taken an option on the Galatea Gold Mines, adjoining the Beattie, and will conduct a diamond-drilling campaign to determine the downward continuation of the mineralized zone located on the surface. Diamond drilling on the McWaters property, in the eastern section of the Rouyn area, has proved the continuation of the rich surface showings to a depth of several hundred feet and the work is still proceeding. A mining plant will shortly be brought in.

Manitoba.—The management of the San Antonia is planning a greatly enlarged programme of mine development. The No. 1 shaft will be put down from the 150-ft. level to a depth of 975 ft. The mill is now treating 150 tons of ore daily and in addition to providing for mill requirements the ore reserves are being steadily increased. The company has opened up a good length of $10 ore in addition to the high-grade on No. 16 vein and mill heads are holding at about $14 per ton. Construction work is being pushed at Island Lake Gold Mines and the mill equipment is being taken in over the winter roads. It is planned to have the mill completed and ready for production early in the summer, by which time the company will have a large tonnage of ore available. The Vanson Gold Mines, Ltd., has decided to install a 10-ton mill on its property in the Rice Lake area. A shaft will be sunk to 125 ft. and drifting on the vein started. Prospecting for gold has recently been very active in the Island, Gods, and Oxford Lakes mining areas and the total number of claims staked up to January 12 was 976, with many others waiting to be recorded.

VANCOUVER

January 10.

Bridge River.—A small block of rather more than one ton of spectacularly-rich ore has been found in stoping above the 8th level of the Pioneer mine. The value is stated to be around $50,000. Although sections of the vein, in which ribbon structure is more pronounced, are found to carry values in gold that are sometimes considerably higher than the average content of the ore, nothing approaching to the richness of this pocket has ever been encountered previously in the workings of this mine, or in the veins of the Bridge River area generally. On the 8th level, in the course of development, consistent values of over $100 per ton were obtained in one section extending for a distance of over 80 ft. on the level. The deep-level development of the mine is said to be proceeding satisfactorily and both laterally and in depth there appears to be a wide field for exploration on the main vein, while possibilities of extension of reserves by cross-cutting in connexion with at least two other veins are of a promising character. The mill has been stepped up to its normal capacity of 300 tons per day and it is reported that the output for the last two weeks of 1932 reached a value of $100,000. Success still attends the operations of the Bralorne Mines, Ltd., in the development of the old Lorne mine. It is stated that the total indebtedness of the company is about to be liquidated out of profits from the operations that have been in progress since February, 1932, and that a surplus of about $250,000 may be estimated from the continuance of the work within the limits of the calculated reserves on the King vein, to which the development has been confined. The Mary Mac and Highland Boy groups, covering discoveries that were made recently by George Morrison, have been bonded by a Vancouver syndicate and development work has been commenced under the superintendence of John Morrison. In appreciation of the possible importance of this discovery, as indicating an extension of the gold-bearing area of the Bridge River district, the Minister of Mines authorized a special visit of inspection by the resident engineer. It is understood that the further development of this camp, which is situated at a distance of about 10 miles north of the Pioneer mine, is fully warranted.

Portland Canal.—The drive on the south-west vein on the property on Georgia River Gold Mines, Ltd., had been extended to a distance of 325 ft. from the point at which the vein was intersected by the cross-cut from the Bullion tunnel workings, when operations were suspended for the winter. It is stated that commercial ore was found along the whole extent of this drive with the exception of two small breaks. This development is said to be the most important that has been carried out during the protracted exploration of the vein system and indicates a probable tonnage of considerable amount, with backs on this vein of about 450 ft.

Atlin.—Following the encouraging report of Dr. F. A. Kerr, of the Geological Survey, in which possibilities were outlined for the occurrence of high-grade gold deposits in an extensive zone, the Whitewater group has been bonded by Alaska Juneau Gold Mining Company and it is reported that an initial payment of $2,000 has been made. An option on the property was ceded recently by Noah Timmins Inc. after a certain amount of exploratory work had been done.

Cariboo.—Milling operations have been commenced at the property of the Cariboo Gold Quartz Mining Co. and keen speculative interest is being manifested in the undertaking, upon the success of which the proof of the economic value of the lode-gold deposits of the Barkerville area are believed to depend. It is reported that a ninth vein has been encountered in the cross-cut tunnel, from which samples taken across a width of 6 ft. have assayed $15 per ton in gold. Cariboo Consolidated Gold Mines, Ltd., with headquarters in Vancouver, has been formed to acquire properties situated in the immediate neighbourhood of Barkerville and on the eastern end of the gold belt, in the Cunningham Creek section. The properties were acquired from the Reward Mining Company, of Vancouver, that has been conducting exploratory work during the past year, from which encouraging results were obtained. These properties were among the first to attract attention to the lode-gold possibilities of the area and several attempts were made in shallow workings to open up ore-shoots at the intersection of the two series of veins that were classified subsequently by the late Dr. W. L. Uglow as the "A" and "B" veins. A small stamp-mill was erected with the assistance of the Government in 1865. These early workings, as well as subsequent attempts, were not successful in outlining possibilities of profitable operation, due, as now appears, to the

fact that insufficient depth was attained. It is reported that development work on a scale similar to that carried out by Cariboo Gold Quartz Mining Co. has been commenced by a new organization called Cariboo Yankee Belle Mining Co. on claims situated on Yank's Peak, between Barkerville and Keithley. In the early days of mining surface prospecting was active in this section, where numerous outcrops of veins of varying width occur. The present operators are driving a 1,000-ft. cross-cut tunnel, in which it is anticipated that the principal veins will be intersected at a depth of approximately 750 ft. below surface.

Sheep Creek.—The Motherlode mill of Reno Gold Mines, Ltd., has been put into operation with an initial capacity of 75 tons per day. It is stated that the performance is entirely satisfactory and that a good recovery is being made. The ore from the Reno mine that is being milled is stated to be of higher grade than that formerly treated in the old mill. The company has every prospect of successful operation, ore reserves having been added to substantially in developments from the 5th level since production was suspended last February. It is understood that preparations for the deep-level development on the Gold Belt property have been completed and that active work is to be commenced forthwith in driving a long cross-cut tunnel with a view to intersecting the four veins that have been exposed at surface in an extensive system of trenching and open-cutting. Carload shipments from the Kootenay Belle property since the workings were reopened in September last by the owners, F. M. Black and associates, of Vancouver, are said to have reached an amount of 235 tons, having a total value of around $7,800. The total amount of ore that has been taken out of the No. 2 tunnel workings is given as 724 tons, of an average value of $47·35 per ton. Work, which was suspended during severe weather conditions in December, has been resumed.

Ymir.—The Goodenough, adjoining the old Ymir mine, on Wild Horse Creek, has been bonded by a Vancouver syndicate and a programme of deep development work is to be put in hand. During the past year the owners have been carrying on some useful exploratory work, in the course of which an amount of 407 tons of ore has been shipped to the Trail smelter in carload lots. Some valuable information was also obtained in regard to the pitch of the ore shoot from which this ore was taken, disclosing, it is understood, attractive possibilities of developing a considerable tonnage. The Goodenough showings are located on the opposite side of a fault zone to that on which the Ymir vein was worked. It will be remembered that the bonanza ore shoot on this vein was responsible for an amount of about 350,000 tons of ore that was passed through the Ymir stamp-mill. This ore shoot was about 480 ft. long, was stoped over a width of 40 ft., and extended down to the 500-ft. level, below which the vein was found to be strongly defined, but values were practically absent. Ymir Gold Mines, Ltd., distributed an amount of approximately $300,000 in dividends to shareholders. The ore on both properties consists of pyrite, zinc blende, and galena, in a quartz gangue filling fissure veins in the Pend d'Oreille schists.

Lillooet.—The property of Anderson Lake Mining and Milling that was active some years ago in developing large bodies of quartz on McGillivray Creek, with a limited production from a small stamp-mill, has been acquired by the National Gold Mining Syndicate, of Vancouver. This organization has been formed on the initiative of T. A. Brett for the purpose of opening up the mine. Mr. Brett was one of the original locators of the property some 20 years ago and has been interested in it ever since, believing that there are possibilities of profitable operation of the low-grade ore. The company milled a few thousand tons of the ore from a 20-ft. vein, upon which two tunnels were driven, and a rise put up to the surface. Mr. Brett was himself in charge of the last milling work, when it is claimed that an amount of 2,000 tons was treated with a recovery of around $4 per ton. An attractive feature of the ore-bodies is in connexion with the occurrence of seams and pockets of extremely rich ore showing free gold. Two years ago the mine was reopened by A. F. Noel and associates and a third tunnel was extended for a short distance, encountering one of the high-grade occurrences, from which a small amount of spectacular samples was obtained. The deposit has been described as representing quartz fillings in a zone of shearing and foliation in argillites. In the No. 2 tunnel, from which most of the ore was drawn, the quartz is found to die out in a pronounced folding of the formation, within a few feet of a rise that was carried up on a 20-ft. vein, and it appears that the dip of the ore-body is reversed below this level. On the other hand, surface exposures indicate greater

persistence of the ore-body and natural facilities for development by adit tunnels are good. The property is situated at a distance of four miles from the track of the Pacific Great Eastern Railway, which follows the shore line of Anderson Lake.

Boundary.—Reports are received of the discovery of ore assaying $16 per ton in gold from exploratory workings around the old copper mines of the Phoenix camp. The claim is made that this ore occurs in brecciated volcanic rock and not in the altered limestone with which the formerly-productive ore-bodies were identified. The Phoenix mines, which represented one of the largest copper resources of the Province, were abandoned following the cessation of work by the Granby company in the Boundary country some years ago. The ore-bodies, carrying an average content of about 1·6% copper, with values of about $1 in gold, were replacements in isolated sections of a contact-metamorphic zone of limestone bordered by a jasperoid formation. Exhaustive exploration is said to have defined the extent of these ore-bodies. Interbedded fine-grained tuffs have been recognized as an original feature of the limestone beds, as well as in the highly silicified jasperoid formation, and brecciation of the limestone was always recognized as being favourable to the mineralization. The discovery, therefore, of the gold values in brecciated tuffs may point to selective action and provide guidance to prospecting for associated bodies of gold ore. It is said that one notable discovery was made on the 80-ft. level of the old Brooklyn mine, where a sample taken across 6 ft. assayed $16 per ton, and that some comparatively high-grade ore has also been found in prospect workings from the old glory hole. Gold values in quartz veins are also reported on the Winner group of claims, located towards the south-east of the town of Phoenix.

Rock Creek.—W. G. Wilkins, of Penticton, is reported as stating that the work carried out by the local company, Rock Creek Mining and Development, during the past season has afforded encouragement to its further prosecution and that plans for more extended operations will be put into effect this year.

Vancouver.—Satisfaction is expressed with the recent decision to renew the power of the Dominion Assay Office to purchase gold in terms of United States funds. Following the embargo upon the export of gold, such producers as were not in a position to avail themselves of the premium that is paid by the Royal Mint in Ottawa or were otherwise debarred from realization of the full value of their gold were severely handicapped and strong representations were made on their behalf, in which it was pointed out that the entailed disability operated adversely to the interests of prospecting.

PERSONAL

E. H. Ackermann has left Northern Rhodesia and is now in Bechuanaland.

Clinton Bernard has returned to the United States.

A. O. Brown has left for Portugal.

James W. Cairns is returning from Northern Rhodesia.

James Caldwell has returned to Mexico.

A. W. Clark has left South-West Africa for Johannesburg.

P. C. Collins is now in Gold Coast Colony.

Carl Davis has returned from West Africa.

H. W. Halton, is returning from Burma.

J. A. L. Henderson is home from Canada.

G. V. Hobson has left for Burma.

R. R. Knuckey is home from Turkey.

H. R. Mackilligin has left for Nigeria.

L. A. Mayo is returning from Northern Rhodesia.

George C. Riley is here from Canada.

Hugh Sandys has left for Kenya.

J. H. Southwood has returned to Sierra Leone.

R. B. Tasker has left South-West Africa and is now in Johannesburg.

S. S. Webb-Bowen has left for Greece.

W. Whyte has returned from Western Australia.

A. Stanley Williams is home from Nigeria.

A. S. Winther is here from Rhodesia.

Harley B. Wright has left for the Sudan.

Francis William Payne, who died on January 15, at the age of 68, was a prominent figure in the dredge-mining industry. After serving his apprenticeship in engineering in this country, Mr. Payne went to New Zealand some 40 years ago, at the beginning of the gold rush in that country. The death of his brother Raymond led to Mr. Payne's permanent return to this country in 1920 to take control of the London office and since then more than 50 dredges have been constructed to the firm's design. Mr. Payne was a member of the Institution of Mining and Metallurgy and at the time of his death was on the Council. It is probably not generally known that Mr. Payne and Mr. Edward Walker, formerly editor of the Magazine, were schoolfellows.

Malcolm Roberts, who died on January 13, was prominently associated with the operations of the Aramayo properties in Bolivia. After graduating from the Royal School of Mines in 1890, Mr. Roberts became junior engineer to the London County Council. In 1892, however, he proceeded to Bolivia to join the Compañie Guadalupe de Bolivia and from 1894 to 1903 was assistant manager and mine manager to the Compañie Oploca de Bolivia. It was in 1907 that Mr. Roberts began his association with the Aramayo group, being appointed manager of the Tasna Mines of the Aramayo Francke Mines, Ltd., subsequently becoming general manager of the company and finally consultant. Mr. Roberts was a Member of the Institution of Mining and Metallurgy.

TRADE PARAGRAPHS

Henry Bath and Son, Ltd., of 37, Lime Street, London, E.C. 3, issue their customary chart showing the average monthly cash prices of standard copper, tin, G.M. spelter, and soft foreign lead.

Walter Hoene, of 78, Bezuidenhout, The Hague, Holland, publish a leaflet giving particulars of their light railway equipment, which includes locomotives and rolling stock, rails, trackwork, mining and other tipping wagons, etc.

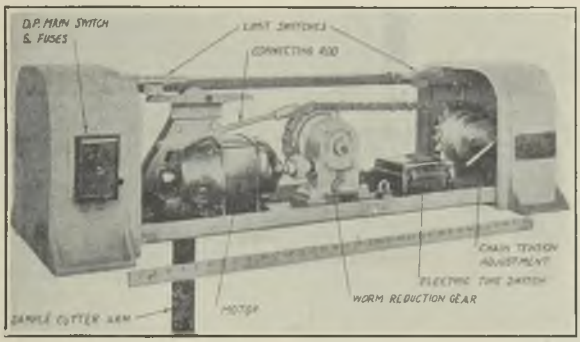
Austin Hoy and Co., Ltd., of Bush House, London, W.C. 2, have published a fully-illustrated booklet on the subject of improvements to the cutting end of chain-machines, which describes in considerable detail the essential features of their British-built coal-cutters.

James Gordon and Co., Ltd., of Windsor House, Kingsway, London, W.C. 2, have prepared a leaflet describing their reducing valves for steam, air, gas, and water. The valves may be either spring or weight loaded and there are two types in each case, each being fully described together with cross-sectional elevations.

their specialties, which include shaker conveyor driving gears, driving heads and frames for belt conveyors, compressed-air shaker engines, gate-end loaders, pneumatic stowing machines, hoists, compressed-air constant type and electric in-bye ventilating fans, drill steel, and also Meco tubes for auxiliary ventilation. Belting, belt fastening, hose, and suchlike can also be obtained from the firm.

Lead Wool Co., Ltd., of Snodland, Kent, have placed on the market a new portable air-compressor, the essential feature of which is that two Ford engines have been used for the outfit, one having been converted into a compressor. Thus most of the spare parts for engine and compressor are available throughout the world. The actual power unit is the Ford industrial unit, Model A.B. The piston displacement of the compressor is 115 cu. ft. of free air per minute suitable for pressures up to 100 lb. per sq. in.

Sir Isaac Pitman and Sons, Ltd., of Parker Street, Kingsway, London, W.C. 2, publish parts 7, 8, and 9 of their *Engineering Educator*. Part 7 continues the subject of applied mechanics and goes on to the consideration of engineering materials, their testing and properties, and begins the subject



GECO ELECTRIC SAMPLER.

Morse Chain Co., Ltd., of Letchworth, Herts, have just prepared a new brochure dealing with Morse flexible couplings suitable for all kinds of power transmission. The coupling is of the chain and sprocket type and is made in a number of standard sizes, while the makers are prepared to supply any requirements whether within the standards or not.

Evershed and Vignoles, Ltd., of Acton Lane Works, Chiswick, London, W. 4, send out some notes with regard to the resistance to earth of large power transmission towers, with particular reference to the grid system of the Central Electricity Board in this country. The purpose of the notes is to illustrate the use of the "Megger" earth tester for measuring these resistances.

Rubber Growers' Association, Inc., of 2, 3, and 4, Idol Lane, Eastcheap, London, E.C. 3, issue a revised and enlarged edition of "Rubber Latex," which is written by the Association's consulting chemist in collaboration with another chemist. Mining men who are interested in the mechanical properties of rubber will be interested in reading the book and especially those sections which deal with the employment of rubber for covering screens and other metal surfaces subjected to severe abrasion.

Mining Engineering Co., Ltd., of Meco Works, Worcester, issue a booklet drawing attention to

of repeated stresses in materials. In part 8 is commenced the subject of power transmission by belting, which is followed by power transmission by chains and then by a chapter on gearing. In part 9 is the commencement of the subject of ball and roller bearings and also of lubrication.

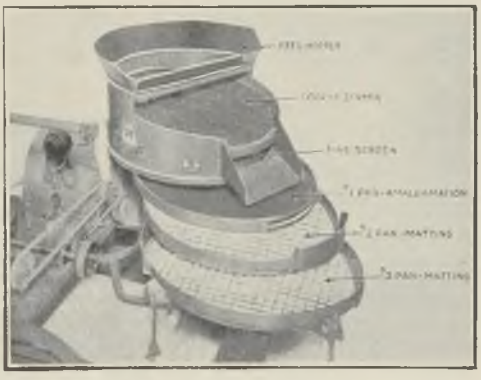
General Engineering Co., Inc., of Adelaide House, London, E.C. 4, have developed the "Geco" electric sampler, which is illustrated here. This has been evolved to fulfil the requirements of a machine intended for taking wet and dry samples in all sorts of continuous processes. As shown in the illustration it is without its usual dust cover, which affords an opportunity of referring to its essential components. The electric motor is connected by means of a flexible coupling to suitable reduction gearing, through which the sprocket is driven. The chain over this sprocket is connected to an idle sprocket, running on an axle with adjustable tension. The carriage, on which the arm carrying the sample cutter is suspended, is operated by the connecting rod. The electric time-switch actuates a single-pole magnetic contactor switch, through which the motor is energized, while limit switches cut off the current at each end of the stroke. The timing switch usually supplied is one designed for standard alternating grid circuits and consists of a Telechron motor, giving the time interval required with

reliability and precision. Sample cutters of all kinds suitable for the work in hand can conveniently be attached to the arm.

Renold and Coventry Chain Co., Ltd., of Renold Works, Didsbury, Manchester, are sending out the newest edition of their catalogue of standard chains for all transmission purposes. This is printed in four languages and contains numerous references to the applications of chain drive. Certain price reductions on previous years have been effected and, in addition, a space reduction of 50% has been achieved by the increased use of duplex and triplex chains, the utilization of which provides drives for the higher speed range of electric motors now coming into favour.

Ransomes and Rapier, Ltd., of Waterside Iron Works, Ipswich, report that they have received an order from Stewarts and Lloyds, Ltd., for a large mechanical excavator to be used for removal of overburden in the Corby (Northamptonshire) ironstone field in connexion with the scheme for producing basic Bessemer steel, to which reference has already been made in the MAGAZINE. The shovel, which it is understood will be the largest of its kind used in Europe and which is certainly the largest yet to be made in this country, will be of 9 cu. yd. bucket capacity, will weigh 500 tons, and will have an active radius of 100 ft. and a height of 68 ft. The shovel will be designed to turn through a complete circle in 40 seconds; thus 11 tons of material will be lifted 70 ft. and transported 70 yds. every minute.

Denver Equipment Co., of 1419, 17th Street, Denver, Colorado, U.S.A., send leaflets drawing attention to their portable mills, which are made in various sizes to suit the small operator, and to which attention has already been directed in these



DENVER MECHANICAL GOLD PAN.

columns. Another leaflet draws attention to their mechanical gold pan, which again is devised for the small operator and is worked by means of a ¾ h.p. petrol engine. This is illustrated in the photograph reproduced here. The principle of the machine is simple in that it utilizes the same motion that for years has made the gold pan famous. This is secured by slightly tilting the nest of pans, the shaking movement being obtained by a steel yoke and saddle connected to a rotating eccentric. The petrol engine is large enough to drive also a small pump furnishing all the water that is necessary for the operation of the pan. Their larger units, specialy suitable for the treatment of the product from all types of gold placer mining, are also described.

METROPOLITAN-VICKERS DEVELOPMENTS

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, have issued their customary report of the year's operations.

Electric Winders.—The developments in control and protection of electric winders which have been made by this company in past years are now becoming known to mining engineers and a fair number of orders embodying these developments have been received. Eight electric winders for export, each with a nominal rating of 1,000 h.p. or over, are in hand or completed, together with a number of smaller equipments. The equipment at the Watnall Colliery of Messrs. Barber Walker and Co. was referred to in the February, 1932, issue of the MAGAZINE and the hydraulic slip regulator which makes it possible to use a synchronous motor in the Ward-Leonard-Ilgner motor-generator set that drives the winder motor. In this case the circumstances are such that an increase of only 14% in the total k.v.a. demand of the colliery was experienced, whereas if an ordinary induction motor had been installed the increase would have been at least 40%.

Another interesting installation which has been put to work during the past year is at the N'Kana Copper Mines, Northern Rhodesia. There are two winding motors, each of 1,350/2,700 h.p. and each driven by a separate Ward-Leonard fly-wheel motor generator with hydraulic slip regulator. Each set consists of a synchronous induction motor of 1,000 h.p. driving a generator of 950 k.w. At present the wind is to a depth of 1,200 ft., but this is to be doubled in the future, when an additional winding-motor will be added to each drum and a further Ward-Leonard set supplied to drive it.

Several completely-automatic winding equipments have been supplied to the mines at Broken Hill, Australia. Some of these equipments are designed to hoist from eleven different levels, the maximum depth being 2,800 ft. with a rope speed of 62 ft. per second. The operation is by means of push button from any of the levels and the winding cycle is carried out automatically.

It may be mentioned here that, while the firm have not interested themselves in the control of steam-driven winders, many of the safety devices and methods that have been developed with such success for electric winders are applicable. An investigation of several steam-operated winders in Lancashire has shown that such devices will (1) in all cases effectively prevent overwind under any circumstances, (2) in all cases prevent the equipment being started in the wrong direction when the cage is at bank, (3) in some cases increase the output, (4) in some cases reduce fatigue on the driver considerably, (5) in some cases allow control mechanism to be simplified considerably, and (6) in some cases make possible increased life of the ropes and reduced wear and tear on brakes, etc.

Researches have been made in the firm's laboratories on the crystallization of materials subject to stresses of various kinds and the time is fast approaching when it will be possible to apply

the knowledge gained to the problem of winding ropes. It seems probable that the automatic arrangements referred to above, by keeping the maximum stress to a known figure, will make winding in deeper vertical shafts practical and thus enable great economies to be made in cases where the winding has hitherto had to be carried out in two stages.

Blast Furnaces.—A completely automatic blast-furnace equipment for the Workington Iron and Steel Co., supplied through John Milburn and Co., and the Workington Bridge and Boiler Co., has been put into full commission and is operating satisfactorily. The equipment comprises automatic control and sequence of the hoist motor, small and large bell-operating and revolving distributor gear, and raising and lowering of the sounding rods. The operations are sequenced and are started by a push button. The same company have also ordered control gear for a vertical horizontal charging gantry for two furnaces. This gear controls the raising, traversing, and lowering on to furnace top of a charging bucket. Signal lamps indicate its position to the driver. The Staveley Coal and Iron Co. have operating a sequencing gear for the bells and distributor and sounding rods for a steam-driven hoist, which gear has been supplied this year.

Welding—During the past year an entirely automatic atomic hydrogen arc-welding machine has been developed. In this machine the length of arc is kept constant by a motor which is controlled by relays and feeds the electrode forward when the arc is too long and reverses when it is too short. The traversing movement is similar to that employed in the ordinary arc-welding equipment. A complete straight seam automatic arc-welding machine equipped with two heads on a travel carriage has been supplied to an order. The machine is of the beam type and is capable of accommodating tanks 10 ft. long by 10 ft. in diameter. The same firm has also been supplied with a circular welding machine which will take tanks of the same diameter. Motor generators for supplying the welders were also part of the contract, which included erecting and connecting up the plant.

A machine has been developed for automatic welding which uses a covered electrode. It is the development of this electrode, which has a braided covering in which the flux is pressed into the interstices of the weave that has made this machine a possibility. The results obtained are a much higher welding speed and a better quality of deposited metal. The covering has great mechanical strength and the method of applying the flux ensures that it shall not flake off when passing through the feed rollers. The welds made with this electrode are strong and ductile and the rate of deposit is more rapid than with any other rods. This may be due to the covering being of the gas shield type, which enables the arc energy to be increased. There is no objectionable slag and the weld is consequently very easy to clean. The electrodes are suitable for both vertical and horizontal welding.

Another new development is a low-voltage generator for multi-operator sets. One of these sets is supplying the multi-operator welders in the firm's works very successfully and with a greatly increased efficiency. The voltage on open circuit is of the order of 35 to 40. This low voltage has been made possible by the use of a special reactor which gives stability to the arc under all current conditions.

METAL MARKETS

COPPER.—On balance, the copper market was fairly steady during January. Naturally, there was considerable conjecture as to what individual producers would do now that the international agreement has lapsed, but the general feeling seems to be that none of them will embark on any very ambitious schemes just yet, the financial question and the menace of the big American stocks probably providing sufficient discouragement. Electrolytic moved within a small compass during the month and closed at about 5 cents per lb. c.i.f. Europe.

Average price of Cash Standard Copper : January, 1933, £28 12s. ; December, 1932, £29 2s. 7½d. ; January, 1932, £39 10s. 1d. ; December, 1931, £38 6s. 5d.

TIN.—Values had spells of weakness at various times during the past month, support being withdrawn, but subsequently they recovered practically all the ground lost. The January statistics, revealing a diminution of 1,500 tons in the world visible supply, were distinctly favourable, but industrial demand continued quiet. The American industrial situation, on which the tin market depends to a considerable extent, is slow to improve.

Average price of Cash Standard Tin : January, 1933, £145 15s. 10d. ; December, 1932, £149 17s. 9¾d. ; January, 1932, £140 5s. 6¾d. ; December, 1931, £138 19s. 7d.

LEAD.—The lead market was not particularly well maintained during January and this was only natural in view of the comparative dullness of demand.

Average mean price of soft foreign lead : January, 1933, £10 12s. 11d. ; December, 1932, £11 6s. 10d. ; January, 1932, £15 2s. 1½d. ; December, 1931, £15 5s. 5d.

SPELTER.—Values lost ground during January, although considerable fluctuations were witnessed. The chief factor which weakened sentiment was the fact that producers were unable to agree regarding the proposed renewal of the International Zinc Cartel and this undermined confidence. At the moment of writing it is somewhat uncertain as to whether the organization in question will be saved or not. Industrial demand was quiet during the past month both in Europe and America.

Average mean price of spelter : January, 1933, £14 9s. 9d. ; December, 1932, £15 5s. 6¾d. ; January, 1932, £14 12s. 6d. ; December, 1931, £14 11s. 9d.

IRON AND STEEL.—The British pig-iron industry opened 1933 with a cheerful tone, with both home and export sales tending to expand. An arrangement was arrived at between Cleveland and Midlands producers aiming at cutting out the previous severe competition and prices have been put on to a delivered basis for the home trade, No. 3 Cleveland being now quoted at 62s. 6d. delivered for local delivery. For export the old quotation of 58s. 6d. f.o.b. still rules. The British steel industry is showing distinct signs of improvement, but the Continental steel market, after a temporary spurt on heavy Far Eastern buying, has become quieter again.

IRON ORE.—Business has tailed off again, after making a rather better showing in December. Best Bilbao rubio is about 15s. to 15s. 3d. per ton c.i.f.

ANTIMONY.—Considerable interest has been

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.		Cash.		3 Months.				Soft Foreign.		English.		Cash.	Forward.		
	Cash.		3 Months.																			
	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		d.		d.		s. d.	
Jan.																						
11	29 11 3		29 18 1½		34 11 3		—		147 6 3		147 18 9		14 16 3		10 10 0		12 0 0		16¼		16 11/16		122	8½
12	29 5 7½		29 11 10½		34 10 0		—		147 1 3		147 13 9		14 12 6		10 12 6		12 0 0		16 1/16		17		122	8½
13	28 14 4½		29 0 7½		34 2 6		31 0 0		145 13 9		146 3 9		14 8 9		10 8 9		12 0 0		16¼		16 11/16		123	2
16	28 9 4½		28 15 7½		33 10 0		—		144 6 3		144 17 6		14 6 3		10 10 0		12 0 0		16⅞		16 11/16		122	8½
17	28 6 3		28 11 10½		33 5 0		30 10 0		145 6 3		145 16 3		14 10 0		10 11 3		12 0 0		16 3/16		16⅞		122	8
18	28 6 3		28 11 10½		33 5 0		—		146 2 6		146 13 9		14 12 6		10 7 6		11 15 0		16½		16 11/16		123	
19	28 3 9		28 9 4½		33 5 0		—		144 7 6		145 2 6		14 8 9		10 5 0		11 15 0		16 1/16		17		122	11
20	28 6 10½		28 13 1½		33 5 0		30 5 0		145 1 3		145 13 9		14 3 9		10 5 0		11 15 0		16 1/16		16 15/16		122	10
23	28 16 10½		29 1 10½		33 5 0		—		145 12 6		146 3 9		14 6 3		10 10 0		12 0 0		16 1/16		17		122	7
24	28 11 10½		28 17 6		33 0 0		30 10 0		145 13 9		146 3 9		14 6 3		10 10 0		12 0 0		17⅛		17 3/16		121	7
25	28 14 4½		28 18 1½		33 0 0		—		146 18 9		147 8 9		14 7 6		10 13 9		12 0 0		17 1/16		17½		121	1½
26	28 11 10½		28 15 7½		33 0 0		—		146 16 3		147 11 3		14 2 6		10 10 0		12 0 0		17 1/16		17⅛		121	4½
27	28 11 3		28 16 3		33 2 6		30 10 0		146 8 9		147 2 6		13 11 3		10 8 9		12 0 0		17		17 1/16		121	5½
30	28 5 7½		28 9 4½		32 17 6		—		147 0 0		147 11 3		13 11 3		10 10 0		12 0 0		17⅛		17 3/16		121	5
31	28 11 3		28 15 0		32 17 6		30 10 0		148 6 3		148 16 3		13 18 9		10 13 9		12 0 0		17 1/16		17 1/16		121	3½
Feb.																						
1	28 7 6		28 11 10½		33 0 0		—		148 11 3		149 8 9		13 18 9		10 13 9		12 0 0		17		17 1/16		121	2½
2	28 11 3		28 15 0		32 17 6		—		150 2 6		150 17 6		13 11 3		10 11 3		12 0 0		16¾		16 15/16		121	3½
3	28 8 9		28 13 1½		32 17 6		30 10 0		149 13 9		150 7 6		13 10 0		10 12 6		12 0 0		16½		16 11/16		121	3
6	28 8 1½		28 13 9		32 17 6		—		149 16 3		150 8 9		13 13 9		10 10 0		12 0 0		16 1/16		16⅝		119	9
7	28 9 4½		28 14 4½		32 15 0		30 10 0		149 13 9		150 1 3		13 15 0		10 7 6		12 0 0		16⅛		16 1/16		120	2
8	28 11 10½		28 15 7½		32 17 6		—		149 0 0		149 8 9		13 15 0		10 7 6		12 0 0		16⅛		16 1/16		120	1½
9	29 1 10½		29 6 10½		33 5 0		—		149 13 9		150 2 6		14 0 0		10 8 9		12 0 0		16⅛		16 1/16		120	2

aroused by reports that China proposes to establish a local Government monopoly on antimony and to impose an additional 10% export tax. So far, however, these are unconfirmed. After being very firm for a time prices are now about £24 c.i.f. for forward shipment from China. English regulus remains at £37 10s. to £42 10s. per ton.

Arsenic.—Demand is slow and prices have eased as a result of selling competition. Mexican high grade is now about £19 c.i.f. whilst Cornish white is around £19 10s. f.o.r. mines.

Bismuth.—The official price is unchanged at 5s. per lb. for 5 cwt. lots and over.

Cadmium.—Only a quiet demand is in evidence, with current quotations about 1s. 7d. per lb.

Cobalt Metal.—There is not much moving, but the official price remains at 7s. per lb.

Cobalt Oxides.—Demand is only moderate and prices continue to vary according to quantity. Black stands at about 4s. 9d. to 5s. 2d. per lb., with grey 5s. 4d. to 5s. 7d. per lb.

Chromium.—About 2s. 9d. per lb. delivered is still quoted for 96 to 98%.

Tantalum.—Current quotations remain at around £15 per lb., although rather more is asked for small lots.

Platinum.—Demand remains poor and with increased competition among producers prices have eased to £7 10s. per oz. for refined metal.

Palladium.—There is very little changing hands but quotations are unchanged at £4 to £4 10s. per oz.

Osmium.—About £12 to £12 10s. is the current quotation.

Iridium.—The market is dull but prices are steady at about £9 10s. per oz. for sponge and powder.

Tellurium.—Around 20s. per lb. remains the current quotation, but sales are few and far between.

Selenium.—High-grade black powder is without change at 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse.

Manganese Ore.—Business is still confined to occasional odd lots which are mostly for the Belgian or French markets. Prices, however, keep very steady at about 9½d. per unit c.i.f. for best Indian, and 8½d. to 9d. c.i.f. for 50 to 52% washed Caucasian ore.

Aluminium.—There appears to have been slightly more business moving recently but producers are still working at much below capacity. Prices are upheld at £100 less 2% delivered for ingots and bars for the home trade.

Sulphate of Copper.—The market has remained pretty steady with English quoted at £16 10s. to £17 per ton, less 5%.

Nickel.—Quotations are affected by exchange movements, the current level being £245 to £250 per ton, according to quantity. Demand recently has been rather better.

Chrome Ore.—Business remains on a decidedly poor scale, but there is no change in prices, which are still about 80s. to 85s. per ton c.i.f. for good 48% Rhodesian, and 100s. to 105s. c.i.f. for 55 to 57% New Caledonian.

Quicksilver.—There is not a great deal moving, current quotations being about £10 5s. to £11 per bottle, net, for spot metal.

Tungsten Ore.—The continued apathy of buyers has resulted in an easier tendency, Chinese ore for forward shipment now being quoted at 9s. 9d. to 10s. per unit c.i.f., with spot worth very little more.

Molybdenum Ore.—Quite a good demand continues with quotations now about 47s. 6d. to 50s. per unit c.i.f. for 85% concentrates.

Graphite.—Around £16 to £18 per ton c.i.f. is quoted for 85 to 90% raw Madagascar flake and £15 to £17 c.i.f. for 90% Ceylon lumps.

Silver.—During January the undertone was quietly firm. Spot bars were 16½d. on January 3, rising to 16 15/16d. on January 12 as the result of some Chinese buying on a market largely devoid of sellers. The introduction of the American Money Bill on January 24 with its clause for the remonetization of silver caused a firmer tendency, although this clause was rejected. On January 31 spot bars closed at 17 1/16d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
January, 1932	890,688	46,096	936,784
February	869,711	44,301	914,012
March	914,017	46,018	960,035
April	901,894	47,902	949,796
May	919,223	46,421	965,644
June	913,297	45,714	959,011
July	933,947	47,213	981,160
August	943,174	48,148	991,322
September	912,870	48,631	961,501
October	926,686	48,279	974,965
November	930,085	48,631	978,716
December	931,749	48,869	980,618
January, 1933	919,125	48,332	967,457

TRANSVAAL GOLD OUTPUTS.

	December.		January.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	112,500	£163,772	112,000	£216,041
City Deep	80,000	21,504	81,000	21,256
Cons. Main Reef	70,200	24,492	75,200	25,330
Crown Mines	279,000	91,023	292,000	91,264
Daggafontein	46,800	£80,707	47,700	£110,768
D'rb'n Roodepoort Deep	50,000	15,585	52,000	15,408
East Geduld	63,300	20,767	64,000	21,456
East Rand P.M.	159,000	41,954	163,000	41,756
Geduld	85,000	27,541	87,800	27,218
Geldenhuis Deep	70,500	16,869	71,000	16,112
Glynn's Lydenburg	7,600	2,745	7,700	2,636
Government G.M. Areas	214,000	£406,591	209,000	£578,927
Kleinfontein	52,000	£45,678	52,400	£10,115
Langlaagte Estate	79,000	£105,121	81,000	£147,557
Luipaard's Vlei	33,300	8,320	34,700	8,199
Modderfontein New	178,000	62,732	176,000	59,107
Modderfontein B	75,000	20,273	77,500	19,922
Modderfontein Deep	44,900	20,820	44,600	19,182
Modderfontein East	76,000	22,088	76,000	21,191
New State Areas	90,000	£187,843	91,000	£267,280
Nourse	71,000	21,078	72,000	20,476
Randfontein	246,000	£309,848	255,000	£436,376
Robinson Deep	96,000	28,054	100,000	26,942
Rose Deep	62,000	13,050	64,200	12,650
Simmer and Jack	77,800	22,383	83,100	20,221
Springs	80,000	£163,210	79,200	£227,727
Sub Nigel	37,800	33,963	37,800	33,941
Transvaal G.M. Estates	19,300	5,645	19,300	5,529
Van Ryn	50,500	£48,258	52,000	£67,870
Van Ryn Deep	71,000	£93,742	72,000	£135,654
West Rand Consolidated	96,500	£107,328	98,000	£152,146
West Springs	80,600	£80,734	81,000	£112,054
Witw'tersr'nd (Knights)	72,000	£57,189	73,000	£78,325
Witwatersrand Deep	45,400	£46,661	46,800	£15,856

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.	£
October, 1931	2,870,800	27 8	19 3	8 5	1,210,743
November	2,726,720	27 10	19 5	8 5	1,144,208
December	2,793,900	27 10	19 5	8 5	1,173,732
January, 1932	2,880,500	27 5	19 4	8 1	1,163,434
February	2,775,400	27 8	19 6	8 2	1,133,212
March	2,901,300	27 10	19 7	8 3	1,200,278
April	2,883,500	27 9	19 5	8 4	1,196,011
May	2,964,100	27 6	19 2	8 4	1,228,198
June	2,927,200	27 9	19 3	8 6	1,241,392
July	2,993,600	27 5	19 0	8 5	1,260,744
August	3,027,700	27 6	19 1	8 5	1,277,923
September	2,940,800	27 6	19 1	8 5	1,234,584
October	2,994,500	27 5	19 0	8 5	1,263,274
November	2,949,050	27 8	19 2	8 6	1,256,717
December	—	—	—	—	1,255,797

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
January 31, 1932	215,752	12,394	1,598	229,744
February 29	216,171	12,177	1,363	229,711
March 31	214,024	12,009	—	226,033
April 30	214,334	11,943	—	226,277
May 31	215,926	11,972	—	227,898
June 30	217,077	11,833	—	228,910
July 31	217,525	12,056	—	229,581
August 31	217,658	11,727	—	229,385
September 30	216,398	11,642	—	228,040
October 31	216,298	11,353	—	227,651
November 30	219,024	11,207	—	230,231
December 31	221,008	11,310	—	232,318
January 31, 1933	222,005	11,292	—	233,297

PRODUCTION OF GOLD IN RHODESIA.

	1929	1930	1931	1932
	oz.	oz.	oz.	oz.
January	46,231	46,121	45,677	42,706
February	44,551	43,385	42,818	45,032
March	47,388	45,511	42,278	47,239
April	48,210	45,806	43,776	46,487
May	48,189	47,645	43,731	46,854
June	48,406	45,208	44,118	48,441
July	46,369	45,810	44,765	47,331
August	46,473	46,152	43,292	49,254
September	45,025	46,151	42,846	50,198
October	46,923	45,006	44,260	50,416
November	46,219	44,351	44,516	48,082
December	46,829	46,485	50,034	52,096

RHODESIAN GOLD OUTPUTS.

	December.		January.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,600	10,497	25,600	9,545
Globe and Phœnix	6,074	6,012	6,082	5,749
Lonely Reef	10,000	2,219	—	—
Luiri Gold	—	—	—	—
Rezende	6,500	2,546	6,500	2,512
Sherwood Star	5,200	£6,800	5,600	£6,166
Wanderer Consolidated	16,100	3,591	16,000	3,593

WEST AFRICAN GOLD OUTPUTS.

	December.		January.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	7,291	£21,621	7,305	£22,183
Ashanti Goldfields	13,452	14,732	13,440	14,730
Taquah and Abosso	10,259	3,272	10,206	3,302

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
January, 1932	44,037	—	916
February	44,672	—	981
March	47,108	9,735†	769
April	48,936	3,912	1,216
May	53,928	2,782	692
June	50,079	—	920
July	53,585	2,530	1,391
August	51,536	—	1,026
September	54,427	—	1,160
October	51,236	—	—
November	53,956	—	—
December	52,282	—	—
January, 1933	45,755	—	—

† Jan., Feb., and March.

AUSTRALASIAN GOLD OUTPUTS.

	December.		January.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,423	5,724	5,234	5,700
Blackwater (N.Z.)	2,860	1,408*	3,787	1,752*
Boulder Persev'ce (W.A.)	3,940	8,001	6,381	12,438
Grt. Boulder Pro. (W.A.)	4,374	3,517*	—	—
Lake View & Star (W.A.)	31,022	33,635	—	—
Sons of Gwalia (W.A.)	12,132	15,419	12,116	13,162
South Kalgurli (W.A.)	9,928	15,946	7,514	11,870
Waihi (N.Z.)	26,647	8,292* / 61,101†	11,780‡	3,502 / 21,013
Wiluna	—	—	—	—

* Oz. gold. † Oz. silver. ‡ To Jan. 21.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA

	December.		January.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Champion Reef	9,520	5,708	9,430	5,552
Mysore	14,908	7,885	14,852	7,671
Nundydroog	19,608	10,388†	19,643	10,342*
Ooregum	11,312	4,153	11,750	4,224

* 1,641 oz. from 1,628 tons Balaghat ore. † 2,378 oz. from 1,848 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	December.		January.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	114,696*d*	—	—
Chosen Corp. (Korea)	9,940	17,337	10,280	16,150
Frontino Gold (C'lbia)	3,548	15,986	3,330	14,286
Fresnillo	81,827	583*d*†	—	—
New Goldfields of Venezuela	9,440	2,265*	8,502	2,166*
Oriental Cons. (Korea)	—	106,320*d*	—	89,543*d*
St. John del Rey (Brazil)	—	38,000	—	38,500
Santa Gertrudis (Mexico)	19,290	11,873*d*‡	—	—
Viborita	—	—	—	—
West Mexican Mines	1,380	24,000*d*	—	—

d Dollars. * Oz. gold. † To Dec. 3. ‡ Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES

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

July, 1932	1,437	January, 1933	2,312
August	1,164	February	—
September	1,123	March	—
October	2,273	April	—
November	2,242	May	—
December	1,590	June	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Nov.	Dec.	Jan.
Ayer Hitam	—	—	113
Batu Caves	—	—	—
Changkat	60	60	58
Gopeng	—	72½*	—
Hongkong Tin	65½	—	—
Idris Hydraulic	18¼	—	17¾
Ipoh	67⅜	—	133½
Kampar Malaya	—	—	—
Kampong Lanjut	—	—	—
Kamunting	125	146	150
Kent (F.M.S.)	—	—	—
Killinghall	35	—	—
Kinta	—	34*	—
Kinta Kellas	—	—	—
Kramat Tin	25	85	78
Kuala Kampar	27	50	—
Kundang	—	—	—
Lahat	12	4½	14½
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	59¼	40¼	80½
Malim Nawar	—	—	—
Pahang	78	78	78
Penawat	—	—	52½
Pengkalen	—	67*	—
Petaling	48	2*	—
Rahman	—	—	25
Rambutan	—	—	—
Rantau	—	—	—
Rawang	33	37	18
Rawang Concessions	25	46	42
Renong	47	17½	22½
Selayang	—	—	—
Southern Kampar	62½	—	93
Southern Malayan	59½	48	53⅛
Southern Perak	—	—	41½
Southern Tronoh	18	18	18
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	31½	35¾	38½
Taiping	—	—	—
Tanjong	—	—	—
Tekka	—	39*	—
Tekka Taiping	—	65*	—
Temoh	—	—	—
Tronoh	39	39	39
Ulu Klang	—	—	—

* 3 months to Dec. 31.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Nov.	Dec.	Jan.
Anglo-Nigerian	12½	13	15
Associated Tin Mines	106½	107½	104½
Baba River	1	2	4
Batura Monguna	—	—	—
Bisichi	16	18½	—
Daffo	—	—	—
Ex-Lands	27	16½	—
Filani	—	—	—
Jantar	10	9	—
Jos	7¾	7¾	—
Juga Valley	5½	5½	5½
Kaduna Syndicate	12	11½	—
Kaduna Prospectors	6	5¾	—
Kassa	6	4½	3
London Tin	74	73	76
Lower Bisichi	2	3	—
Naraguta Extended	—	—	—
Nigerian Consolidated	4½	4½	4
Offin River	—	—	—
Ribon Valley	11½	11½	10
Tin Fields	—	—	—
United Tin Areas	11	10	10
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Nov.	Dec.	Jan.
Anglo-Burma (Burma)	50⅝	41½	38
Aramayo Mines (Bolivia)	124	110	116
Bangrin (Siam)	68½	70½	43
Beralt	25*	22½*	—
Consolidated Tin Mines (Burma)	90	79	90
East Pool (Cornwall)	48¼	44½	—
Fabulosa (Bolivia)	36	36	39
Kagera (Uganda)	42	31	—
Kamra	—	—	—
Malaysiam Tin	14½	14½	14½
Mawchi	213*	220*	—
Patino	—	—	—
Pattani	—	—	—
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	56½	106½	137⅜
South Crofty	56½	55½	50
Tavoy Tin (Burma)	61	84½	69
Tongkah Harbour (Siam)	34	26	35
Toyo (Japan)	54½	68½	56
Zaaiplaats	15	15	—

* Tin and Wolfram.

COPPER LEAD, AND ZINC OUTPUTS.

		Dec.	Jan.
Britannia Lead	Tons refined lead	4,646	—
	Oz. refined silver	238,767	—
Broken Hill South	Tons lead conc.	5,832	—
	Tons zinc conc.	6,019	—
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	508,769	520,889
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	350	400
	Tons yellow metal	520	513
Messina	Tons copper	790	809
Mount Isa	Tons lead bullion	4,544	—
Mount Lyell	Tons concentrates	2,655	3,314
North Broken Hill	Tons lead conc.	6,050†	—
	Tons zinc conc.	6,170†	—
Rhodesia Broken Hill	Tons V_2O_5	20	—
	Tons V_2O_5 conc.	100	20*
Roan Antelope	Tons blister copper	3,002	—
Sulphide Corporation	Tons lead conc.	1,754‡	—
	Tons zinc conc.	2,538‡	—
Trepca	Tons lead conc.	4,971	4,990
	Tons zinc conc.	7,170	7,062
Zinc Corporation	Tons lead conc.	5,809	—
	Tons zinc conc.	4,757	—

* And 1,051 tons zinc. † Six weeks to Dec. 31. ‡ To Dec. 24.

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

	Nov.	Dec.
Iron Ore ..... Tons	159,737	159,571
Manganese Ore ..... Tons	3,628	6,351
Iron and Steel ..... Tons	57,892	72,748
Copper and Iron Pyrites ..... Tons	13,693	26,207
Copper Ore, Matte, and Prec. ..... Tons	2,314	2,411
Copper Metal ..... Tons	18,852	12,971
Tin Concentrate ..... Tons	2,329	3,462
Tin Metal ..... Tons	196	170
Lead Pig and Sheet ..... Tons	28,730	19,844
Zinc (Spelter) ..... Tons	4,749	5,330
Zinc Sheets, etc. ..... Tons	1,722	1,709
Zinc Oxide ..... Tons	39	14
Zinc Ore ..... Tons	28,151	6,575
Aluminium ..... Tons	1,324	568
Mercury ..... Lb.	119,303	92,862
White Lead ..... Cwt.	5,543	4,942
Barytes, ground ..... Cwt.	23,914	22,000
Asbestos ..... Tons	1,389	2,350
Boron Minerals ..... Tons	1,119	469
Borax ..... Cwt.	6,280	15,926
Basic Slag ..... Tons	—	—
Superphosphates ..... Tons	2,191	2,298
Phosphate of Lime ..... Tons	15,250	24,444
Mica ..... Tons	132	107
Tungsten Ores ..... Tons	192	413
Sulphur ..... Tons	4,831	2,905
Nitrate of Soda ..... Cwt.	—	1,602
Potash Salts ..... Cwt.	119,984	141,506
Petroleum: Crude ..... Gallons	21,653,730	29,992,986
Lamp Oil ..... Gallons	13,039,661	36,385,226
Motor Spirit ..... Gallons	62,484,205	82,619,717
Lubricating Oil ..... Gallons	4,587,309	7,065,418
Gas Oil ..... Gallons	3,705,314	8,801,775
Fuel Oil ..... Gallons	29,426,173	45,982,069
Asphalt and Bitumen ..... Tons	4,026	10,383
Paraffin Wax ..... Cwt.	101,880	110,149

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	Nov.	Dec.	Jan.
Anglo-Ecuadorian	15,465	16,007	16,117
Apex Trinidad	44,970	43,020	45,190
Attock	1,622	1,669	1,533
British Burmah	3,443	3,789	3,911
British Controlled	37,575	39,589	—
Kern Mex	794	847	832
Kern River (Cal.)	3,000	3,292	3,346
Kern Romana	87	84	77
Kern Trinidad	1,549	1,561	1,903
Lobitos	23,700	24,287	23,071
Phœnix	86,333	78,406	65,719
St. Helen's Petroleum	4,130	4,218	3,967
Steaua Romana	103,664	100,837	90,564
Tampico	2,201	2,290	2,219
Tocuyo	1,255	1,186	1,219
Trinidad Leaseholds	27,450	29,950	28,550

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Jan. 10, 1933.	Feb. 9, 1933.
	£ s. d.	£ s. d.
Anglo-Ecuadorian	12 9	11 0
Anglo-Egyptian B	1 11 3	1 10 0
Anglo-Persian 1st Pref.	1 5 9	1 8 3
,, ,, Ord.	1 16 3	1 17 6
Apex Trinidad (5s.)	1 0 3	18 9
Attock	10 6	8 9
British Burmah (8s.)	3 0	3 6
British Controlled ($5)	4 0	3 9
Burmah Oil	3 0 6	3 0 0
Kern River Cal. (10s.)	2 6	2 3
Lobitos, Peru	1 16 3	1 12 6
Mexican Eagle, Ord. (4 pesos)	7 9	7 3
,, ,, 8% Pref. (4 pesos)	7 3	6 6
Phœnix, Roumanian	11 6	9 6
Royal Dutch (100 fl.)	19 0 0	17 15 0
Shell Transport, Ord.	2 9 3	2 5 0
,, ,, 5% Pref. (£10)	10 17 6	11 2 6
Steaua Romana	8 9	8 0
Trinidad Leaseholds	2 11 3	2 7 6
United British of Trinidad (6s. 8d.)	5 0	4 6
V.O.C. Holding	1 11 9	1 10 0

PRICES OF CHEMICALS. Feb. 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.	1 0 9
,, ,, 80%	,,	1 18 5
,, ,, Glacial	per ton	59 0 0
Alum	,,	8 7 6
Aluminium Sulphate, 17 to 18%	,,	6 15 0
Ammonium, Anhydrous	per lb.	1 1
,, 0·880 solution	per ton	15 10 0
,, Carbonate	,,	27 10 0
,, Nitrate (British)	,,	16 0 0
,, Phosphate, comml.	,,	40 0 0
,, Sulphate, 20·6% N.	,,	6 7 6
Antimony, Tartar Emetic, 43/44%	per lb.	10
,, Sulphide, golden	,,	9
Arsenic, White (foreign)	per ton	20 0 0
Barium, Carbonate (native), 94%	,,	4 10 0
,, Chloride	,,	10 10 0
Barytes	,,	8 5 0
Benzol, standard motor	per gal.	1 6½
Bleaching Powder, 35% Cl.	per ton	8 15 0
Borax	,,	16 10 0
Boric Acid	,,	26 10 0
Calcium Chloride, solid, 70/75%	,,	5 15 0
Carbolic Acid, crude 60's	per gal.	2 2
,, ,, crystallized, 40°	per lb.	10½
Carbon Disulphide	per ton	30 0 0
Citric Acid	per lb.	9¾
Copper Sulphate	per ton	15 10 0
Creosote Oil (f.o.b. in Bulk)	per gal.	3¾
Cresylic Acid, 98-100%	,,	1 2
Hydrofluoric Acid, 59/60%	per lb.	6
Iodine Resub. B.P. (28 lb. lots)	,,	15 5
Iron, Nitrate 80° Tw.	per ton	6 0 0
,, Sulphate	,,	1 15 0
Lead, Acetate, white	,,	31 10 0
,, Nitrate (ton lots)	,,	27 10 0
,, Oxide, Litharge	,,	25 10 0
,, White	,,	37 10 0
Lime, Acetate, brown	,,	9 5 0
,, ,, grey, 80%	,,	12 15 0
Magnesite, Calcined	,,	8 5 0
Magnesium Chloride	,,	6 10 0
,, Sulphate, comml.	,,	4 10 0
Methylated Spirit Industrial 61 O.P.	per gal.	2 0
Nitric Acid, 80° Tw.	per ton	19 0 0
Oxalic Acid	per ton	48 0 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	32 0 0
,, Chlorate	per lb.	4
,, Chloride, 80%	per ton	9 10 0
,, Ethyl Xanthate	per 100 kilos	7 0 0
,, Hydrate (Caustic) 88/90%	per ton	40 0 0
,, Nitrate	,,	30 0 0
,, Permanganate	per lb.	8½
,, Prussiate, Yellow	per ton	75 0 0
,, ,, Red	per lb.	2 0
,, Sulphate, 90%	per ton	10 10 0
Sodium Acetate	,,	23 10 0
,, Arsenate, 45%	,,	23 0 0
,, Bicarbonate	,,	10 10 0
,, Bichromate	per lb.	4
,, Carbonate (Soda Ash), 58%	per ton	6 0 0
,, ,, (Crystals)	,,	5 5 0
,, Chlorate	,,	32 0 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 (refined)	,,	8 10 0
,, Phosphate, comml.	,,	12 0 0
,, Prussiate	per lb.	4¾
,, 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	9 15 0
,, Roll	,,	9 15 0
Sulphuric Acid 168° Tw.	,,	4 5 0
,, ,, free from Arsenic, 140° Tw.	,,	3 0 0
Superphosphate of Lime (S.P.A. 16%)	,,	3 4 0
Tartaric Acid	per lb.	10½
Turpentine	per ton	67 0 0
Tin Crystals	per lb	1 0
Tetanous Chloride	,,	10½
Zinc Chloride	per ton	9 10 0
,, Dust, 90/92%	,,	20 0 0
,, Oxide (White Seal)	,,	35 0 0
,, Sulphate	,,	9 0 0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

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

COPPER:		
Bwana M'Kubwa (5s.), Rhodesia	3 6	3 9
Indian (2s.)	1 3	1 6
Loangwa (5s.), Rhodesia	1 6	1 6
Mason and Barry	—	10 0
Messina (5s.), Transvaal	6 0	6 6
Mount Lyell, Tasmania	16 9	16 0
Namaqua (£2), Cape Province	—	2 0
Rhodesia-Katanga	10 0	10 0
Rio Tinto (£5), Spain	18 2 6	16 12 6
Roan Antelope (5s.), Rhodesia	12 3	12 6
Tanganyika Concessions	19 3	19 3
Tharsis (£2), Spain	3 10 0	3 2 6

LEAD-ZINC:	Jan. 10, 1933. £ s. d.	Feb. 9, 1933. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	7 6	7 6
Broken Hill Proprietary, N.S.W.	1 1 0	1 1 6
Broken Hill, North, N.S.W.	2 13 9	2 13 9
Broken Hill, South, N.S.W.	1 17 6	1 16 9
Burma Corporation (10 rupees)	10 6	10 3
Electrolytic Zinc Pref., Tasmania	11 3	12 6
Mount Isa, Queensland	8 0	7 6
Rhodesia Broken Hill (5s.)	1 9	2 0
San Francisco (10s.), Mexico	7 9	7 9
Sulphide Corporation (15s.), N.S.W.	6 0	6 0
ditto, Pref.	7 9	8 3
Trepca (5s.), Yugoslavia	7 9	7 9
Zinc Corporation (10s.), N.S.W.	1 2 6	1 1 3
ditto, Pref.	3 7 6	3 5 0

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

DIAMONDS:		
Consol. African Selection Trust (5s.)	17 6	17 6
Consolidated of S.W.A. (10s.)	3 9	5 9
De Beers Deferred (£2 10s.)	5 3 9	5 7 6
Jagersfontein	1 6 3	1 6 3
Premier Preferred (5s.)	1 5 0	1 8 9

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

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 BROKEN HILL LODE

The geological structure of the Broken Hill lode is described by E. J. Kenny in the *Proceedings* of the Australasian Institute of Mining and Metallurgy for September 30 last, the author saying that, for the purpose of his paper, the name "The Broken Hill Lode" refers to that complex unit which includes pre-eminently the famous ore-bodies exposed in the workings from the North Mine on the one extreme to the South Blocks (Zinc Corporation) Mine on the other. While the paper deals primarily with the structure of the lode, an outline of the general geology and of the geological history of the district is furnished by way of a preface as a knowledge of these aspects is essential to any appreciation of the major conditions governing the occurrence of the ore-deposits.

The conclusions as to structure advanced by the author embody not only the results of his personal observations but also the summation of evidence adduced by all previous and contemporary investigators. Extracts from this paper are given here.

General Geology.—The geological formations exposed in the neighbourhood of Broken Hill comprise, principally, igneous and sedimentary rocks of Pre-Cambrian age with which the ore-deposits are associated and, subordinately, the cover of Recent sediments embracing alluvium, wind-blown sand, soils, loams, waste material, and rocks of chemical origin such as secondary limestones ("Kunkar"). For simplicity the Pre-Cambrian complex may be subdivided as follows—

(1) Willyama Series—altered sediments.
(2) Older Intrusives—altered igneous.
(3) Newer Intrusives—unaltered igneous.

Formerly the term "Willyama Series" included all Pre-Cambrian rocks in the vicinity of Broken Hill, but its use is here restricted to apply only to the oldest formations—namely, the altered sediments. The classification adopted indicates at once the sequence of Pre-Cambrian rocks.

(1) *Willyama Series.*—This oldest group comprises a considerable thickness of thinly-bedded sandstones, grits, and shales in part sandy, which, by reason of the intense alteration they have undergone, now appear as gneisses, schists, phyllites, slates, and quartzites. In general, a zonal arrangement of alteration, with Broken Hill as the centre of maximum intensity, is apparent. Thus, rocks which outcrop as sillimanite-gneiss at Broken Hill appear as mica-schists, phyllites, and even slates, in outer localities. Andalusite and chiastolite schists are common in the western portion of the district, notably in the Apollyon valley and to the north of Purnamoota.

Many traces of the original bedding-planes have been preserved even in the centre of greatest alteration. Particularly is this noticeable in sillimanite-gneisses so well developed near the Broken Hill lode; sillimanite being common in those layers which were originally silts or shales, while the more sandy laminæ are practically devoid of this mineral. Banding within the ore-bodies and in unreplaced masses of gneiss is indicative also of the original structure of the altered beds.

Garnets, micas, cordierite, staurolite, and other minerals are developed also within the altered sediments.

(2) *Older Intrusives.*—Acid and basic igneous rocks are represented by many types of gneiss, granulite, aplite, pegmatite, and amphibolite, arranged in sheet-like masses or sills conformable in marked manner to the bedding-planes of the associated sediments. The exposures may be very small or they may be of great superficial extent; nevertheless they are of moderate thickness only. No trace of any "feeder" has yet been found.

(3) *Newer Intrusives.*—These younger igneous types do not exhibit dynamic alteration. They include the granite of Mundi Mundi, gabbro (serpentine), dykes of pegmatite and uralitic dolerite, together with the ore-bodies of the field and their associated masses of "lode pegmatite," pyroxenes (rhodonite, manganhedenbergite), garnet, calcite, quartz, and other constituents of the gangue.

Geological History.—During the earlier period of igneous activity the sediments of the Willyama series were affected by folding movements which produced a complicated system of asymetrical arches and basins and contributed in great measure to the development of new structures and new minerals. Under the influence of heat and pressure at great depths the beds tended to change form readily without loss of their solidity. Further compression resulted in the production of a certain amount of rock-flowage with rupture in many places accompanied by dragging of the beds to a considerable extent. The zones of flowage (crush or shear-zones) intersect both the Willyama Series and the Older Intrusives, and are typified by the presence within them of sericitic schist, which has been replaced, in many instances, by silica, garnet, magnetite, and lode materials. In places they are occupied by igneous dykes.

The shear-zones were destined to become the channels by which the ore and gangue minerals gained entry to the closely-folded beds, which had been dragged against and stretched along the zones of strain. It is with one of these major shear-zones that the ore-bodies of the Broken Hill lode are associated and the period of ore-formation was, in all probability, contemporaneous with the final phases of the later expression of igneous action which marked the intrusion of the Mundi Mundi granite and the acid and basic dykes referred to.

Structure of the Ore-Deposits.—(*A*) *General.*—With few exceptions the ore-deposits of the Broken

Hill district are of the same structural type. The ore-masses, although presenting great variety of shape and size, are comparable by reason of their development within altered and folded sediments associated with one or more zones of shear, which acted as channels of " ore entry." The economically-valuable bodies occur within the folds, whereas the shear-zones usually embrace small and low-grade lenses only. In other words, the shear-zones themselves are of no great importance commercially, but are of paramount significance structurally, being important data for guidance in the conduct of prospecting campaigns. In general principles the structure of the Broken Hill lode is not at variance with these postulates, but the complexity and variety of the shapes exhibited in plan and section tend to mask the fundamental form.

(*B*) *Previous Opinions.*—The author gives a recapitulation of the opinions expressed by previous investigators which portrays clearly the evolution of ideas as to structure progressively with mining development.

(*C*) *Present Diagnosis.*—Prior to 1927, when the present diagnosis was first enunciated by the writer, the generally accepted version of the structure of the lode implied a two-fold sub-division, although it must be noted that the Geological Sub-Committee suggested the possible existence of a third unit, synclinal in section. However, it would appear that the Sub-Committee did not attempt to establish the relationship of the possible eastern bodies either to the foot-wall lode or to the " lode fault."·

In 1927–28 the author furnished two reports in his official capacity as geological surveyor of the Mines Department, New South Wales, in which attention was drawn to the fact that certain large ore-bodies, which had been mined to a considerable extent, actually lie to the east of the main zone of shear with which the ore-deposits of the Broken Hill lode are associated. Furthermore, they are of such form and arrangement as to suggest that they are, in reality, the counterparts of the hanging-wall bodies or " bulges " and not components of the so-called common limb known hitherto as the " Foot-wall Lode." In addition, the eastern masses were noted to possess the fundamental form of a syncline in cross-section as opposed to the arch-like or anti-clinal shape exhibited by the ore-bodies developed to the west of the shear-zone. It was considered also that the eastern and the western masses represent members of a formerly continuous series of sediments, owing their present relative positions to displacement along a zone of powerful shear or crush.

Consideration of all the available evidence in the new light led to the formulation of the conclusions herein advanced. The old terminology was discarded, and the " Foot-wall Lode " ceased to exist as such. In fact, the ore-deposits, as envisaged in general now, do not possess any true " foot-wall," but this term is retained by common usage for purposes of orientation in description. While it is realized that abnormal conditions arise in some instances, it is contended that the adoption of a triparite subdivision for the general structure of the lode at least has tended to simplify problems of mining geology, and thus has contributed some measure of assistance to the mining engineer. Moreover, as will be shown below, the origin of the structure can be explained by simple geological processes which can be readily understood, thus obviating many of the difficulties attendant upon earlier ideas.

The three units of the structure are classified as follows—

(1) Main Lode Channel.
(2) Western ore-bodies (Anticlinal).
(3) Eastern ore-bodies (Synclinal).

(1) The *Main Lode Channel*, or simply the " Channel," is a term applied to the narrow zone of strong shear and/or strain to which the ore-deposits are intimately related, for the reason that, in all probability, it functioned as the channel through which the materials of the ore-bodies found ingress to the drag-folded sediments on either side. In reality, the shear-zone is a powerful, pre-lode fault responsible for differential displacement of the contiguous beds, either by actual rupture or by " stretching " along an attenuated limb, connecting an anticline on the one hand to a syncline on the other.

In plan and section the Channel is seen to pursue a somewhat sinuous course, curves of broad outline alternating with pronounced variations of trend. This sharp deflection from the general strike is apparent in places, notably between the Thompson shaft of the British mine and the King shaft of the Junction mine. Similar conditions exist in sub-ordinate degree at places where the western and the eastern ore-bodies are brought into juxtaposition. " The Intersecting fault " of the Central and South mines is considered to have arisen by post-lode readjustment upon a sharp " kink " in the channel where the drag-folds were connected with it. At a point to the north of the North mine the channel has been displaced westerly by a pronounced shear-zone known as the de Bavay fault, the lateral throw as measured along the plane of dislocation being of the order of 2,500 ft. The effect of this fault in vertical dimensions is not known definitely at present, but, for various reasons, the writer is inclined to the belief that the mass lying to the north-east has been upthrown with respect to the southern block. High angles of dip are denoted for the channel, principally in north-westerly and northerly directions, but, in places, as in the Thompson section (British mine) and in the Zinc Corporation leases, equally steep dips towards the south-east are present.

The channel is occupied mainly by sericitic schist, in part replaced by lode-material, usually of siliceous composition. In some instances the foliation planes of the schist are bent to accommodate small " pressure-lenses " of ore with a characteristic siliceous gangue. On the whole, however, the channel, in itself, is of little commercial value. Its importance lies in its significance as a datum to which the distribution and arrangement of the ore-bodies within the drag-folds may be referred. Hence the determination of its position can be of material assistance in prospecting and development campaigns. In this connexion it should be noted that the recognition of the channel is fraught with considerable difficulty in some sections. An outstanding example is afforded by the conditions obtaining in the southern portion of the South mine, particularly at lower levels, and it would appear that the intensity of shearing displayed elsewhere is not in evidence here, due, perhaps, to the possibility that actual rupture did not take place but, rather, an extreme degree of stretching along the limb between the western anticline and the eastern syncline. Again, where western and eastern ore-bodies are in juxtaposition,

the trace of the channel through a stope may be expressed by one or more of the following features—

(*a*) A system of cracks or joints, more or less parallel, filled with secondary carbonates such as manganocalcite and rhodocrosite. These are not to be confused with similar features, produced by post-lode movements within the ore-bodies and which bear no relationship to the position of the main shear-zone.

(*b*) A line of vughs or slickensided planes ; or

(*c*) A narrow band of silicified schist.

These criteria may be used as indicators of the position of the channel only where such evidence is combined with more definite exposures along the walls of the ore-bodies.

The channel is not in direct contact with the ore-bodies at all places but, in a number of instances, is separated therefrom by occurrences of contorted and/or strained gneiss, which evidently represent the truncated portions of drag-folded beds. In stoping operations such masses are troublesome and form weak walls by reason of the fact that they become detached along pug seams within the shear zone.

As now understood the channel is confined to a much narrower zone than hitherto. Even the long, narrow, ore-bodies mined in the southern portion of the South Blocks (Zinc Corporation) workings and formerly believed to be largely within the shear-zone, are now considered to occur within extensions of the large " bulges " developed in the northern portion of the leases. An extreme condition is postulated in which the drag-folds are " teased out " very acutely along the shear-zone. Ultimately the trace of the main lode would be represented by a confined zone of shear within which veinlets and small lenses of sulphides with siliceous material are likely to occur. In fact, the evidence of the exposures in the Rising Sun mine suggests that such is the case.

Before passing to the other units of structure, attention must be drawn to the fact that the main lode channel has not been recognized in the workings of the North mine.

(2) *Western ore-bodies* (*Anticlinal*) *and* (3) *Eastern ore-bodies* (*Synclinal*)—

These two units possess many features in common, and may be grouped for descriptive purposes. The main points of similarity may be summarized as follows—

(*a*) Development within altered and drag-folded sediments which represent displaced portions of a formerly continuous series. That is, the one is the counterpart of the other in the structural sense.

(*b*) Intimate attachment and relationship to the main lode channel.

(*c*) Conformity in general outline to the bedding planes of contiguous sediments.

(*d*) " Open " ends of the extreme limbs of the folds. Ore " pinches out " between bedding planes.

(*e*) Great diversity of size and shape of members of each group yet comparable in fundamental form, namely, an anticline (western ore-bodies) or a syncline (eastern ore-bodies).

(*f*) Common origin of the structure and of the ore.

Essential differences between the two are, firstly, an anticlinal form in the western ore-bodies in contradistinction to a synclinal section in the eastern examples ; and secondly, the distribution of the former on the western side of the main lode channel as opposed to the arrangement of the latter on the eastern side of that feature.

The important point to be stressed is the fact that the members of each unit, though exhibiting great diversity of size and shape, both in plan and section, nevertheless are comparable in basic principles, and may be referred either to an anticlinal structure on the one hand or a synclinal fold on the other. In fact, the use of the singular noun " ore-body " for each unit would be more correct, as all examples in each group belong virtually to one and the same structure.

The western ore-bodies were regarded formerly as " bulges " attached to the " Foot-wall Lode," and were designated " Hanging-wall ore-bodies." Their behaviour in plan and section has been recorded by many observers, and very little can be added now to the statements expressed by them. However, the present diagnosis admits of no other interpretation than the dying out of the ore-bodies between the planes of bedding at some point in the structure. The explanation of the origin of the general structure connotes such a condition. The same may be said of the eastern ore-bodies.

In longitudinal section the ore-bodies pitch in an undulatory manner, as shown by comparison of corresponding points of attachment to the main lode channel. The western examples are shallowest at the Thompson shaft (British mine) and in the vicinity of King shaft (Junction mine). Between these points erosion has removed any trace of them. From King shaft the bodies pitch northerly, but their extension beyond the Junction mine is obscure. On the other hand, a general southerly pitch from Thompson's shaft is apparent with a major variant in the nature of a sharp roll or peak in the south end of the South mine.

In like manner also, but not in the same degree, the eastern ore-bodies incline toward the north and south from a centre about the Block 14-British mine boundary. To the south of this point conditions appear quite normal, but, to the north, complex problems arise which await solution. Eastern ore-bodies have been identified in Thompson section (British mine) on the one hand, and the Junction, Marsh, and Junction North workings on the other, but the relationships of these two occurrences are indefinite, although the latter example certainly pitches towards the north, and, finally, is exposed extensively in the North mine.

Subsidiary shear-zones of local extent have been noted in many places along the marginal portions of both eastern and western ore-bodies. The evidence suggests that these have been formed in areas where folding proceeded to such an intense degree that the rocks could not withstand the strain, and relief was found in rupture. The structures known as " droppers " in the central portion of the field may be included here ; the sulphides appearing to have invaded zones of sheared gneiss, representing sharp folds in the underwalls of the ore-bodies.

(*D*) *Origin of the Structure.*—Folding movements culminating in extreme stretching and shearing produced the structure practically in the form exhibited to-day. Some degree of modification may have been exerted during the period of ore-formation by such means as the growth under pressure of dense masses of sulphides and gangue materials, but in the main the results of such influences would appear negligible. The folding processes were not of the normal type, but were such as characterized compression of relatively weak (incompetent) beds interpolated between stronger (competent) members. The term " drag-folding " is used to designate deformation under such circumstances,

the incompetent rocks being corrugated and puckered against the stronger beds which are more competent to resist the forces of compression and, hence, possess relatively simple curves of folding.

The successive stages in the growth of the structure may be outlined as follows—

Stage 1.—Commencement of compression with production mainly of gentle folds, but a tendency to development of a major fold in one place.

Stage 2.—Folds becoming more acute, limbs being stretched, and "thickening" under tension at crests of anticlines and troughs of synclines. Relatively greater corrugation in incompetent beds with movement of these upon the neighbouring competent beds, "squeezing" of incompetent beds in places (X).

Stage 3.—Extreme asymmetrical condition reached. Limbs of competent folds very attenuated. Incompetent members "squeezed out at X and competent beds practically brought into juxtaposition at these points."

Stage 4.—(a) Extreme stretching of limbs without actual rupture—an abnormal condition. Or (b) Rupture along attenuated limb and development of the shear-zone (main lode channel). Either of these movements would cause displacement and account for the present relative positions of the anticline.

Stage 5.—Modification of the simple curves of the competent beds by the imposition upon them of complex corrugations, partly, by "dragging" along the shear-zone in places where relief was found in rupture and, partly, as a result of extreme compression in sections where stretching of the limb rather than actual rupture took place.

During Stage 4 the structure attained the ideal condition and, in general principle, the form of the Broken Hill lode, if the materials of the ore-bodies be substituted for the incompetent beds. However, as might be expected, the altered sediments, as a whole, presented variation in their degree of resistance to the forces exerted upon them and the less yielding withstood greater compression and "dragging," finally, to be bent into the complex shapes of Stage 5.

(*E*) *Post-Lode Faults.*—In the past, notably by the Geological Sub-Committee, importance has been attached to certain faults of which the "Intersecting fault" is the best known example. These phenomena may be expressed, firstly, by a single pug seam, secondly, by a sub-parallel series of such seams, or thirdly, by a narrow zone, a few feet in thickness, having defined walls and occupied in part by "rubbly" or fragmental material, resulting from crushing. Slickensides are common also along the planes of movement. The faults in question are present alike, in ore-bodies, in the main lode channel, and in the country-rocks. They possess great diversity in direction and degree of hade, but the displacement effected by them is relatively insignificant, probably not exceeding 50 ft. horizontally or vertically.

There can be no doubt that such faults are of post-lode age and originated partly from movements along or within pre-existent zones of shear and partly from the attempt to reach a condition of static equilibrium on the part of neighbouring masses of different density. To the former group belong the "Intersecting fault" developed along a "kink" in the main lode channel; the pug seams within, and parallel to the foliation of the sericite schist of the channel and the faults related to close folds in the walls of the ore-bodies. Differences in specific gravity either between contiguous portions of an ore-body, such as dense sulphides in comparison with lean siliceous masses, or between ore and unreplaced gneiss, probably resulted in block movement and slumping equivalent to local post-lode faulting.

(*F*) *Abnormal Occurrences.*—(1) *The Zinc Lode.*—The zinc lode developed in the Zinc Corporation and South mine leases is a narrow but regular zone of segregation of sulphides conformable to the structure of the neighbouring gneisses. It is not known to be connected with any zone of shear or strain and is separated from the main lode channel by a considerable thickness of altered sediments in which a sporadic development of sulphides, garnet, rhodonite, pegmatite, and siliceous material is apparent. The mass of altered country with its associated sulphides—including the zinc lode—forms an important geological unit which lies stratigraphically above the western ore-body and appears to pitch in sympathy with it.

The zinc lode is simple in form—a regular, tabular deposit, parallel to the bedding planes of the altered sediments, practically vertical as far as exposed and persistent in strike. Thus, its outline, in plan and section, contrasts with the complex shapes assumed by the ore-bodies of the Broken Hill lode proper and it can only be suggested that the beds contiguous to the former were stronger and more competent than the country-rocks of the latter, and thus were enabled to retain their status as normal folds, in contradistinction to the intense puckering and corrugation of drag-folding.

(2) *East Vein, British Mine.*—In the British mine, Blackwood section more particularly, relatively small masses of ore, developed considerably to the east of the main lode channel, are grouped usually under the term "East Vein." They are quite separate and distinct from eastern ore-bodies proper, which are present in the mine also, but exhibit so many features similar to the major structure that the "East Vein" as a whole may be regarded as a replica of the main lode with the exception that no structure comparable with a western ore-body has yet been revealed. The ore-bodies lie to the east of a defined channel, which possesses a persistent easterly dip and exhibits evidence of both post-lode and pre-lode movement, a prominent layer of pug or dig being formed along it. Like the main lode channel, in itself it has no commercial importance.

All the features of drag-folding and convergence typical of the main lode are repeated in the east vein workings. The ore-bodies conform to the planes of bedding of the gneisses and are attached ultimately to the channel in some places, while, in other exposures, a barrier of strained, sericitic schist exists between the pug seam and the ore.

The east vein has not been recognized in the neighbouring Block 14 mine, its trend being southerly and distinctly divergent from the general strike of the main lode.

Conclusion.—It is contended that sufficient evidence has been adduced to permit of a simple explanation of the structure of the lode, but it is only by the application in actual practice of the basic principles enunciated that the hypothesis can be supported or disproved. To date, the results of any prospecting and development work done with a realization of the new ideas, together with most of the observations made by those intimately associated with mining operations at Broken Hill, tend to verify the conclusions. Thus many of the

problems peculiar to the mining geology of the Broken Hill lode have been simplified and partly elucidated.

Much remains to be done in the systematic correlation of geological features as mining proceeds so that ample opportunity will be afforded to test the accuracy or otherwise of the diagnosis. It is hoped, therefore, that some measure of assistance may accrue to those concerned in the future development of this most important ore-deposit from an appreciation of the fundaments of its structure.

SCREW-TYPE FANS

In the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for October last there appears a paper by Dr. J. T. McIntyre on "New Possibilities in Mine Ventilation with Particular Reference to Screw-Type Fans." In the introduction to this paper the author remarks that it is generally realized that the recent wonderful advances made in aviation since its inception and our emulation of birds in flight at the beginning of this century, have had a very marked effect on our attitude towards fluid flow problems in all branches of industry. All that can be learned from the actual observation of flying creatures has been utilized, plus a vast amount of scientific research of a most ingenious and original character to assist in producing the amazing aircraft we have to-day capable of speeds up to at present 420 miles per hour. Thus in every field of industrial activity there are opened up new possibilities hitherto unknown and not the least of these is in connexion with the movement of large quantities of air through mine galleries for efficient ventilation.

With the great depths at which some mines are now operating methods of air movement that proved successful for less exacting conditions are no longer permissible since the secondary effects, such as heating of the air in passing through the machines and high resistances giving large pressure differences, all become much more prominent than hitherto and place definite limitations to further progress. The problem becomes more like that met with in high-speed rotary machinery, where the addition of material to give increased surface for carrying the load actually increases the stresses instead of reducing them. This is only one aspect of the case.

Another feature is that the general difficulties of mining are usually increasing as the easier worked areas are finished, so that working costs per ton of material must be kept constant or even be reduced in order to maintain a sound economic condition. Thus the efficiency of the working methods must increase and so it is with the ventilation system, which must give more air travelling longer distances with the same horsepower as previously, or even less. Power utilized in creating air flow for this purpose is generally a 24-hour load every day in the year, so that even small percentage savings when multiplied by the 100% load factor soon show appreciable benefits and are well worth the closest investigation. Under Rand conditions the production of each 10 brake horsepower from an electrical machine having 85% efficiency, costs £160 per annum exclusive of capital charges, with a price of 0·5d. per kilowatt hour and 100% load factor. The introduction of the more efficient machine, however, must not be accompanied by increased maintenance and repair charges since this would depreciate the advantage of the improved performance.

Apart from the machine or fan creating the air flow and another aspect which is just as important, is the question of design and finish of the ventilation airways and the layout of the whole scheme. In a mine these factors require the most careful and continuous study if the ventilation efficiency is to be maintained or increased and it is here again that the knowledge gained in aerodynamic research is of the utmost value and can be utilized to give an appreciable advance in mine ventilation methods.

A great deal of the knowledge now available on fluid flow has been built from the work of the great physicists towards the end of last century, and more notable among them as a specialist at the beginning of this century was Professor N. E. Joukovsky, of Moscow University. His great intuitive mathematical ability enabled him to create mathematical expressions for previously insoluble physical problems connected with vortex motion, and he established equations for the now well-known Joukovsky aerofoil shapes and by this means it was possible for him to calculate circulation paths around these bodies when placed in a stream of air, or other fluid. One of the professor's pupils and collaborators, Mr. M. T. Adamtchik, has carried the work of his teacher a stage further and has interested himself particularly with the design of screw propellers, at first for working in free air as used on aeroplanes and later for pressure building qualities inside a length of piping or casing. This work of Mr. Adamtchik's led to the marketing of the "Aeroto" screw-type fans which have made a name for themselves in many branches of industry and now with the further help of design specialists in high speed rotary machinery the new "Aerex" fan has been developed. This latter is something entirely different from any previous type and has many special and novel features over its predecessors, and has given efficiencies of the highest order so far attained with air-propulsion machines.

In this paper the author describes shortly the guiding principles for the use of screw-type fans, beginning with a short résumé of the initial developments and design considerations and then passing on to particular features and applications. The paper covers the following subjects: (*a*) Aerodynamic and Mechanical Design Considerations on Screw-Type Pressure Fans; (*b*) Test Performance Curves; (*c*) Types of Casing and Installation Methods Adopted; (*d*) Variable Performance Booster Fans; (*e*) Small Electric and Air Driven Screw Fans for Connexion to Lengths of Ducting and General Remarks Relating Thereto; (*f*) Economies in Driving Power and General Conclusions.

In this final section the author points out that in estimating the economies in driving power to be obtained by the use of screw-type fans of high efficiency, the saving is not only related to the difference in fan efficiency compared with the old type of fan previously used, but the total pressure required to pass the same volume of air is reduced by the avoidance of inlet and outlet losses due to tortuous passages and high leaving velocities. Thus the screw-type fan is not required to work against such a high water gauge, so that a further reduction in power is possible and in many cases this is only 50% or less than that required on centrifugal

type fans for the same air-volume passing. There is also a considerable saving in the initial cost of installation and although the screw fan itself may be a little more expensive, the total outlay incurred to get the fan running on site is usually very much less. The cost of the prime mover is also reduced by the use of higher speeds and decreased power rating. Thus every unit installed is a sound economic investment from every point of view.

The feature of reliability has been well demonstrated by the large number of these screw-type fans operating for periods up to five years in many phases of land and marine work. A particularly interesting application requiring continuous absolutely non-stop running for a period of about two years is in the cooling of glass furnaces. These new fans have now been adopted as standard by the large glass factories in Belgium and have given 100% service with no breakdown, which would lead in this instance to a very expensive stoppage of 24-hours production plant apart from the great difficulties of restarting.

In Britain, where the annual expenditure on driving power for mine ventilation amounts to from three to four million pounds per annum, it has been estimated that the annual saving in running costs by modernizing mine ventilation on the scientific lines described above would be at least one and a half million pounds. The expenditure of capital adequate for this purpose would be recovered in most cases in twelve or eighteen months in virtue of the saving effected. On the Rand a somewhat similar state of affairs exists except that on the deeper mines the secondary effect of heating the air in passing through the fan due to inefficiency and high pressure requires close attention. Improvements on such schemes will require a close study of all the factors influencing the ventilation pressure in order to reduce this to a minimum. Methods of streamlining and the general principles of aerodynamics will have to be applied in addition to the avoidance of restrictions and leakages—the writer has described in a previous paper the precautions necessary to attain this end in deep mines. With these adjustments and the use of the highest efficiency fans the future prospects of obtaining reasonable working conditions underground are greatly enhanced. In general it should be realized that simplicity is the keynote of success in ventilation, as also in many other walks of life.

HOLLINGER MINE GEOLOGY

A preliminary paper by Dr. L. C. Graton, H. E. McKinstry, and others on the outstanding features of Hollinger geology appears in the *Canadian Mining and Metallurgical Bulletin* for January. The authors regard this paper as a brief record of the conclusions reached during a study of the Hollinger mine which began in June, 1929, and was concluded in October last. The authors state that while intended to give a reasonably balanced perspective of Hollinger geology, the condensed presentation naturally emphasizes those views which are not in complete accord with accounts hitherto published regarding this district.

General Geology.—As shown by Burrows the principal rock formations in the Porcupine district are volcanic flows referred to Keewatin age and younger sediments of Timiskaming age. By careful mapping of sedimentary outcrops and of flow tops Burrows showed that the dominant structure is an east-pitching synclinal fold which has now been exposed by erosion in such a manner that the younger sedimentary formation is surrounded on the west, north, and south by the older folded volcanic flows. The authors' own detailed mapping, both on surface and underground, has made it possible to subdivide the Keewatin into well-defined persistent horizons corresponding to individual flows and sedimentary beds, and to extend the deciphering of structure beyond the area worked out in detail by Burrows. This, in addition to confirming Burrows' interpretation of the major structure as an easterly-pitching syncline, has revealed other structures which we interpret as the reflection of earlier periods of folding.

The detailed stratigraphy is not given in the paper, but the grouping into several series is as follows—

Timiskaming:
Conglomerate, slate, greywacke, etc.

Keewatin:
Porphyry-bearing agglomerate and conglomerate.

Gold Centre Series.—Greenstone flows with well-defined tops.

Vipond Series.—Greenstones; also pillow lavas characterized by spherulitic texture; certain formations are palagonitic. *Ninety-nine Flow* forms the bottom of the Vipond Series.

Central Series.—Alternation of greenstones and amygdaloidal pillow lavas.

McIntyre Series.—Thin and discontinuous carbonaceous bed overlain by greenstone and at least one palagonite-bearing flow.

Northern Series.—Greenstones with amygdaloidal pillow lava. Similar to Central Series.

Structure.—As interpreted from mapping of recognizable rock formations, the most important events of the structural history were as set forth hereafter.

Folding.—Probably before Timiskaming deposition, the Keewatin rocks were moderately folded along an east–west axis. Evidence for this early period of folding is found in the relation of porphyry to a syncline of the *McIntyre formation* in the northern part of the mine; the beds of the syncline are cut by a dyke-like body of porphyry, whereas folding of the main period is believed to be later than the porphyry. This syncline now plunges steeply to the east. Subsequent to this first deformation and probably after Timiskaming deposition, another early period of folding along a north–south axis produced an anticline in the *Vipond Series*; this fold, which the authors designate the *Vipond cross-anticline*, died out in the lower formations.

Then came the main period of post-Timiskaming folding, which is responsible for the broader features of structure in the district and in the mine. It produced the east-pitching Porcupine syncline and at the same time distorted the older north–south anticline in such a manner that the portion of the anticline lying on the north limb of the main syncline assumed a steep south-west pitch and the portion on the south limb assumed a north-west

pitch. The axis of the older anticline was itself drag-folded like the contacts of the flows.

The result of these successive periods of deformation was that in the Hollinger mine, which lies on the north limb of the main syncline, *Ninety-nine Flow* dips southward at an average angle of about 55° in the central portion of the mine and strikes eastward across the property. But westward *Ninety-nine Flow* passes across the northern end of the Vipond anticline. In plan, this now south-westward-pitching cross anticline is expressed in formations immediately overlying *Ninety-nine Flow* as a long south-westward-pointing peninsula extending obliquely across the axial plane of the main folding. Below (i.e. north of) *Ninety-nine Flow*, formations of the *Central* and *Northern series* have been folded into a minor east–west anticline of the type normally formed on the flank of a major syncline.

Foliation.—During or following the main period of folding, the rocks of the district were rendered schistose in varying degree. Schistosity is, in a broad way, parallel to the axial plane of major folding in the sense that, ignoring local exceptions noted below, this strike is everywhere within 20° of east and the dip is within 10 to 15° of vertical. However, on the north limb of the syncline, the dip of the foliation is steeply south, while on the south limb it is steeply north. There is great variation in the intensity of shearing and schistosity from place to place. Thick and coarser-textured flows escaped with less intense development of shearing and foliation than that which affected pillow lavas or thin flows. But along certain strong shear-zones schistosity is especially developed regardless of the nature of the rocks involved; doubtless, however, the shearing itself was localized in the broad way by the strength and distribution of the rock masses. The schistosity is not only planar—it has a marked linear element, which is expressed in elongation of nearly every feature in the rocks in a direction pitching downward to the east. The schistosity was later deformed locally.

Faulting.—Fault movements took place at a number of stages in the geological history—before porphyry intrusion, after porphyry intrusion and folding, and after ore deposition. The *Main fault*, which is the most conspicuous and continuous zone of dislocation, parallels the main ore-zone. It offsets the porphyry to the extent of a few hundred feet; the movement appears to have been mainly pre-mineral, though renewed movement after ore disposition has offset the veins a few feet. Post-mineral faulting is rather widespread, but only in a few instances has movement been sufficient to cause difficulty in following veins.

Ore Deposits.—A remarkable profusion of veins is present in the Hollinger mine. The vein-pattern is highly complex in its broader aspects and even more intricate in detail. The vein system of the upper levels swings in a broad arc from a north-easterly strike in the western part of the property to a more easterly strike in the eastern portion. The ore-bodies are commonly so arranged with respect to each other as to produce a pattern either braided or *en échelon*. The individual ore-bodies are in the usual case themselves composite, consisting of a collection of stringers and veinlets together with the immediately adjoining or intervening pyritized wall-rock; they might more properly be called lodes than veins. As a rule, they have nearly east–west strikes and steep dips.

From a structural viewpoint, the ore-bodies may be roughly classified as follows:—

1.—Simple veins, more or less continuous but usually curving and locally branching.

2.—"Contorted" veins, often consisting of a single stringer or vein which is highly sinuous and produces a series of kinks and meander-like curves. Some of these veins follow and replace drag-folded sedimentary horizons, though others occur within essentially uniform rock formations.

3.—Lodes consisting of essentially parallel stringers. Many of these lodes have a nearly east–west strike, as have the stringers that comprise them.

4.—Lodes consisting of stringers in *en échelon* arrangement. In general, these lodes strike north-easterly, though the component stringers strike nearly east–west.

Although many of the veins have shapes which suggest, on casual observation, that they have experienced folding since deposition, evidence offered by detailed study is strongly against this view. It is our conclusion that the veins have not been deformed since quartz deposition, except by minor faulting. The shape of veins was determined in its broader features by fractures which offered channelways of ingress to ore solutions; but in detail, the outlines were modified and rendered highly complicated by replacement of wall-rock adjacent to the fractures. Replacement has played an important rôle in the emplacement of vein material, and all stages have been observed from clean-cut non-replaced rock inclusions to mere residual wisps of schist and patches of chlorite, pyrite, and sericite in the quartz veins. Despite abundant and inescapable evidence of replacement, the change from vein-stuff to wall-rock is commonly abrupt, so that the margins of veins and stringers are generally sharply defined. In view of the abundance of quartz deposited and the prevalence of replacement, there is surprisingly little partial silicification of wall-rock.

Zoning of Mineralization.—Detailed study of the mineralogy of veins and stringers has revealed the existence of definite rudely concentric zones within the property. In the inner zone the veins consist of quartz with subordinate to abundant ankerite. Outside this central zone the veins are composed of quartz and calcite. At many, though not all, places near the boundary between these two dominant zones an intermediate zone appears wherein mineralization of either the quartz-ankerite or quartz-calcite type is accompanied by albite. The boundary between any two zones is not abrupt and there is usually a transitional area within which the characteristics of either may occur. A single vein may thus be alternately of the quartz-ankerite and of the quartz-calcite type over a length of a hundred feet or more. Despite extreme irregularity in shape and lack of definition in the boundaries between the several zones, the zones, when viewed in a broad way, are surprisingly regular.

Economically, the important aspect of this zoning is that most of the productive veins occur within the quartz-ankerite zone, a small number of productive veins occur in the quartz-albite zone, and, with hardly an exception, veins in the quartz-calcite zone are barren. The ankerite-bearing zone is characterized by occurrence in or with the veins not only of gold but of fine-grained pyrite; in fact, much of the gold is intimately associated with this pyrite. Scheelite, although sporadic in distribution,

is found almost exclusively in this quartz-ankerite zone. On the other hand, axinite and clinozoisite are found exclusively in the calcite zone. Tourmaline occurs with the veins of all zones.

The commercial veins and lodes generally comprise either a central quartz-rich vein with marginal bands of pyritized country rock, or a collection of quartz-rich veinlets and stringers with intervening and marginal pyritized rock. Inclusions of wall-rock in various stages of alteration are common within the quartz or other gangue of the veins proper. Despite the general unimportance of gold in wide, inclusion-free quartz veins, as later discussed, there is, nevertheless, an important dependence of the gold on the proximity of plentiful quartz; single narrow stringers remote from broad quartz-rich veins or lodes rarely carry sufficient gold, either in the vein proper or in the adjacent wall-rock, to constitute ore for mining width.

Wall-Rock Alteration.—Throughout the Porcupine district, the wall-rocks are altered in greater or less degree by development of carbonates and other minerals. While some areas of alteration were apparently established ahead of vein formation, it is difficult if not impossible to separate alteration accompanying veins from the general rock alteration of the district, or to draw a distinction between "hydrothermal" and "regional" rock alteration. In fact, it may be that the observed widespread alteration was caused by ascending solutions permeating the rocks throughout a wide region, while ore deposits resulted from the same solutions in those localized places where circulation was freest and continued longest.

Source of the Ore.—The ores of the Porcupine district are unquestionably of the type deposited under conditions of relatively high temperature and great depth by solutions emanating from an igneous source. Inquiry into nature and location of the parent magma naturally leads to a consideration of the age and conditions of emplacement of the known intrusive rocks of the region. It is believed that the quartz porphyry was intruded long before the introduction of the ore and, we strongly believe, before the now-ore-bearing. Timiskaming sediments had even been deposited. The authors are, therefore, unable to accept the view that the quartz-porphyry intrusions are the source of the ore. There is, on the other hand, ample reason to consider the quartz monzonite as derived from a magma younger than the quartz-porphyry and intruded during or after regional folding and schisting but before ore-deposition. This place in the time-scale, taken in conjunction with the general distribution and the compositional character of the quartz monzonite, afford plausible ground for entertaining the belief that the ore-solutions which yielded the Porcupine deposits were derived at depth from the same magma which furnished the quartz monzonite intrusions. Convincing proof of such genetic relationship must await evidence additional to that encountered up to the present.

Localization of Ore.—While the porphyry bodies are probably not the magmatic relative of the ore, they nevertheless played an important mechanical rôle in its localization. Large bodies of this rock having physical characteristics distinct from those of the lavas could scarcely have failed to be influential in determining places in which a composite rock-mass under stress would yield by fracture. Contemplation of the actual fracture pattern present in and near the Hollinger mine renders inescapable the recognition of a physical relation to porphyry masses.

Genetic Classification.—The ores of the Hollinger mine clearly belong in the hypothermal class—that is, when they were formed they were at great depth below the then-existing surface. At such depths the temperature and pressure gradients are gradual, and the physico-chemical effect of these on kind and quantity of minerals deposited from solution is therefore conducive to constancy in grade and abundance of ore. This coincides with the known habits of deposits of this class, which are toward persistence to great depth provided structural conditions remain favourable.

Résumé.—The more important conclusions of the paper are set forth categorically at the end, and these are reproduced here in full.

Between certain of the Keewatin lava flows are beds of slate and chert, some of which contain carbonaceous matter, probably of organic origin. "Graphitic slips" are mainly shears along which the carbonaceous sediment has been dragged.

Quartz porphyry of alaskitic composition intruded the Keewatin rocks before the main period of post-Timiskaming folding and probably before Timiskaming deposition.

A horizon of agglomerate or conglomerate, consisting largely of fragments and boulders of alaskitic porphyry, lies above the more basic Keewatin lavas but below the well-bedded porphyry-bearing conglomerate of the Timiskaming.

No support is found for the hypothesis of "école injection." The small elongate units of porphyry are not "fish"-like intrusive bodies but are merely fragments or pebbles of porphyry-bearing breccia or conglomerate, respectively, notably stretched at the time of rock foliation. Entirely similar shapes are possessed by the fragments or pebbles of Keewatin flow rocks intermixed with the porphyry in these composite accumulations.

The principal folding was that of east–west axis which produced, or at least greatly accentuated, the Porcupine syncline, with attendant minor anticlines on its flanks and drag folds of subordinate dimensions where layers of different competency were in contact. There had already formed a rather sharp arch along a north–south axis, and, still earlier, one or more troughs of generally east–west axis. These earlier folds, especially the transverse anticline, were strongly deformed by the late dominant folding.

The striking complexity of vein shapes is ascribed to the effect of fracturing stresses on rock material already highly complex structurally and to selective replacement of contorted beds rather than to important deformation of the quartz veins after they were formed. Minor faulting is the only post-vein disturbance.

The major mineralization was a single and continuous though somewhat complex process, during which the minerals were precipitated in a definite sequence. Gold deposition occupied a span rather toward the end of this process and the deposition of quartz continued to the close. Distribution of the gold is not controlled by late fracturing of the quartz or by deformation of the vein walls, but rather by the distribution of ankerite and pyrite with which it is intimately associated.

A zoning of mineralization is expressed by the gangue minerals. An inner zone of quartz-ankerite veins with pyrite and gold is surrounded by an outer zone of unproductive quartz calcite veins with little

pyrite. Between the two is a discontinuous zone of moderate productivity in which either type of mineralization is accompanied by albite.

Ore deposition followed so long after introduction of the quartz porphyry that ore solutions and the porphyry are probably independent as to source. A plausible but unproved source of the ore was the magma which yielded the post-Timiskaming quartz monzonite. The porphyry, however, did exert an undoubted influence on gold localization, partly through mechanical control on fracturing and partly through its own chemical inhospitality, to gold precipitation.

On a broad scale, the important deposits were formed at places of extreme structural complexity.

THE WAVE-TYPE TUBE-MILL LINER

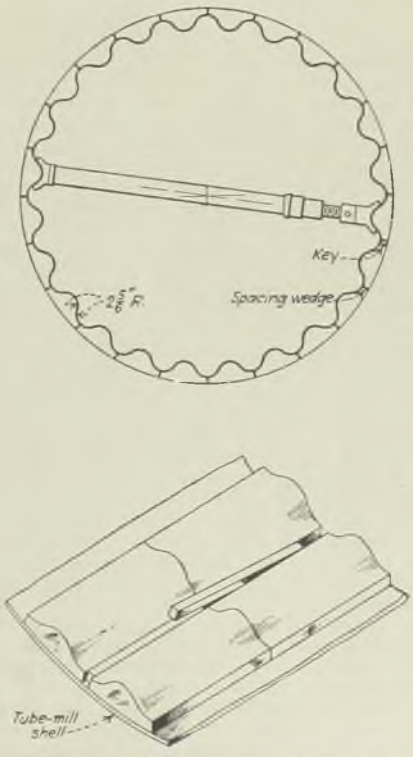
In the *Engineering and Mining Journal* for January E. D. McIntyre, superintendent of the reduction plant of New State Areas, Ltd., discusses boltless cylindrical mill linings. He says the wave type of tube-mill liner was designed to grip the load or grinding medium, thus preventing slip and insuring a vigorous inter-load action. A considerable amount of the work done in the tube-mills on the Witwatersrand is by causing the load to cataract. This cataracting is governed by the peripheral speed of the mill and the angle of liner grip, which effects fall of the grinding or crushing medium on the ore. Given sufficient peripheral speed, a liner with too positive a grip will throw its load on to the liner on the opposite side, above the pulp level, thereby wasting power that should be consumed in reducing ore. A liner that is too flat will drop grinding medium on grinding medium, or give a cascade effect only under ideal conditions. The pulp at the base of the load should be of sufficient volume so that energy imparted by the cataracting grinding medium will be absorbed in it, although it should not be of such a volume that would cause energy to be "smothered." The aim, therefore, is to provide a type of liner that will give a maximum spin to the ball or pebble and insure the correct drop when the liner is half-worn.

The corrugated liner described in the article, a common type, is mostly made of hard white iron with sufficient chrome, or manganese, or both, to toughen it. Each block weighs from 120 to 175 lb. Dimensions vary according to requirements, the average being about 19 in. long by 10½ in. wide by 4 in. deep, rounded off to 1½ in. at the fitting edges. The weight of a complete set of liners for a 6 ft. 6 in. by 20 ft. mill is about 17 tons. In this liner the corrugations are regular, except that the concavities are generally narrower than the convexities, to prevent undue wear at the joints, which wear is influenced by the size of the grinding medium. The ends of the blocks are rough and the joints abut. The blocks from the inlet end of the mill are thicker than those from the centre outwards, so that the liner may be completely worn out before being discarded. Greater wear takes place at the inlet end, so the first half of the liner may be ¾ in. thicker there. With good operation it should retain a corrugation until ready for discard, but it will be considerably flattened, measuring ¾ in. at the edges to 2 in. at the highest point, though this shape will not obtain with poor-quality castings.

Liner blocks are put in a sliding tilting cradle at the foundry, which passes them to and fro before an emery wheel. This straightens the edges and splays them so that the radial lines are correct. A gage is passed over them before acceptance.

The door of the tube-mill is the starting point for lining. Frame pieces, cast to the pattern adopted, fit around the door opening, allowing plenty of clearance. Assuming that the door measures 24 by 18 in., each half-frame would be two block lengths of 19 by 1½ in. units, or 15 in. with the door portion housed out. These frames put together show 6 to 7 in. of metal around the door opening. A door piece to complete the liner is bolted to the door cover and this piece must have the sides and ends well splayed to facilitate withdrawal for inspection purposes.

Jacks are necessary for lining. These are usually made of rock-drill screws fitted into pipes, having a hollow foot and head to go over the rounded liner. A length of 3-in. pipe, with a pronged footpiece welded in at one end and the nut for the rock-drill screw (2 in.) welded in the other, makes a good light jack; but both nut and footpiece must be collared over the pipe to take the thrust. The screw must have a plain, enlarged square, near one end, through which holes are bored for tommy-bar operation, or it may be turned with a spanner or wrench. Above the square



Method of Keying Wave-Type Liner Blocks.

the screw is turned plain for about 2 in. This fits easily into a shallow U-piece, corresponding to the footpiece external to the pipe. Six of these jacks are necessary when lining a tube mill, or one to each row of blocks put in at one time.

Lining is started with the door at the bottom. The frame pieces are put carefully in position around the door, making sure that all are straight. Six circles of blocks may be put in thus, laying them on both sides of the door piece, up to the centre of the mill, when a jack is spanned across, gripping the top blocks of each row. As the jacks are tightened, the blocks must be hammered together, so that all fit tight. Sufficient are put into the tube at each end and clear of the jacks to complete the six circles when the mill is turned over. After making sure that all jacks are secure, the mill is turned around with chain tackle. As it revolves blocks are laid to complete the circles; and then, when the last is in, a space of about 1 in. should be available for keying purposes. The keys are inserted in the right-hand corner at an angle, downward. This allows the block completing the next circle to pass under it. As each row is completed keys are inserted and temporarily tapped up. When the six rows are laid all keys are slogged home and the jacks removed, when the next six rows may be started. During the keying operation the jacks are slackened just enough to allow the tightening movement to take place over the whole circle.

Tapered bar iron is procurable 1½ in. wide and in varying thicknesses, which compensate for inequalities in keying spaces. Sizes of tapered iron start from 0 to ½ in., rising by eighths of an inch to 1 in. If ½ in. or more keying space is left, the liner will not drop because of weak keys, but the edges must be well fitted. Should the keying space be too wide packing pieces may be used in the final few joints to bring the last ones closer. Some operators insert thin shims between the left-hand joints of the last block or two, whereby the opening of the last joint will be wider on the right, or keying, hand, thus insuring a driving fit to the key.

The time taken in lining a 6 ft. 6 in. by 20 ft. tube mill is seven hours and the same mill can be stripped of old liners, relined, and the load put back for starting in eighteen hours, with a gang of ten kafirs.

In breaking down an old liner the blocks should be thin enough to permit them to be broken with sledge hammer. A weak section is selected and struck with the sledge hammer, standing well to one side. Fracture of the block should allow that row to fall, but some blocks may have to be pried down with a pinch bar, if pieces of metal become wedged in the ends. Should the liners be unbreakable, or if the liner has to be removed before it is worn out, the keys must be drifted out, using tools the shape of which will be suggested to the operator.

MANITOU LAKE, ONTARIO

A preliminary report by J. E. Thomson on the Manitou Lake area has been issued by the Department of Mines of Ontario. The author says that during the past summer he was engaged in making a geological survey in the vicinity of Manitou Lake, which is situated south of Wabigoon station on the Canadian Pacific Railway in the district of Kenora. The area examined during the field season was the belt of early pre-Cambrian rocks extending from Anzhekumming (Upper Manitou) Lake eastward to Kawashegamuk and Stormy Lakes, and from Minnehaha Lake on the north to Manitou, Meggisi, and Wapageisi Lakes on the south. About thirty years ago Manitou Lake was the scene of considerable mining activity. Many gold mines were opened at that time, but the great majority of them never became producers. They were generally located on small gold-bearing quartz veins and anxiety on the part of the management to install unnecessary surface equipment, including a mill, long before these additions were justified, generally led to a disastrous end. Only three mines—the Laurentian, Big Master, and Sakoose—have produced any appreciable amount of gold. Some of these old properties have been re-examined in recent years, but, so far, none have received any further development.

The Manitou area may be easily reached from either Wabigoon or Fort Frances. A bi-weekly transport service is offered during the summer months from Wabigoon to Gold Rock, a small village located at the northern extremity of Anzhekumming Lake. The whole area is dotted with a myriad lakes so that all parts of the country may be reached by convenient canoe routes. This feature, combined with excellent rock exposures and, in general, good bush for traversing, makes ideal prospecting conditions.

The consolidated rocks of the district consist of early pre-Cambrian greenstones, sediments, granites, and related rocks. Keewatin acid and basic lavas, with associated agglomerate, volcanic tuff, and greywacke, cover the greater part of the area. On the north-east shore of Manitou Lake there is a narrow band of gneisses and sediments, somewhat similar to the Coutchiching rocks on Rainy Lake. A belt of distinctly sedimentary rocks, probaby Timiskaming in age, was located during the summer. Conglomerate, arkose, quartzite, slate, greywacke, and some included volcanic material are the predominant rock types. The belt averages about two miles in width and is divided into two parts which are on the same strike but separated by an intrusive mass of granite. Each of the two belts has been traced about 14 miles. These sediments extend in an arc north-easterly from the north end of Manitou Lake to near Rattlesnake Lake, where they are nosed out by granite. They are again found on Washeibemaga Lake and were traced eastward along the south side of Stormy Lake to its south-eastern extremity.

Both greenstones and sediments are intersected by small irregularly-shaped masses of basic intrusives usually altered gabbro or diorite. All the above-mentioned rocks are intruded by granite and associated aplites, lamprophyres, and quartz and felspar porphyries. These are Algoman in age. The porphyries occur largely as dykes, but two distinct stocks of quartz porphyry, approximately three to four square miles in extent, are found. One

of these occurs north of Boyer Lake, the other is on Thundercloud and Washeibemaga Lakes. In the vicinity of the Manitou Lakes gold-bearing quartz veins are found, these are genetically related to the Algoman granite or porphyries. A few small dykes of Keweenawan diabase occur in the district. The greenstones and sedimentary rocks have been closely folded in the greater part of the area. This is particularly true of the belt extending from Anzhekumming Lake south to Manitou Lake. Along this zone the rocks are often intensely schisted. A distinct fault or " break " was traced south-westerly from Kabugukski (Mud) Lake for a distance of 16 miles to Manitou Lake. Along the east side of Manitou Straits it cuts off the belt of sedimentary rocks. The fault is characterized by a narrow zone of highly fissile schists ; in the sedimentary rocks adjacent to it, pronounced drag-folding, distortion, and minor faults may be observed. The rocks in the vicinity of Boyer, Washeibemaga, Stormy, and Wapageisi Lakes are generally massive, being largely pillow lavas, agglomerate, and conglomerate.

During recent years a limited amount of prospecting has been carried on in the district, this being chiefly development work on old mining locations. In 1928 and 1929 the Gold Rock mine, located at the south-west end of Anzhekumming Lake, was opened up. A shaft was sunk on a small quartz vein to a depth which is reported to be 150 ft. and a small test mill was constructed. The mine closed in 1929. On Manitou island in Manitou Lake, a considerable amount of surface development work has been done by the Anglo-Canadian Explorers, Ltd. A few quartz veins were stripped and a zone of greenstone heavily impregnated with sulphides was opened up. The property was dropped by the Anglo-Canadian Explorers and restaked by Mr. Frank Gaffney. A sample chipped across 12 ft. of sulphides by the writer assayed $42·80 per ton in gold. Another sample chipped across 6 ft. of a nearby quartz vein assayed $1·40 per ton in gold.

A syndicate from Dryden has done a considerable amount of trenching on claims on the north-west end of Manitou Lake. A sheared zone containing quartz veins and schist has been traced about 650 ft. A sample chipped across 8 ft. of quartz and schist by the writer assayed $1·00 per ton in gold ; another sample from the same vein at another location assayed $12·80 per ton.

In June, 1931, Mr. Percy Hopkins, consulting geologist, examined the Sakoose mine, located six miles south of Dyment station on the C.P.R. Mr. Hopkins has informed the writer that No. 1 shaft averaged $17 per ton in gold across 18 in. to a depth of 120 ft. and sampling of the open-cut to the east of the shaft averaged around $10 per ton in gold. Four short diamond drill-holes were sunk west of the shaft in an endeavour to find an extension of the vein under drift, but it was not located.

During the past summer, Chas. Merrill of Gold Rock restaked the old Swede Boy location south-west of Anzhekumming Lake. He has recently uncovered a small vein, about 250 ft. east of the old Swede Boy vein, from which rich samples of free gold have been taken. Jonas Wetclainen, also of Gold Rock, has three claims east of Glass Bay on Manitou Lake on which some small gold-bearing veins have been uncovered. The road to the Reliance mine, near Carlton Lake, has been repaired preparatory to some development work at the mine. The Swede Boy island in Anzhekumming Lake was restaked during the summer. A quartz vein on which an old shaft is located occurs on the island. A grab sample of the broken rock on the old dump assayed $8·80 per ton in gold. A gold-bearing quartz vein also occurs on Frenchman's island in the same lake.

MINING PETROLEUM BY UNDERGROUND METHODS

A study of methods of underground mining for petroleum as used in France and Germany and their possible application to depleted oilfields under American conditions, by George S. Rice, is contained in Bulletin 351 of the United States Bureau of Mines. The following introduction taken from the paper explains the scope of the investigation. The author says that the methods of extracting petroleum from sands or sandstones by wells have been studied for years but, while methods have been greatly improved in the last decade, the present percentage of extraction of the total amount of oil in the sands according to various petroleum authorities is usually only 10 to 30%. If stimulative methods are used under favourable conditions the recovery may be greater. Although this situation is comprehended by the petroleum industry it is not generally known to the public, because the fact is obscured by the great production of oil from the opening up of new pools and by the development of deeper oil-bearing sands in older fields. The small percentage of potential yield constitutes one of the greatest challenges to engineers in the entire mining industry, because in no other branch is so large a percentage of merchantable mineral left in the ground. For example, in the coal industry, which has been at times criticized for wastefulness, under present methods used in the United States an average of two-thirds of the coal is mined and one-third left in the ground. However, by certain well-known mining methods practised in some of the coal-fields only 5 to 10% of the recoverable coal is left permanently in the ground and there is a constantly growing improvement in coal extraction throughout the United States. In those metal mines where the veins or deposits are well defined the percentage of extraction of ore of profitable grade is very high. That the percentages of extraction of petroleum from the ground may and undoubtedly will be greatly increased in the future by underground mining methods where natural conditions will permit seems logical. The limitations imposed by depth, temperature, and flow of water under high pressure through the sands are discussed later.

It is thought that where the natural conditions of the formations are favourable and when the oil is of high quality and no longer flows to the wells and when the price reaches a point where there is an incentive to make the large initial expenditure necessary to insure success in the development of methods not yet tried on a large scale under American conditions mining is likely to be undertaken in competition with stimulative methods from wells. The terms " oil mining " and " oil-sand mining " as ordinarily employed comprise the driving of tunnels, galleries (French), or entries for drainage of oil from a sand stratum and usually do not include excavation of the oil sand, except

incident to the driving of entries. Unlike many other kinds of mining, such as coal mining, it is not possible first to try petroleum mining on a very small scale, then develop it to a larger scale. From an investment standpoint it is more akin to the development of great disseminated bodies of ore involving underground caving methods which require large initial expenditure and delayed returns.

According to petroleum engineers, oil moves laterally through the bedded sands to wells, chiefly through the agency of the pressure of gas stored in the sands and oil. Except where a hydrostatic head of water pushes the oil and gas through porous sands, gravity appears to play little part in the movement of oil into the wells. Generally, oil wells reach the economic limit of production because of exhaustion of natural gas associated with or contained under pressure in the oil, rather than because the oil itself is depleted. This is due to the fact that the propulsive and expansive properties of gas under pressure are the principal agencies in driving the oil into the wells. Under the conditions in most oilfields it has been found that, although the immediate result of a rapid rate of uncontrolled release of the oil and gas into the wells—and of the natural pressure of the gas which is propelling it—is a temporary increase in the production of oil, the ultimate recovery is likely to be less than under methods of controlled flow because, under conditions of "open flow," after the first forced rush of oil much of the gas by-passes through channels or more porous places in the sand or rock and leaves the oil behind in tight or less pervious places in the sands or rocks.

The foregoing refers to porous sands and sandstones, but conditions are found in certain oilfields—for example, in the well-known Bradford field of Pennsylvania—where the oil fills the pores of the fine-grained sandstones so completely that an augmented (surface) pressure of water of 1,000 lb. or more per square inch is required to cause penetration in forcing oil ahead of the water to the draining well.

Several methods of increasing recovery of petroleum have been devised which have increased appreciably the extraction in many fields where the natural-gas pressure has been exhausted. These include forcing compressed air or gas into the oil-bearing formations, replacing, partly at least, the original gas pressure in the sand, and "water flooding" by which the oil is forced through the sand to the producing well. The use of chemical solutions to assist in freeing the oil absorbed or adsorbed by the sands or pocketed in rock spaces has been tested during recent years. Such chemical method of treating oil-sand beds was advocated by the United States Geological Survey in 1925. In practice it is still in the experimental stage. Although undoubtedly the foregoing methods of using compressed air, gas, water, and chemical solutions will be developed more and more, there are physical conditions of the oil sands and oil-sand rock formations which make it look doubtful whether it will be feasible so to treat through wells that it will be possible under most conditions to obtain as high a percentage of recovery of petroleum as may be obtained, within limits hereinafter defined, by some suitable method of mining, with close spacing of drainage points.

Although the writer agrees that there are possibilities of greatly increasing recovery of oil from depleted sands by appropriate mining methods, it is evident that there are definite technical and commercial limitations to its application. These limitations are found where there is too high a pressure of gas, oil, or water in the sand and also where the rock pressure is too high for successful mining or else the ground temperature is too high for the men to work. The limiting pressure of gas, oil, or water depends on other conditions in the formation and can not be stated in general terms. As regards possible depth of mining, tentatively the suggested limit should probably be not greater than that of the deepest coal mines, which reach a depth of about 6,000 ft. in Europe. Apart from questions of the value of a mineral being mined a high ground temperature that can be reduced only to a limited extent by artificial means provides the final controlling limit to deep mining.

Primitive methods of mining shallow oil-bearing formations have been used for ages in Asia Minor, first by merely bailing from natural oil springs and later by digging pits or shallow wells and driving short drifts into oil-sand outcrops; the oil seeps in and then is bailed out. At a later period wells were sunk by hand to considerable depths, a practice that prevailed in south-eastern Europe, as in Rumania, until recently. Such mining methods were practised several centuries ago in France and Germany in localities where later the only intensive underground mining for petroleum as yet is being done, as described herein.

The general studies presented in this paper were begun in 1923, when at the request of the then director of the United States Bureau of Mines, Dr. H. Foster Bain, the writer undertook to investigate general mining methods in Europe and visited the oil-sand mines at Pechelbronn, Alsace, France, and Wietze, Hannover, Germany. Subsequently, in 1925, the writer with his associate, John A. Davis, prepared a paper describing these mines for presentation to the American Institute of Mining and Metallurgical Engineers. Recently, despite the flood of petroleum produced in late years by wells in western and southern fields, there has been a continued interest in the subject of underground mining in Pennsylvania oilfields, and the author addressed the Engineers' Society of Western Pennsylvania informally at Pittsburgh on February 25, 1929. In view of the interest shown in the address and discussion at that meeting, which were not published, it was deemed desirable by Director Scott Turner that a formal paper on oil-sand mining be issued by the Bureau of Mines, to include both old and also new material gathered by the writer in visits to the Pechelbronn and Wietze mines in October, 1929, and subsequently by correspondence with the operators of these mines; also test data of oil-sand samples submitted by the writer and examined and reported on by Dr. P. G. Nutting, through the courtesy of the United States Geological Survey, and references to new material in recent publications.

The following conclusions are set out by the author at the end of the bulletin. He says—

(1) Where conditions are favourable, mining methods in depleted oilfields may bring large financial returns and recover oil that might otherwise be lost.

(2) Favourable conditions mean—

(*a*) That there is remaining, in at least one oil sand, sufficient oil, of which at least 5,500 barrels may be recovered per acre, by drainage or by repressuring systems.

(*b*) That there is a tight, firm shale stratum more than 20 ft. thick within 30 ft. of the oil sand.

(*c*) That the price of crude oil at the top of the shaft is at least $2·25 per barrel.

(3) That under favourable natural conditions the mining method for depleted areas gives cheaper production of oil at depths down 1,500 ft. than wells for repressuring or flooding, and the advantage in favour of mining appears to increase rapidly with depth to perhaps 3,000 ft.

(4) That at 4,000 ft. depth the limit of practical or commercial mining is being approached, due to high temperature for mine workers and the cost entailed by increasing ground pressure.

(5) There are also limitations in the pressures that can be safely used in repressuring and flooding from mine passages because of the possible leakage through fissures or permeable places in the shale or rocks in which or below which the mine entries are made, or by breaking down the roof or upheaving the floor, or bursting pipes or fittings.

(6) That mining methods should not be used as a primary method of oil extraction from an oil field; the inflammable and sometimes toxic vapours and gases at high pressure would make it too dangerous for mine workers. The gas and oil pressure would have to be relieved by prior drilled and operated wells and must be kept under low pressure limits in repressuring and flooding.

(7) That under favourable strata conditions, to be tested by core drilling, driving mine passages in tight impervious shale should present no greater problems than driving entries in a gassy coal mine; in fact, less so than in a bituminous mine, as the dust would not be explosive in air as it is in a bituminous-coal mine.

(8) That in the interests of conservation of a great national resource, every encouragement should be given to recovering part or all of the 60 to 80% of the original oil content of the oil sands of this country said by competent petroleum authorities to remain in the sands following escape of the entrained gas.

Power for Broken Hill.—A description of the central power plant for the Broken Hill mines, which is operated by the Western New South Wales Electric Power Pty., Ltd., is given by F. J. Mars in the *Proceedings* of the Australasian Institute of Mining and Metallurgy for September 30 last. The author recalls that Broken Hill is situated at an elevation of approximately 1,000 ft. above sea-level, on the Barrier Ranges, in the State of New South Wales, Australia. It is approximately 700, 280, and 330 miles from the ports of Sydney, Pirie, and Adelaide, respectively. The summers are usually hot and dusty, with a recorded maximum shade termperature of 114° F. The rainfall averages approximately 9 in. per annum. The Barrier Ranges were discovered by Captain Sturt in 1844 and in 1875 the first silver-lead ore was found in the hills. It was not until 1883 that the first mining leases at Broken Hill were pegged out. These proved to be very rich, with the result that a number of mines developed. During the fifty years of operations, improved methods of ore-treatment have resulted in the higher recoveries of metals and during this period there has been a steadily increasing application of electricity and compressed air to the mining industry. Steam power plants of varying types and capacities were installed by the various mining companies to cope with their own demand for electric and compressed-air power.

In June, 1927, the author, consulting electrical engineer for the several mines in Broken Hill, placed before the principal mining companies a proposed scheme to centralize the source of electric and compressed-air power required for mining, hoisting, and milling purposes along the line of lode at Broken Hill. A close investigation was made into the advantages and disadvantages of the steam and Diesel installations for the Broken Hill conditions and the final scheme involved the installation of Diesel engines as prime-movers for the alternating-current generators and the air compressors. A factor in the preference of internal-combustion oil engines was the intermittency of mining and milling operations, which prevents a high load factor being maintained, this intermittency being brought about by

(*a*) the long week-end shut-down period,

(*b*) the short shift underground with the hour interval between shifts, and that of

(*c*) no "stoping" on the night shift in the underground workings.

The extremely variable and reduced power requirements on certain days and hours do not adversely affect the economical operation of internal-combustion engines to the same degree as with steam plants. The cost of water—2s. 6d. per 1,000 gal.—also, and the uncertainty of its supply, were important factors considered with relation to power generation.

In July, 1928, the scheme, including the layout of the plant proposed for the Broken Hill field, was accepted. The leading manufacturers throughout the world were then asked to tender in London for this special equipment by December, 1928, but this time was extended to January, 1929. Tenders were accepted in Australia in July, 1929, and, on receipt of certain dimensions, the site excavations for the plant and buildings in Broken Hill were seriously commenced in November, 1929.

The site selected for the power plant (Plate IV) required careful consideration, and depended upon

(*a*) the land available at a sufficient distance from the "lode" and underground workings to be free from creepages,

(*b*) good rock to carry the concrete foundations,

(*c*) the power load centre,

(*d*) the railway facilities for handling the heavy machinery and the fuel oil,

(*e*) the "skimps" and sandy material blown from the dumps on a windy day, and

(*f*) utilization of one of the existing circulating water cooling towers.

Eleven months after the excavations were commenced, the first Diesel engine was delivered at Port Pirie, South Australia, on October 26, 1930. By the end of December, 1930, the erection of the engine was completed and the remainder of the two-stroke engines erected at the rate of one per month, the last being completed towards the end of June, 1931. In June, 1931, the control of the power plant was transferred from The Australian Ore and Metal Co. Pty., Ltd., to Western N.S.W. Electric Power Pty., Ltd., and the Diesel engines were run for the first time. On July 17, 1931, the electrical power load was taken over from

the existing power plants of the mines. The Central power plant has been operating continuously from that date. Owing to the late delivery of the four-stroke engines, the first Diesel engine air-compressor set was not started until September 9, 1931.

Electric power is being supplied as required to the following companies :—

North Broken Hill, Ltd. (including the British mine).

Broken Hill South, Ltd.

The Zinc Corporation, Ltd.

The Sulphide Corporation, Ltd.

Also to the Public Works Department (for the pumping station at Stephen's Creek).

Compressed air is being supplied to the following companies :—

North Broken Hill, Ltd.

Broken Hill South, Ltd.

The Zinc Corporation, Ltd.

For the twelve months ended June 30, 1932, approximately 35,000,000 kelvins were generated, of which 30,000,000 were for electrical equipment and the remainder as air power. During this period the mines were working on "short time," that is, one mine was closed down for one week in four, and another, one week in seven ; and only towards the end of the period were the electric winders of two mines put into operation. It is expected that a total of 50,000,000 kelvins will be generated during a full year of normal mining operations, of which 44,000,000 will be required for the electrical equipment and the remainder as air power.

Metallurgical Research.—Some of the new and improved methods becoming available for metallurgical research are discussed by S. L. Hoyt in *Mining and Metallurgy* for January. The author states that a novel contribution to furnace equipment is the electric arc reflector furnace announced recently by Dr. Benedicks. By using a copper reflector to concentrate the heat of an electric arc on a crucible, a charge can be raised quickly to upwards of 2,000° C. This furnace is simple and is said to operate at an efficiency of about 25%, while the fusion can be carried out in a vacuum.

In metallic microscopy there is no more important operation than that of polishing micro-sections for high-powered photography, the study of foreign inclusions, etc., and a number of improvements along this line have been recently announced. Among these the author has used the automatic polishing machine developed at the United States Bureau of Standards, the particular machine having been manufactured outside for the market. It so happens that much of this work has related to the identification of foreign inclusions where excellence of polish has been vital and the large number of micro-sections has made the automatic feature particularly welcome. At the University of Michigan a method of polishing has been developed which has the advantage of polishing sections flat out to the edge and without gouging out a soft constituent to leave a cavity.

Another tool for the metallurgist, which is being reintroduced, is the microscope with a special binocular eyepiece for visual examination. The virtues of this microscope are the excellence of the images, which is not approached by the monocular eyepiece, freedom from eye strain, and general all-round utility. The mechanical stage is large and a special adapter can be made which receives the brass cup of the automatic polishing machine to hold it properly for even high-powered examinations.

For studying foreign inclusions in steel a German metallurgist has prepared thin sections for the use of petrographic methods. This has enabled him to locate the source of certain inclusions by comparing those found with samples taken from the refractories with which the steel came in contact.

The author has had considerable experience with another method of identifying foreign inclusions which utilizes polarized light. It is simple and satisfactory if one has a reliable method for polishing the samples. When viewed on the polarizing microscope the inclusion can be readily classified as (1) opaque, (2) transparent but coloured, or (3) transparent and clear. In steel this distinguishes broadly between the opaque oxides of iron and manganese, manganese sulphide, etc., the iron-manganese silicate type of inclusion, and clear glass silicates, etc. Subsequent tests can then be used to carry the identification further. Polarized light has also been successfully used in the study of metallic alloys and for the identification of phases. Though old, this method now appears to be valuable in metallographic research.

A method for dark field illumination has recently been developed for metallographic work which produces some striking effects, but so far as the author is aware it has not been used sufficiently for appraisal.

Another recent development, though old in principle, is the use of ultra-violet light in photomicrography of metallic objects. This has been used by Dr. Lucas of the Bell Telephone Laboratories and extended by him to biological work where, it is understood, it has met with success. In the ordinary metallographic laboratory the inconvenience of the method and the small number of useful applications for it make it a rather illogical tool.

In physics, one of the most important advances of recent years is that of electron diffraction which was first brought out by the Bell Telephone Laboratories. A description of this method is not included, but the author points out that with effectively longer wave lengths than the X-ray, the main use of interest is the study of the atomic arrangement in films and surfaces. The nature of passive films on metals was early studied, and more recently the heavier films of sulphides on silver and its alloys, and of oxides on metals, have been investigated. Even gas films on metals can be detected and the thickness and atomic arrangement determined. The same technique has been used to study the nature of sputtered films. Those formed at low temperatures are found to be amorphous, crystallizing on heating. This ability to distinguish between amorphous and crystalline metal in thin layers has led to the study of the nature of a polished surface. Several recent publications in *Nature* indicate that a profound change in the nature of the surface metal occurs on polishing, but that it does not completely lose crystallinity, as would be called for by the Beilby hypothesis. However, the change reported is in the direction proposed by Beilby. With the importance which films of one kind or another may attain in metallurgy, the methods of electron diffraction furnish a most useful tool for their study.

Methods of analysis that give new facts are always of interest, and one which is capable of allocating the "total oxygen" in steel among the various oxides, iron oxide, manganese oxide, silica, alumina, etc., must be of great value in studying steel. Such a method of fractional analysis has now been worked out by Dr. L. Reeve of the A. O. Smith Corp. and successfully applied to many samples of commercial steel and welds. In the same laboratories F. Roach has developed the methods of spectrum analysis of steels to determine many of the elements of steel quantitatively, and has used the procedure in the study of foreign inclusions in steel and weld metal and to determine small local segregations of those elements. Finally, the method of electrolytically extracting foreign inclusions from steel as developed at the United States Bureau of Mines by Mr. Fitterer and associates is important. Some interesting comparisons have been drawn between this method and the aforementioned fractional oxygen method, which show a reasonably satisfactory agreement.

Pashkokogan-Misehkow Area.—A preliminary report by W. S. Dyer on the Pashkokogan-Misehkow area, Ontario, has been issued by the Provincial Department of Mines. The author states that the area is in general of low relief and is typical of the glaciated and peneplaned areas of the Canadian shield. Very few hills reach elevations of more than 100 ft. above the level of the lakes. Lakes are very numerous in the western part of the area, and fewer lakes and more rivers in the eastern part. In most parts of the area rock outcrops are numerous. In the granite portion of the southwestern corner of the area there are many bare rock ridges. In this country underlain by sediments and greenstones outcrops are numerous although small, there being large stretches of muskeg and glacial sand and boulders. On the Albany River near Miminiska Lake, on Shabuskwia Lake and River, and on the lower part of Misehkow River, glacial drift, usually of sand and gravel, is thicker and rock outcrops less numerous. Most of the forest is green, but second growth, and too small to be commercial. Small patches of virgin forest still remain, however, with spruce and birch up to 18 inches in diameter. There is much good water power available for development, especially along the Albany River below Lake St. Joseph. There are no settlements in the area, the nearest being Osnaburgh House, a Hudson's Bay Company post, on one of the eastern arms of Lake St. Joseph.

General Geology.—A synclinal trough of Keewatin sediments and greenstones averaging 10 miles in width, extends east-north-east to north-eastwardly throughout the area. This trough connects to the west with the Lake St. Joseph Keewatin belt, and to the east with the Fort Hope Keewatin belt, the whole belt forming one of the most extensive in north-western Ontario. The Keewatin trough lies within great granite batholiths of Algoman age. Other rocks of interest are the sedimentary gneisses of Couchiching age (the Miniss series) which underlie the Keewatin, iron formation within the Keewatin, masses of hornblendite which intrude the Keewatin, fresh-looking conglomerates, presumably of Temiskaming age, and diabase dykes intruding both the Keewatin and Algoman.

Miniss Series.—The Miniss sediments are the oldest rocks in the region. They consist of quartz-biotite gneiss, and are of very uniform appearance at all localities. Commonly they are garnetiferous, and they sometimes hold staurolite. Originally the sediments were probably shallow-water argillaceous sands.

Keewatin Series.—This series consists of interbedded sediments and greenstones. The sediments consist among other types of greywacke, quartz, hornblende-gneiss, and quartzites. The greenstones are usually of the andesitic type, but in some places coarser dioritic or gabbroic types were seen, which probably represent the inner part of the flow which cooled more slowly. Rhyolites are present locally and typical pillow lavas were sometimes seen. Part of the greenstone is massive, but much of it has been affected by the intrusion of the Algoman granite batholiths and shows steep angled dips with strikes varying from 45° to 80°. Chlorite schists are quite common and an interesting series of agglomerates and tuffs was observed on Miminiska Lake. Iron formation occurs in the Keewatin at several points, namely on Doran Lake, on the shores and islands of Lake St. Joseph, and on the north of the Misehkow River.

Temiskaming Conglomerate.—Conglomerate is exposed on the south shore of Doran Lake and on Doran River. The pebbles were not greatly compressed and the material composing them was clearly identifiable. They consisted chiefly of granite and quartzite, but some pebbles of greywacke and iron formation from the Keewatin series outcropping nearby were also observed.

Algoman Intrusives.—There are two varieties of granite in the great batholiths of the area; a grey, and a pink or red. The former is usually gneissic, but the latter nearly always massive. Besides the large batholiths of granite there are several stocks and dykes of granite within the Keewatin syncline, as at Doran Lake, Pashkokogan Lake, and Constance Lake. These granite stocks were more numerous in the western part of the area than in the eastern.

Pegmatite dykes, presumably of Algoman age, are of common occurrence in the Miniss sedimentary series. Porphyry was not commonly seen; the only occurrences in the western part of the area being a quartz porphyry mass among the sediments of the Miniss series on one of the north-easterly arms of Miniss Lake. Dykes of grey granite porphyry and felspar porphyry were found on the Misehkow River in the eastern part of the area. Quartz veins were numerous throughout the area.

Keweenawan Diabase Dykes.—Diabase dykes were observed at three localities, the first on Charlewood Lake, the second on the south branch of the Albany River, the third on Misehkow River.

Structural Geology.—The intrusion of the Algoman batholiths have folded the Keewatin and Miniss rocks into a very definite syncline. The axis of the syncline is definite enough to be shown on the map through most of the area. There is a striking difference in the succession of rocks on either side of the axis, particularly in the vicinity of Woodilee and Lowry Lakes. North of the axis there are wide belts of greenstone with some interbedded sediments and iron formation, but south of the axis greenstones are entirely wanting and the rocks consist of Keewatin and Miniss sediments. Thus, strong faulting along the axis of the syncline with the upthrown side to the south is indicated.

Impurities in Lead.—In the *Proceedings* of the Australasian Institute of Mining and Metallurgy for September 30 last R. S. Russell discusses the influence of impurities on the properties of lead, his

paper being introduced by Prof. J. N. Greenwood. The summary at the end of Mr. Russell's paper is reproduced here. The author states that commercial lead, containing 0·008% total impurities, has been refined by electrolysis. The electrolytic lead after casting, was found by chemical analysis to contain 0·002% total impurities. The electrolyte was a solution of lead perchlorate. The distribution of the impurities between the sludge, the electrolyte, and the cathode lead was investigated. Certain physical properties of these two leads were compared. The comparison was extended to a third sample which had been made by an extension of the fire-refining methods used for the commercial lead and which contained 0·003% impurities. The comparison consisted of rolling and annealing the leads under identical conditions and noting the extent to which recrystallization and grain-growth occurred after each stage of the treatment. The amounts of reduction in thickness by rolling varied between 2½ and 20%. Annealing was done at 18°, 50°, 75°, and 175° C.

Results indicated that electrolytic lead was much more susceptible to the influences of distortion and annealing than the other two leads—that is, it recrystallized more easily and upon less provocation. Thus, electrolytic lead recrystallized completely upon being distorted 5% and standing at 18° C. for 1½ hours. On the other hand, the other leads showed only partial recrystallization after 20% distortion and standing for 24 hours. As far as could be seen, these differences in tendency to recrystallize could be attributed only to differences in chemical composition.

A solution of ammonium molybdate in dilute nitric acid is recommended as a new etching reagent for lead.

SHORT NOTICES

Level Development.—In the *Engineering and Mining Journal* for January L. Eaton discusses the layout of the underground development.

Trackless Mining.—At the annual general meeting of the Institution of Mining Engineers, held in London on January 25 last, H. W. Smith and G. M. Gullick discussed, under the title "Trackless Mining," an ideal development of a coal property.

Liquid Oxygen Explosives.—In the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for November last T. Coulter and A. E. Lance describe the results of tests on the use of liquid oxygen explosives in Northern Rhodesia and on the Witwatersrand.

Capping Stations.—H. H. Carroll describes capping stations on Broken Hill South, Ltd., in the *Proceedings* of the Australasian Institute of Mining and Metallurgy for June 30 last.

Detonators.—A paper on "Propagation Tests and the Photography of the Disturbance sent out by the Explosion of Commercial Electric Detonators" appears in the *Journal* of the Franklin Institute for December.

Surface Metal Mining.—The costs of open-cut mining are discussed by M. J. Elsing in the *Engineering and Mining Journal* for January.

Crushing and Screening.—A large stone-dressing plant on the Hudson Rover, New York, is described by L. A. Slattery in the *Engineering and Mining Journal* for January.

Standard Sieve Ratios.—P. E. Masters discusses the $\sqrt[10]{10}$ as an aperture ratio for a universal standard sieve series in *Engineering* for January 20.

Particle Size.—T. Hatch describes the determination of "average particle size" from the screen-analyses of non-uniform particulate substances in the *Journal* of the Franklin Institute for January.

Pioneer Mill, British Columbia.—H. G. Nichols describes the mill of Pioneer Gold Mines of B.C., Ltd., in the *Canadian Mining Journal* for January.

Diesel-Electric Power Costs.—The low power costs of the Diesel-electric plant installed by the Hudson River Stone Corporation are discussed by O. J. de Gaetano in the *Engineering and Mining Journal* for January.

Pipe-Line Protection.—The value of protective coatings for protecting pipe-lines is discussed by S. Gill in *Industrial and Engineering Chemistry* for January.

Copper Determination.—A shorter method for determining copper iodometrically is described by T. H. Whitehead and H. S. Miller in *Industrial and Engineering Chemistry* (Analytical Edition) for January 15.

New Reagent for Zinc.—The use of borneol-glycuronic acid for precipitating zinc is described by A. J. Quick in *Industrial and Engineering Chemistry* (Analytical Edition) for January 15.

Determination of Cadmium.—L. C. Hurd and R. W. Evans give a critical study of the Everard method for determining cadmium in *Industrial and Engineering Chemistry* (Analytical Edition) for January 15.

Fluorine in Cryolite.—In *Industrial and Engineering Chemistry* (Analytical Edition) for January F. J. Frere describes a volumetric method for the determination of fluorine in cryolite, using yttrium nitrate as a reagent.

Metals for Coinage.—Some observations on the supplies of copper, nickel, tin, and zinc for coinage operations are given in the annual report of the Deputy Master and Comptroller of the Royal Mint for 1931.

Northern Rhodesia.—Dr. G. C. A. Jackson describes the geological history of the N'Changa district, Northern Rhodesia, in the *Geological Magazine* for February.

Tin in Spain and Portugal.—A description of the tin-ore occurrences of Spain and Portugal by Dr. A. Dittmann appears in *Metall und Erz* for January.

Malaria Control.—Tropical hygiene and malaria control on mines at various elevations are discussed by Sir Malcolm Watson in a paper appearing in the *Bulletin* of the Institution of Mining and Metallurgy for January.

Engineering Research.—The buildings and equipment of the engineering department at Cambridge University are described in *Engineering* for February 3.

Quicksilver.—N. H. Stearn describes the mining and furnacing of quicksilver ore at the Pamell Hill mine, Arkansas, in the *Engineering and Mining Journal* for January.

Microscope in Ore-Dressing.—A. S. Hecht in the *Engineering and Mining Journal* for January discusses the microscopical determination of ore-treatment methods.

RECENT PATENTS PUBLISHED

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

14,771 of 1931 (384,327). W. M. GRANT, Birmingham, Alabama. Finely divided particles of metallic oxides are carried in a continuous gas stream through a heated zone in the presence of carbonaceous material, the oxide particles being thereby reduced to metal.

35,106 of 1931 (384,449). I. G. FARBENINDUSTRIE A.-G., Frankfort-on-Main, Germany. Sulphur dioxide is obtained in a continuous process in which fuming sulphuric acid acts on solid or liquid sulphur, the process proceeding in counter current at elevated temperatures.

1,877 of 1932 (384,464). B. F. HALVORSEN, Oslo, Norway. Sulphur and iron are directly produced from sulphide iron ores by a roasting process in which oxygen sufficient to oxidize the metal alone is supplied, the sulphur being obtained in un-oxidized form.

14,650 of 1932 (385,204). H. H. SMITH and GENERAL MINING AND FINANCE CORPORATION, Johannesburg. A jig which includes a circular sieve that may be vertically reciprocated and on to which pulp may be fed at the centre and tailings discharged from the circumference.

14,947 of 1932 (384,564). KODAK, LTD., London. Improved apparatus for the electro-deposition of silver from solutions containing silver salts.

18,184 of 1932 (384,926). DEUTSCHE GOLD- UND SILBER SCHEIDEANSTALT, Frankfort-on-Main, Germany. The beryllium in beryllium compounds is recovered as insoluble oxide after roasting the original compound with alkaline earth oxides or carbonates.

20,896 of 1932 (384,243). I. G. FARBENINDUSTRIE A.-G., Frankfort-on-Main, Germany. The alumino-thermic method is used for the production of alloys of beryllium with heavy metals substantially free from aluminium.

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.

Alloys of Iron and Molybdenum. By J. L. GREGG. Cloth, octavo, 507 pages, illustrated. Price 36s. London: McGraw-Hill.

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

High-Speed Diesel Engines, with special Reference to Automobile and Aircraft Types. By A. W. JUDGE. Cloth, octavo, 248 pages, illustrated. Price 10s. 6d. London: Chapman and Hall.

Gmelins Handbuch der anorganischen Chemie. 8 Auflage. System-Nummer 59: Eisen. Teil A—Lieferung 4. Paper covers, pp. 587–846, illustrated. Price RM. 41; subscription price 35.50. Berlin: Verlag Chemie.

Workmen's Compensation: Its Medical Aspect. By Sir JOHN COLLIE. Cloth, octavo, 160 pages, illustrated. Price 7s. 6d. London: Edward Arnold.

Geological Survey of Great Britain: Summary of Progress, 1931. Part II. Paper covers, 166 pages, illustrated. Price 3s. London: H.M. Stationery Office.

Royal Mint: Report of the Deputy Master and Comptroller, 1931. Paper covers, 171 pages, illustrated. Price 3s. 6d. London: H.M. Stationery Office.

Borates. Imperial Institute Monograph on the Mineral Industry of the British Empire and Foreign Countries. 2nd edition, 1920-1932. Paper covers, 44 pages. Price 9d. London: H.M. Stationery Office.

Gob-Fires. Part I.—Explosions in Sealed-off Areas in Non-Gassy Seams. By T. N. MASON and F. V. TIDESWELL. Paper covers, 30 pages, illustrated. Price 1s. Part II.—The Revival of Heatings of Intakage of Air. By T. N. MASON and F. V. TIDESWELL. Paper covers, 19 pages, illustrated. Price 6d. Safety in Mines Research Board Papers Nos. 75 and 76. London: H.M. Stationery Office.

Pressures Produced by the Striking of Momentary Arcs in Closed Vessels. By T. S. E. THOMAS. Safety in Mines Research Board Paper No. 77. Paper covers, 16 pages, illustrated. Price 6d. London: H.M. Stationery Office.

Miners' Welfare Fund. Departmental Committee of Inquiry (1931). Report to the Secretary for Mines. Paper covers, 93 pages. Price 1s. 6d. London: H.M. Stationery Office.

Rare-Element Minerals of Canada. By H. V. ELLSWORTH. Canadian Geological Survey Economic Geology Series No. 11. Paper covers, 272 pages, illustrated. Price 40 cents. Ottawa: Department of Mines.

Manganese Deposits of Canada. By G. HANSON. Canadian Geological Survey Economic Geology Series No. 12. Paper covers, 120 pages, illustrated. Price 20 cents. Ottawa: Department of Mines.

Canada: Investigations of the Mineral Resources and the Mining Industry, 1931. Reports on sands, helium, radium and silver discoveries at Great Bear Lake, rock wool, bituminous sands, and a quartzite from Nova Scotia. Paper covers, 153 pages, illustrated. Ottawa: Department of Mines.

South Australia: (1) Report of the Director of Mines and Government Geologist, 1931. Paper folio, 8 pages. (2) Mining Review for Half-year to June 30, 1932. No. 56. Paper covers, 80 pages, illustrated. Adelaide: Department of Mines.

British Guiana: Mineral Resources. 1, North-West District. 2, Mazaruni and Puruni Districts. 3, Potaro-Essequibo District. Booklets with paper covers, issued by the Lands and Mines Department, Georgetown, Demerara.

Mineral Resources of the United States, 1931. Part I, pp. 89–101, Platinum and Allied Metals, by H. W. DAVIS; pp. 859–962, Mineral Production of the World, 1924–1929, by L. M. JONES. Part II, pp. 159–164, Silica, by E. R. PHILLIPS. Each part in paper covers. Washington: Superintendent of Documents.

Accidents at Metallurgical Works in the United States, 1930. By W. W. ADAMS. Bureau of Mines Technical Paper 530. Paper covers, 36 pages. Washington: Superintendent of Documents.

Gold Coast: Map of Parts of the Gold Coast Colony and Ashanti, showing the positions of the Gold and Diamond mining properties. Price 2s. 6d. London: C. D. Syndicate, Ltd.

COMPANY REPORTS

Northern Transvaal (Messina) Copper.—This company was formed in 1923 and is developing copper-bearing ground in the Zoutspanberg district of the Transvaal. The report for the year to June 30 last shows that no active mining was done, the labour employed being engaged in prospecting and maintenance work. The results of the work of the Elbof Geophysical Prospecting Co., Ltd., have still to be tested by actual drilling and endeavours are being made to raise the capital necessary for the purpose.

Bulolo Gold Dredging.—Formed in 1930, this company is operating on gold alluvials on the Bulolo River, New Guinea. The report for the year ended May 31 last shows that the first dredge started operations on March 21 of the year under review and for seven days was working its way out of the pond and digging to bedrock. From March 28 to May 31 it was in continuous operation and dug 558,800 cu. yd. of gravel, from which 10,442 oz. of bullion, worth $167,796 Canadian, was extracted. During the period under review working costs were estimated to be 4 gold cents per cu. yd., the reduction from the 12½ gold cents estimated being due to high yardage dug and favourable exchange and, also, in part to the few replacements which had been necessary. During the year the company acquired further properties on the Bulolo and Watut Rivers, the area acquired adding 4,460 acres to that already owned.

Sungei Way.—This company was formed in 1924 and operates alluvial tin property in the State of Selangor, F.M.S. The report for the year to June 30 last shows that under restriction the output of tin concentrates amounted to 614 tons, as against 1,119 tons in the previous year, sales of ore realizing £72 3s. 11d. per ton, against £63 18s. 4d. Owing to the restriction, No. 3 dredge was idle during the whole year and Nos. 1 and 2 dredges worked only for two-thirds of the year. No. 2 dredge was closed down on May 1 last. The profit for the year was $10,430, which, added to the sum brought in from the previous account, gave an available total of $68,849, which was carried forward.

Changkat Tin.—This company was formed in 1925 and operates alluvial tin property in Lower Perak, F.M.S. The report for the year 1931 shows that the dredge treated 1,565,000 cu. yd. of ground and recovered 605 tons of tin concentrates, the area worked over covering 15·03 acres. The yield of tin ore was equal to 0·87 lb. per cu. yd. and costs amounted to 2·92d. per cu. yd. The value of the ore recovered was £44,332, the sales averaging £118 6s. 6d. per ton. The profit for the year was £21,027, which, added to the sum brought in, gave an available total of £34,433. Of this amount, £6,500 has been distributed as dividends, equal to 1s. per share, and £5,000 transferred to reserve, leaving a balance of £22,933 to be carried forward.

San Francisco Mines of Mexico.—Formed in 1913, this company owns a group of silver, gold, lead, and zinc mines in the State of Chihuahua, Mexico. The report for the year to September 30 last shows that operations at the mine were suspended at the end of December, 1931, work being at present confined to maintenance and improvement. During the period under review the mill treated 98,940 tons of sulphide ore and produced 11,550 tons of lead concentrates and 9,071 tons of zinc concentrates. The ore reserves at September 30, 1931, were reduced during the period by 72,920 tons and have not been recalculated. The operating loss for the year was £45,452 and, after adding all expenditure and allowing for depreciation, there was a total loss of £112,247, reducing the credit balance brought in to £51,872.

DIVIDENDS DECLARED

Balaghat.—Ord., 3s. 6d. (return of captital).

Changkat Tin.—1s., less tax, payable January 28.

Consolidated Gold Fields.—9d., less tax, payable March 16.

Fanti Consolidated.—3d., less tax, payable January 25.

Jos Tin.—6%, less tax, payable January 12.

Petaling Tin.—8%, less tax, payable February 6.

Rezende.—6s. 6d., less tax, payable January 31.

Venture Trust.—6d., free of tax.

West African Diamond.—1½d., less tax, payable January 31.

NEW COMPANIES REGISTERED

New Goldfields of Australia Exploration.—Registered as a private company. Capital: £35,000 (20,000 Six per cent Cumulative Preference and 15,000 Ordinary). Objects: To adopt an agreement with H. T. Price, as attorney for the British Australian Mining Syndicate, of Adyar House, Bligh Street, Sydney, and to carry on all kinds of exploration business. Office: 6, Broad Street Place, E.C.

Oriole Gold Mining.—Registered as a private company January 11. Capital: £10,000. Objects: To acquire any mines and mining rights in Shan States of Burma or elsewhere. Registered Office: 17, Victoria Street, Westminster, S.W. 1.

Rand and East African Corporation.—Registered January 10. Capital: £85,000 in 2s. 6d. shares. Objects: To adopt an agreement with the Anglo-Portuguese (East Africa) Concessions and the liquidator. Registered Office: Finsbury House, Blomfield Street, E.C. 2.

Rare Earth Concentrates.—Registered as a private company. Capital: £5,000 in £1 shares. Objects: To carry on the business of manufacturers of titanium, thorium, zirconium, and kindred metals; manufacturers of chemicals, etc. Directors: Sir John P. Hewett, Sir Hugo Hirst, Major D. J. Burke, and E. Neumann.

West African Gold Corporation.—Capital: £100,000 in £1 shares. Directors: J. A. Agnew, O. V. G. Hoare, J. H. Batty, Julius Wetzlar, Carl Davis, and H. G. Latilla. Offices: 49, Moorgate, E.C. 2.

West Witwatersrand Areas.—Incorporated in South Africa on November 12, 1932. Capital: £500,000 in 10s. shares. Objects: To acquire any mineral rights, mining claims and rights in Africa or elsewhere and to adopt two agreements with New Consolidated Goldfields. Directors: W. A. Mackenzie, W. S. McCann, Sir George Albu, Sir Abe Bailey, and R. B. Hagart.