The Mining Magazine

Managing Director: W. F. White.
Assistant: St. J. R. C. Shepherd, A.R.S.M., D.I.C., F.G.S.

Editor: Edward Walker, M.Sc., F.G.S.
Assistant: F. Higham, A.R.S.M., M.Sc., F.G.S.

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

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

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

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

Vol. XLI. No. 3. LONDON, SEPTEMBER, 1929. PRICE ONE SHILLING

CONTENTS

PAGE

Editorial

Notes ... 130
The Mining Magazine Staff; Sir John Cass Institute; Imperial Smelting Corporation; International Congress of Mines, Metallurgy and Applied Geology; The Tin Producers' Association; Birmingham Mining Research Laboratory; Empire Marketing Board; The Sinoia Cut; Dr. Pirow on South Africa's future and Sir Thomas Holland on the Union's Iron and Steel Industry.

The Third Empire Mining Congress ... 131
Arrangements for the South African meeting are briefly described.

Secondary Metals in the United States ... 132
Interesting figures are given for the output of "recovered" metals.

The Limpopo Bridge ... 133
The opening of the Beit Bridge and future developments in Rhodesia are discussed.

Review of Mining ... 134

Articles

The Geology of Sable Antelope and Neighbouring Mines, North-Western Rhodesia *R. Murray-Hughes and A. A. Fitch* 137

The Volumetric Estimation of Lead by the Molybdate Method *J. E. Clennell* 142

The South Terras Radium Deposit, Cornwall *T. Robertson and H. G. Dines* 147

Book Reviews

Eve and Keys' "Applied Geophysics in the Search for Minerals" ... *H. Shaw* 153

"Geophysical Prospecting" ... *H. Shaw* 154

Niggli's "Ore Deposits of Magmatic Origin" Translated by H. C. Boydell *A. Brammall* 155

Brown and Debenham's "Structure and Surface" ... *A. Brammall* 155

Hentze's "Sintern, Schmelzen und Verblasen Sulfidischer Erze und Hüttenprodukte" ... *Henry Louis* 156

Gmelin's "Handbuch der Anorganischen Chemie: Eisen" ... *M. S. Fisher* 157

News Letters

Johannesburg ... 157
Nitrate Deposits in S.W. Africa; Diamond Fields of Tanganyika; The New Coalfield; A New Extraction Process; Important discovery of Asbestos; Railway to the Chrome and Asbestos Fields; Aeroplanes for Mining Engineers.

Brisbane ... 159
Mount Morgan; Chillagoe Ore Treatment; North Queensland Mining; Mount Isa; The Coal Industry; New Guinea Leases.

Vancouver ... 161
The Kootenays; Britannia Beach; Portland Canal; Vancouver Island; Peace River Region; Report of Progress.

Toronto ... 163
Sudbury District; Porcupine; Kirkland Lake; Rouyn; Patricia District; Manitoba; Chibougamou.

Camborne ... 166
Introduction; Wheal Kitty; Polhigey; Jantar; Unemployment in the Mining Districts.

Personal ... 167

Trade Paragraphs ... 168

The Bridge-Meg Resistance Tester ... 169

New Equipment at the Barnstone Cement Works ... 169

Metal Markets ... 171

Statistics of Production ... 173

Prices of Chemicals ... 175

Share Quotations ... 176

Mining Digest

Concentration by Jigs on Tin Dredges *O. B. Williams* 177

Platinum Concentration in South Africa *T. K. Prentice* 180

The Problem of Secondary Tin in Bolivia (concluded from August issue, p. 115) *Joseph T. Singewald, Jr.* 183

The Cayzer Tin-Smelting Furnace ... 185

Open-cut Mining *F. E. Cash and M. W. von Bernewitz* 187

Smelting at Rio Tinto ... *H. R. Potts* 188

Waterval Platinum ... 188

Anodes for Electrolytic Zinc *U. C. Tainton* 189

Strontium Supplies ... *R. M. Santmyers* 189

Short Notices ... 190

Recent Patents Published ... 191

New Books, Pamphlets, etc. ... 191

Company Reports ... 192
Fabulosa Mines Consolidated; Rhodesia Broken Hill Development; Rhodesian and General Asbestos Corporation; Tetiuhe Mining Corporation; Waihi Grand Junction.

Dividends Declared ... 192

New Companies Registered ... 192

EDITORIAL

THE current issue marks the commencement of the 21st year of publication of the MAGAZINE. Mr. Edward Walker has been connected with it since its inception and has been editor since 1916, when Mr. W. F. White became managing director. As recorded on the contents page since July, Mr. F. Higham, A.R.S.M., M.Sc., F.G.S., is now assistant to the editor and Mr. St. J. R. C. Shepherd, A.R.S.M., D.I.C., F.G.S., who has been with the MAGAZINE for the past four years, assistant to the managing director.

THE 1929–30 Session of the Sir John Cass Technical Institute, of Jewry Street, Aldgate, commences this month. The classes, which are held in the evenings, include a course on metallurgy which meets the requirements for the London degree of B.Sc. in Engineering.

AT the statutory meeting of the Imperial Smelting Corporation it was announced that 750,000 ordinary shares would be offered for subscription at an early date in order to provide funds for the extension of works. The chairman also stated that before long copper smelting would be commenced and that arrangements had been made for the manufacture of zinc white and lithopone.

AN International Congress of Mines, Metallurgy, and Applied Geology is to be held at Liége next year in connection with the International Exhibition. The arrangements are in the hands of L'Association des Ingénieurs Sortis de l'Ecole de Liége and La Société Géologique de Belge à Liége, and information can be obtained from M. Lepersonne, 16, Quai des Etats Unis, Liége. The Congress will last for a week at the end of June and will include the usual meetings, receptions, visits to works, and other functions.

THE Tin Producers' Association, the objects of which were discussed last month, has been registered as a company limited by guarantee and Sir Philip Cunliffe-Lister, M.P. (ex-President of the Board of Trade), has consented to become chairman of the Association and of the Council. An Executive Committee of Council has also been appointed, with Sir William B. Peat, the eminent chartered accountant, as independent chairman. It is notable that Mr. C. V. Thomas, head of the Tronoh group, and Mr. F. E. Mair, representing the Osborne-Chappel group, are members of this committee.

SOME time ago a description was given in these pages of the Mining Research Laboratory which is an adjunct of Birmingham University. The report of the work done during 1928, which has just been published, gives an outline of the many problems that are receiving the attention of the directors of the laboratory. Like many other similar institutions its energies are cramped by shortness of funds and contemplated extensions of the buildings have had to be postponed. Among the many subjects receiving attention may be mentioned the dehumidifying of mine air by means of silica gel, the liquefaction of coal by hydrogenation through the action of various catalysts, of which ammonium molybdate appears to have been the most successful, and the spontaneous combustion of coal.

THE Empire Marketing Board is a Government Department which does not come very prominently before the notice of mining engineers. Perhaps its only direct connection with mining has been its association with the Imperial Geophysical Experimental Survey, some particulars of which were given in the last issue. Indirectly, however, the fostering of exhibitions by the Board has been of advantage to the mining world in many ways. In looking through the report for the period from its foundation to the end of March last we also find reference to other work financed by the Board that will appeal to the mining man. For instance, the research into conditions of cold storage of food—a matter of importance in hot countries—cheap mechanical transport in out-of-the-way places, and means for suppressing pests such as the tsetse fly. Taking it altogether, therefore, the Board is an organization concerning the existence of which the mining man should not be entirely uncognizant.

IN June last, when discussing Rhodesian developments, we stated that, though the Sinoia-Kafue short cut between Beira and Northern Rhodesia was held up by the railway authorities, the persistent demands for it would result in present objections being overcome. Unfortunately for Rhodesians, a further official refusal to consider the project has been issued. The authorities are definitely of opinion that the construction of such a line would entail a serious loss to the administration, for it would mean the maintenance of two railway lines with very little increase in traffic. To make up for this extra cost of operating the railways it would be necessary to raise the rates to such an extent that the cost of hauling by the new and shorter route would in effect be higher than the present charges by the longer route. The railways, in consequence, will not consider the proposal until the time arrives when more local traffic is in prospect.

DR. HANS PIROW, Government Mining Engineer to the Union of South Africa, has simultaneously issued his report for 1928 and delivered a presidential address to the Chemical, Metallurgical, and Mining Society. As regards gold, he estimated that another thousand million pounds' worth remains to be extracted on the Rand and its extensions and he pointed out that diamonds will give increasing revenue for some years, but he reiterated the general belief that South Africa will depend in the future on coal and base metals rather than on gold and diamonds. One of the visitors at the meeting was Sir Thomas H. Holland, who followed up his address before the British Association on the world's resources of minerals and metals with detailed arguments on the subject. In point of fact, he re-stated the views which he had expressed in previous years before the Institution of Mining and Metallurgy and the Empire Congress in Canada. He is a far-seeing man, who can state his opinions with clearness and force, and whatever may be the actual result of his campaigns his services in drawing attention to the exhaustibility of our mineral resources and to the folly of our present Micawberlike attitude cannot be gainsaid. One of the most interesting of his remarks at the South African meeting was to the effect that any country, to get full benefit of its base metal output, must have a home industry based on iron and steel manufacture. It is only in this way that a country can establish manufactures on a large scale. Otherwise the metals are exported to those lands where there is a consumptive demand and the transactions end as far as the producing country is concerned. Undoubtedly Sir Thomas's suggestions will carry weight and will encourage those whose ambition is to expand South Africa's iron and steel industry and place it on a permanent and profitable basis.

The Third Empire Mining Congress

With the tours of the British Association and the International Geological Congress over, undivided attention can now be given to making a success of the Third (Triennial) Empire Mining and Metallurgical Congress, to be held in South Africa early next year. The first Congress was held in 1924 at the Wembley Exhibition and the second took the form of a tour through Canada during 1927, which is still fresh in the memory of our readers. The programme for the third Congress, as mapped by the committee formed by the South African Institution of Engineers and the Chemical, Metallurgical, and Mining Society of South Africa, which is under the presidency of Sir Ernest Oppenheimer and has the active support of the Governments of the Union and the Rhodesias, promises to be as comprehensive and of as great interest as that of the Canadian visit. The Congress will open at Cape Town on March 24, with a session at which an inaugural address will be given. The two following days will be devoted to a further session and to visits including Cape Point, the Botanical Gardens, and Groote Schuur. The party will then leave by train for Kimberley, where two days will be spent at the diamond mines. Proceeding thence to Johannesburg, three days will be occupied in visiting the gold and coal mines and in holding three sessions. The next place of halt will be Mafeking, where the visit will be only brief—just long enough for the party to join in the regret of the inhabitants that Sir Robert Baden-Powell did not choose "Lord Mafeking" as his title—and next day the visitors will reach Bulawayo. Here a further session will be held and subsequently the party will split into two, taking different routes from April 10 to 18 and joining again at Bulawayo. No. 1 tour will cover Wankie Colliery and Broken Hill, Bwana M'Kubwa, N'Kana, and Roan Antelope mines, and on the return journey two days will be spent at Victoria Falls. Those taking tour No. 2 will visit Wankie, the Victoria Falls, the Zimbabwe ruins, Salisbury, the Shamva gold mine, and the Shabani asbestos mines. Both tours will devote half a day to the Matopo Hills, the "View of the World," 18 miles from Bulawayo, where Cecil Rhodes lies buried in company with Dr. Jameson and Sir Charles Coghlan, the first Prime Minister of Rhodesia. The two parties will then join and visit Pretoria, the Premier diamond mine, the Amianthus asbestos mine, the Kruger National Park, and the Barberton gold mines, and then pass into Natal, where the coal mines and steel works will be inspected and visits paid to Ladysmith, Colenso, and Durban. Finally the itinerary includes Bloemfontein, Port Elizabeth, Oudtshoorn—near which are the Cango stalactite caves—and the Knysna forests, and the tour will conclude at Cape Town on May 8. In the account given here no mention has been made of the platinum workings and of other mining operations of some importance, but it is probable that if there is sufficient desire expressed to visit these centres arrangements may be made to squeeze them in somewhere. Neither is South-West Africa included in the tour, and here again some modification of or addition to the programme may be made.

To the visitors the mining districts will be the primary objects of interest from a professional point of view, but their hosts will have much else to show them. The scenery and the other industries will receive attention and everything which is of special attraction will be seen. Some of these sights have already been mentioned in the foregoing account of the tour, but there are many others included in the programme. The ascent by railway of the Hex River Mountains to the plateau of the Karroo provides a notable view. The game preserve at the Kruger Park will be of exceptional interest to both zoologist and hunter, for it is believed that specimens in plenty of every African animal are to be found there, and as the park occupies 9,000 square miles they live under natural conditions. Ostrich land, the Toverwaterpoort defile, and the panorama of the Drakensberg are also unforgettable features of the continent.

As regards the cost of the visit, the official figure for the period from March 24 to May 8 is given at £140 to £150, which includes hotel accommodation and transport by rail and motor, in fact everything except drinks and tobacco. To this must be added the fare by steamer from England or other starting point. These fares vary widely according to accommodation and the speed of the vessels. On the Union-Castle line they may be anything from £75 to £160 for the return journey from England to Cape Town, less 20% rebate for members of the party. In conclusion it should be added that those desirous to participate in the trip should communicate without delay with Congress Headquarters, 100, Fox Street, Johannesburg, or with Mr. C. McDermid, 225, City Road, London, E.C.

Secondary Metals in the United States

The United States Bureau of Mines publishes fairly detailed estimates of the output of secondary metals every year—that is, the amount of metal produced from scrap and waste. These statistics, as was mentioned by Mr. J. B. Richardson in his paper before the Institution of Mining and Metallurgy last December, are of importance in arriving at accurate figures for the total amount of metal coming on the market, and the increasing proportions of secondary metals recovered indicate the attention paid to the conserving of the world's metal resources. The following table gives the figures for the production of secondary metals within the United States during the year 1928 :—

	Short Tons
Copper, including that in alloys other than brass	325,000
Brass scrap remelted	302,000
Lead as metai	138,000
Lead in alloys	170,600
Zinc as metal	70,700
Zinc recovered in brass	66,000
Zinc in alloys other than brass	12,500
Tin as metal	8,200
Tin in alloys and chemical compounds	27,600
Antimony as metal	745
Antimony in alloys	11,155
Aluminium as metal	24,500
Aluminium in alloys	23,300
Nickel as metal	635
Nickel in non-ferrous alloys and salts	3,865

The amount of secondary copper produced as metal was 230,000 short tons, while 211,400 tons of copper was contained in secondary brass and 95,000 tons in alloys other than brass, making a total recovery of no less than 536,400 tons of copper. As regards zinc, in addition to the recovery as spelter and alloys, it is estimated that 6,208 tons of zinc dust was made from zinc dross and that 12,186 tons of zinc was contained in 61,665 tons of lithopone made from zinc skimmings and ashes, while 9,692 tons of zinc was contained in 44,057 tons of zinc chloride made from similar material. Some details are also available relating to the recovery of tin. The detinning plants treated 215,431 tons of clean tin-plate scrap and 550 tons of old tin-coated containers and recovered 877 tons of metallic tin and 2,216 tons of tin in the form of 4,592 tons of oxide and chlorides. It appears, therefore, that the industry of collecting tin from old tin cans has made no progress in the United States.

To give some idea of the relative amounts of primary and secondary metals produced in the United States, it may be said that the outputs of secondary copper, lead, and zinc were 536,400 tons, 308,600 tons, and 149,200 tons respectively, compared with 1,103,000 tons, 780,000 tons, and 594,500 tons of the primary metals. As regards tin, the total of primary tin, 87,327 tons, was imported. It must be remembered in making these comparisons that some of the secondary metal may have been re-worked more than once. Nevertheless the proportion of secondary to primary metal seems large. Perhaps this is due to the fact that Americans scrap their machinery so liberally.

The Limpopo Bridge

The opening on August 31 of the bridge over the Limpopo River, connecting the Transvaal with Southern Rhodesia, marks another step in the establishment of adequate communications in South Africa and incidentally calls attention once more to the beneficent effect of the Alfred Beit Trust. The bridge crosses the river at a point nine miles north of the Messina copper mine. It is 1,560 ft. long, 32 ft. wide, and consists of fourteen steel spans, and it is designed in such a way as to accommodate both railway and road traffic. The building has been in the hands of the South African Railway Administration, which is also building a mile of railway into Rhodesia, where a township called " Beitbridge " is being founded. This new township is situated about 90 miles from West Nicholson, which is the present terminus of a spur line running south from Bulawayo. A glance at the map will show that the logical conclusion of the enterprise will be the continuation of the line from West Nicholson to the bridge and thus the linking of the Rhodesian railways with Delagoa Bay and the provision of an alternative route from Bulawayo to Pretoria and Johannesburg. In the meantime, before this connecting railway is built, the bridge will afford valuable facilities to road traffic, both heavy and light. The main motor roads southwards in Rhodesia, from Salisbury *via* Victoria and from Bulawayo *via* Gwanda, converge on the bridge and the through traffic will be immensely facilitated by its existence.

We have said that the building of the bridge draws attention to the value of the

Alfred Beit Trust to South African development. The late Alfred Beit had always told Cecil Rhodes that communications were the key to South African prosperity and when he died he left a large sum of money to be used in promoting schemes for the establishment of such communications, this money being vested in a body called the Beit Railway Trust. It has already been recorded in these pages that the extension of Beira port was aided by grants from this Trust and a similar grant for the bridge over the Limpopo now improves the position with regard to Delagoa Bay.

REVIEW OF MINING

Introduction.—Mr. Snowden's straight talk about Britain's burden has had a satisfactory effect and our share in the reparations has been increased. This incident has strengthened our position morally and financially. The coal and iron trades of this country show some improvement and the railway receipts from goods traffic have increased. The merging of Bolckow Vaughan and Dorman Long is likely to ameliorate conditions, not only on the North-East coast, but in the Kent coal and iron field. The metal market has been featureless during the past month and there is no excitement in tin.

Transvaal.—The output of gold on the Rand during August was 850,952 oz. and in the outside districts 38,649 oz., making a total of 889,601 oz. The natives employed on the gold mines at the end of August were 190,062, as compared with 190,031 at the end of July.

Cape Province.—Dr. Pirow, acting Minister of Mines, has stated in Parliament that the Alexander diamond field in Namaqualand has already yielded stones valued at £7,000,000 and that an output of £1,000,000 a year for forty years may be expected.

The British Swiss International Corporation announces that it has paid £302,000 to the Government of the Union of South Africa, this being the estimated cost of the railway now in course of construction from Koopmansfontein to Postmasburg. The Manganese Corporation, which, as already recorded in these columns, was formed by the first named corporation to develop the Postmasburg manganese deposits, has deposited securities worth £100,000 with the Union Government.

Southern Rhodesia.—The output of gold during July is reported at 46,369 oz., as compared with 48,406 oz. in June and 48,960 oz. in July last year. Other outputs for July were: Silver, 8,774 oz.; coal, 100,295 tons; chrome ore, 33,310 tons; asbestos, 3,585 tons; arsenic, 14 tons; corundum, 1 ton; mica, 16 tons; tin, 5 tons; diamonds, 63 carats.

The Cam and Motor Gold Mining Co. reports a decrease in the ore reserves both as regards tonnage and assay value. The figures at the end of June were 1,026,500 tons averaging 51s. 2d. per ton, as compared with 1,060,000 tons averaging 53s. 11d. when the estimate was made last year. The company also states that the grade of ore mined is expected to be lower than normal during the next few months until certain high-grade ore can be mined.

Northern Rhodesia.—The Rhodesian Selection Trust reports the results of No. 15 bore at Mufulira, which passed through the second and third ore-bodies. The true width of the ore was indicated at 109 ft. averaging 3·44% copper, the two ore-bodies being separated by only 4·3 ft. which averaged 1·12% copper.

The Kansanshi copper-gold mine, which is being reopened by the Rhodesia-Katanga Co., is to be connected with the Benguela Railway by means of a branch line, partly in Northern Rhodesia and partly in Portuguese Angola. This line will bring the mine within 1,200 miles of Lobito Bay. The last progress report issued by the company gives the ore reserves so far developed at 1,371,510 tons averaging 6·4% copper and 5 dwt. gold per ton. This estimate does not include the graphitic copper beds or the northern section of the mine, which are likely to increase these figures substantially.

There has been unexpected delay in obtaining a full output of electrolytic zinc at Rhodesia Broken Hill owing to technical difficulties, the plant being the first to treat silicate of zinc with which is associated unusual minerals. These difficulties have been overcome and the output should become normal by October. The capacity of the plant will be still further increased when additional facilities are provided at the hydro-electric plant, and the monthly output should then become 1,500 tons. Much development and prospecting have recently been done with the object of discovering further bodies of lead ore, and by the diamond-drill something like 200,000 tons have been indicated. The latest news is that hole L30 struck ore at 387 ft., passed through 25 ft. of silicate of zinc, then 101 ft. of sulphide ore assaying 26% of lead and 26% of zinc, and afterwards passed into silicate of zinc again. When the lead position has been rectified it is intended to proceed with the erection of a vanadium plant; in the meantime small parcels of the picked ore are being sold. The company still requires working capital and has decided to issue a short loan of £250,000 on the security of the hydro-electric plant. It is expected, when the above-mentioned metallurgical programme has been completed, that it will be possible to retire the loan by the taking up of shares on which there are options at present.

Tanganyika.—Railways in Tanganyika Territory are gradually increasing. After the completion of the line from Tabora to Mwanza on Lake Victoria, attention was paid to the continuation westward of the line from the east coast at Tanga. It is now announced that the railway has been completed for a distance of 50 miles from the terminus at Moshi, thus reaching Arusha. This will help in developing the highlands of Mt. Meru, where there is already a white settlement.

Diamonds.—The Consolidated Diamond Mines of South-West Africa, which is under the control of the Anglo American Corporation of South Africa, publishes some details of the diamond deposits on the shore north of the Orange River. This marine terrace has been proved for 10 miles and the ground is estimated to contain at least a million carats. Before proceeding to production, the company intends to seek a larger allotment for South-West Africa under the agreement among the leading producers.

Nigeria.—The Northern Nigeria (Bauchi) Tin Mines reports that the output of tin concentrates during the quarter April to June was 500 tons, an increase of 50 tons over the preceding quarter and 80 tons greater than during the corresponding period last year. The output during the company's year ended June 30 was thus 1,850 tons, as compared with 1,710 tons during the previous twelve months. It is expected that the output will be at a lower rate during the next few months, as it is desirable to devote as much power as possible for stripping the overburden during the rainy season.

Australia.—As reported last March, the Golden Horse-Shoe mine at Kalgoorlie was sold to the Lake View and Star in order that the lodes passing from Lake View into Golden Horse-Shoe ground could be worked by the Lake View, the purchase price being 900,000 4s. shares in the latter company. The Golden Horse-Shoe directors have since decided to distribute these shares among their shareholders in the proportion of one share in respect of each of the 800,000 preferred ordinary shares of 5s. each and one share for every three ordinary shares, the distribution being effected on the liquidation of the old company. At the same time a new company has been formed, called the Golden Horse Shoe (New), Ltd., with a capital of £220,000 in 1,100,000 shares of 4s. each, to take over the remaining assets, which consist of 2,553,000 tons of accumulated tailings assaying 7s. 10d. per ton. A plant is in course of erection for the treatment of these tailings at the rate of 40,000 tons per month and it is expected to be ready for operation in January next.

Boulder Perseverance reports that a bore-hole driven in the 1,600 ft. level off the Lake View lode in a northerly direction passed through an ore-body which was supposed to be a downward continuation of the East Boundary lode found on the 1,300 ft. level. The core averaged 5 oz. 4 dwt. over a width of 11 ft. 4 in. A cross-cut following the bore-hole has subsequently confirmed the value indicated by the bore, but owing to the known patchy nature of this lode on the 1,300 ft. level more work is to be done on it on the 1,600 ft. level before the true value of the ore can be judged.

A cable message reports that the net profit of the Broken Hill Proprietary Co. for the year ended May 31 was £332,671, as against £222,616 the year before. The output of pig iron was 330,803 tons, as compared with 333,368 tons, and of steel ingots 374,059 tons, as compared with 359,389 tons. The lead-zinc mine was not worked during the year, but a start was made on the retreatment of old residues, 65,676 tons yielding 9,009 tons of lead concentrates. An arrangement has been made with Messrs. Stewarts and Lloyds for the manufacture of steel tubes in Australia and a company called the Buttweld Co. has been formed for the purpose. At the subsequent meeting of shareholders the chairman stated that arrangements were in hand for reopening the lead-zinc mine at Broken Hill.

The Whitworth Finance and Mining Corporation announces that Mr. J. W. Newbery is visiting its Queensland tin properties and that one of the directors, Mr. S. C. Magennis, will arrive at the properties shortly. Our Brisbane correspondent also writes relating to the properties in which the corporation is interested. An important group in the City has taken an option on a block of shares, which, if the results of examinations are satisfactory, will provide the additional finance required.

Several references have been made recently by our Brisbane correspondent to the orders for coal sent from Australia to England. Further news came to hand last month to the effect that an order for 40,000 tons of coal from Scotland, Wales, and Northumberland has been placed by the Victorian Railways Department. This coal is to be used on the locomotives as an admixture with Wonthaggi low-grade coal and displaces best Maitland coal, which has hitherto been used for this purpose.

The Electrolytic Zinc Co. of Australasia announces that the capacity of its hydro-electric station at Risdon, Tasmania, is to be enlarged from 50,000 tons per year to 65,000 tons, in order to treat the material from the Rosebery mines.

New Guinea.—Dr. Richardson, geologist to the Anglo-Persian Oil Co., who has been making investigations in New Guinea for the Government of Australia, reports favourably on the structure of the Aitape region. He is of opinion that the folded rocks of the Miocene age, with proved oil indications, present the most hopeful proposition his party has yet encountered and that full scope should be afforded for its complete investigation.

Mexico.—The San Francisco Mines of Mexico reports a breakdown of the plant of the company which supplies electric power to the mine, with the result that for some weeks the mill has been able to work at only half capacity. It is hoped to resume the usual output by October 1.

Colombia.—The Nus River Gold Mines, Ltd., control of which was recently acquired by the Anglo-Oriental group, reports that the dredge erected by the previous controllers has not proved satisfactory and that the Yuba Associated Engineers, under the advice of Mr. Vivian Clark, have recommended the expenditure of $60,000 in remodelling the dredge and $75,000 in providing electric power. A loan was negotiated with the Anglo-Oriental and General Investment Trust, but capital will also be required for the purpose of carrying out Mr. Clark's recommendations.

Japan.—The Toyo Tin Co., a member of the Anglo-Oriental group, which works the Mitate tin mine, reports that the new mill is almost ready to start and that developments on the 550 ft. cross-cut are encouraging. In order to provide further working capital and repay loans, the company has created 200,000 new shares of 10s. each, of which 150,000 are being offered at par to shareholders.

Spain.—The Tigon Mining and Finance Corporation, of which Mr. R. E. Palmer is chairman, reports that the development of the elemental sulphur deposits is proceeding satisfactorily. Until the new plant for sulphur extraction is completed the old Clarete furnaces are being employed. The antimonial-silver-lead property is being tested by drilling, but the tin property is being left for the time, as the results of investigation are not sufficiently promising with tin at the present price.

Camp Bird.—Arrangements have been made for a closer affiliation between Camp Bird and Consolidated Gold Fields. The offices of Camp Bird, Santa Gertrudis, Mexican Corporation, and other companies of the Camp Bird group will be moved to those of the Gold Fields at 49, Moorgate. Gold Fields will appoint directors to the several boards and will subscribe £250,000 Camp Bird debentures. Camp Bird also announces that it has transferred its interests in the Lake George mine in New South Wales to a company called the Lake George Metal Corporation, which will erect a treatment plant with an initial capacity of 500 tons per day.

Selection Trust.—The Selection Trust, of which Mr. Chester Beatty is the moving spirit, reports a profit of £213,248 for the year ended March 31 last, as compared with £53,594 the year before. The 200,000 7½% £1 preference receive their dividend and the 600,000 £1 ordinary shares receive a dividend of 10%. Since the close of the year £300,000 6½% debentures have been issued, for the purpose of providing the company with funds to enable it to participate in new capital issues of the Rhodesian and other companies in which it is a large shareholder. The report gives particulars of the various companies which it controls—namely, the Consolidated African Selection Trust, which has diamond interests through subsidiaries in the Gold Coast and Namaqualand, the Rhodesian Selection Trust and the Roan Antelope Copper Mines, which are developing copper properties in Northern Rhodesia, the Tetiuhe Mining Corporation, which works a lead-zinc-silver mine in eastern Siberia, the Trepca Mines, which has developed lead-zinc ores in Jugoslavia, and the Novo Brdo Mines, which is developing similar properties adjoining those of the Trepca Mines.

THE GEOLOGY OF SABLE ANTELOPE AND NEIGHBOURING MINES, NORTH-WESTERN RHODESIA

By R. MURRAY-HUGHES, F.G.S., A.Inst.M.M., and A. A. FITCH, A.R.C.S., B.Sc.

Location.—In Fig. 1 a triangular area is shown at A 120 miles west of Broken Hill, a station on the Bulawayo-Congo Railway. It marks a concession which was granted to the Northern Copper Company, and within it are three smaller areas (Fig. 2), each of ten square miles, which were handed to a subsidiary, the Kafue Copper Development Company. From west to east these areas are named from the principal mines situated within each, Silver King, Crystal Jacket, and Sable Antelope, 8½ miles separating the first and last.

General Geology [1].—The sedimentary rocks in the area belong to the Lusaka and Kafue Systems, equivalent to the Transvaal and Pretoria Systems of South Africa. These sedimentaries have been folded and then metamorphosed by the intrusion of a large granite mass known as the Hook Granite (Fig. 2). The sedimentaries form hilly country.

Local Geology.—The Lusaka Beds in the area consist of a series of limestone, shale, dolomite, greywacke and quartzite; they show a predominant strike from east to west dipping to the south. They have been greatly folded, the local folds appearing to be minor plications on the flanks of a pitching anticline, whose axis runs about three miles north-west of the mines, pitching to the north-east.

Small faults are numerous, the movements being accompanied by a coarse brecciation. In all of the fault-breccias, the cementing material is dolomite with varying amounts of iron and manganese replacing the calcium and magnesium. The weathering of these brecciated bodies is strongly contrasted with that of the limestone. In the brecciated bodies the cement oxidizes to a deep reddish-brown colour, the limestone fragments remaining pink. The rock shows a weathering typical of insolation, forming miniature inselbergs,[2] while the soil derived from it is full of nodules of iron and manganese oxides, consolidated to form a laterite. The limestone gives rise to pinnacled and serrated outcrops, 6 to 50 ft. high, and produces a sticky red soil.

[1] Vide R. Murray-Hughes and A. A. Fitch, *Q.J.G.S.*, vol. 85, pp. 109–66, 1929.

[2] Vide Editorial Note, *Geol. Mag.*, 1923, pp. 383–4.

A well-defined cleavage is noticeable in rocks to the north of the mines, but it dies out within 3 or 4 miles of them. The contact metamorphism due to the Hook Granite shows itself as marmorization, and in places as silicification of the limestone. In the

Fig. 1—Showing Location of the Concession in the North of Kafue District, Northern Rhodesia.

Silver King mine a group of minette intrusions is much in evidence. The nearest outcrop of the Hook Granite is 8 miles away, and part of this distance is across an alluvial plain of the River Kafue. Furthermore, the contact plunges very gently, and the granite is probably less than 1,000 ft. from the surface at the mines.

The Ore Deposits.—The deposits are practically all of one type, namely, brecciated pipes in the Lusaka Limestone (Figs. 3 and 6). Within these pipes the metallization is restricted to the periphery.

Further, where the pipes are inclined, the ore is concentrated along the foot-wall. The pipes vary in diameter from 800 yards in the case of the Sable Antelope to 70 yards in the case of the Maurice Gifford. The Silver King is exceptional in that the metallization occurs in shatter-belts following the minette dykes.

Oxidized and secondarily enriched ores are not abundant, except at the Silver King mine, where the ready weathering of the minette has allowed a more free and deeper circulation of surface waters.

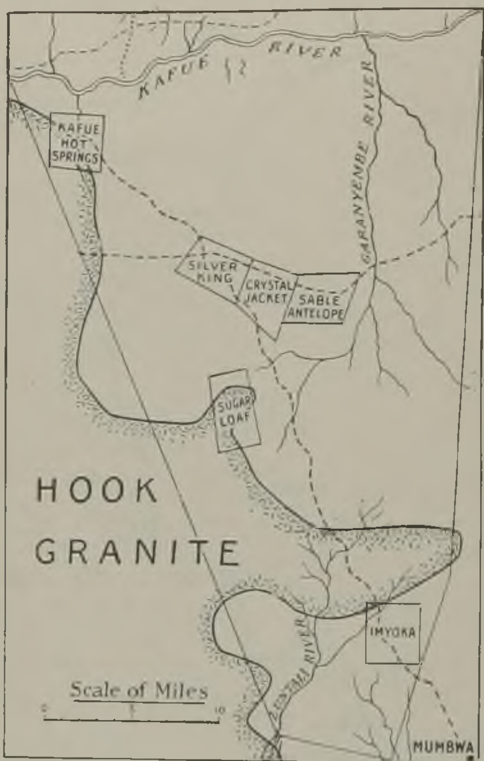


Fig. 2.—Showing Location of the Mines with respect to the Granite Contact. The roughly triangular area of the large Concession, bounded on the North by the Kafue River, is indicated.

Sable Antelope Mine.—This enormous "plug" of breccia (Fig. 3) shows a steep pitch to the east, so that the metallized portion outcrops at the western margin, where it follows the periphery and has been developed up to the present for 300 ft. A peculiar feature is the differentiation of the deposit into arsenical and non-arsenical parts. In its northerly part it is composed of chalcopyrite and bornite, while in its southerly part it is essentially tennantite with subordinate amounts of the first-named minerals.

The massive tennantite breaks into rectangular blocks, and water following the lines of weakness deposits films of oxidized products. In the tennantite are found occasional masses of bornite, 4 to 6 in. in diameter, surrounded by a red-stained aureole 1 to 18 in. wide. In the northern portion of the mine, masses of almost solid bornite were found, one of which yielded 500 tons of practically pure mineral.

A study of thin and polished sections of the ores shows the following to have been the sequence of events in the mineralization.

(1) A first stage resulting in the production of a white crystalline dolomite with striated cubes of pyrite. Occasionally the order of crystallization is reversed, and rhombs of dolomite are included in irregular masses of pyrite.

(2) Inter-mineralization brecciation.

(3) Cementation of the breccia by grey dolomite carrying bornite, chalcopyrite, and chalcocite. The chalcopyrite may form a mesh structure in the bornite, a primary structure due to unmixing of a sulphide matte intermediate in composition between bornite and chalcopyrite. The chalcocite tends to occur separate from the other sulphides, but, where they are in association, the chalcocite is shown to be later. This grey cementing dolomite replaced a part of the brecciated material, as is shown by the sub-angular nature of the breccia fragments, and by the occurrence of a few residual kernels of pyrite in the copper sulphides, which have been marginally enriched in the highly cupriferous environment of the grey dolomite.

(4) The final stages of enrichment are due to secondary processes. The pyrite of the white dolomite, which is unaltered during the course of the primary mineralization, is enriched to chalcopyrite and then to chalcocite. The bornite develops covellite along cracks and marginally, the chalcopyrite mesh resisting enrichment and projecting through the covellite.

(5) Oxidation results in the appearance of an abundant laterite with loose nodules composed of the hydrated oxides of iron and manganese. Several concentrated bodies of these iron deposits were found, and in one willemite was discovered in three small, irregular masses, but not associated with any metallization by copper, and a mile further from the Hook Granite contact.

Silver King Mine.—This is marked by an outcrop, 300 ft. long and 70 ft. wide, of an almost black rock locally stained yellow with iron. It represents the zone of contact metamorphism on either side of the minette dykes, and marks their course, which is N. 65° E. At the most westerly point it rises into a small hill or kopje 100 ft. high which shows abundant coarse quartz, and limonite in radial concretions. Several veins were exposed on the lower part of the outcrop, and a number of shafts were sunk following them, but were abandoned at water-level (90 ft.), without having uncovered a pocket. The rock traversed was composed mostly of coarse siderite with much calcite stained by manganese oxide.

The outcrop is abruptly terminated at its eastern end by a fault which crosses it obliquely running N. 10° E. The fault shows numerous veins of pyrolusite and occasional specks of chalcopyrite, which have given rise to green copper carbonate stains at the surface. The fault is post-minette in age, for fragments of this dyke-rock occur in the fault-breccia as allogenic constituents. It was at the junction of this fault with the crush-zone that the largest rich pocket was discovered.

The composition of the ore can be gathered from the assay records in the accompanying table.

	I	II	III
	%	%	%
Cu	49·77	6·93	18·03
S	—	—	4·80
Insol.	11·78	15·29	14·18
FeO }	3·37	9·29	17·14
MnO }		3·76	1·50
CaO	4·77	30·23	25·78
MgO	0·96	6·53	4·79
Silver (oz. per long ton)	20	—	52·07

I. Typical assay of ore from the rich pocket, occurring to the east of the fault. (From the old assay records.)
II. Picked material from dumps of shafts to the west of the fault (analyst R. M.-H.).
III. Ore from 200 ft. level, west of fault (analyst R. M.-H.).

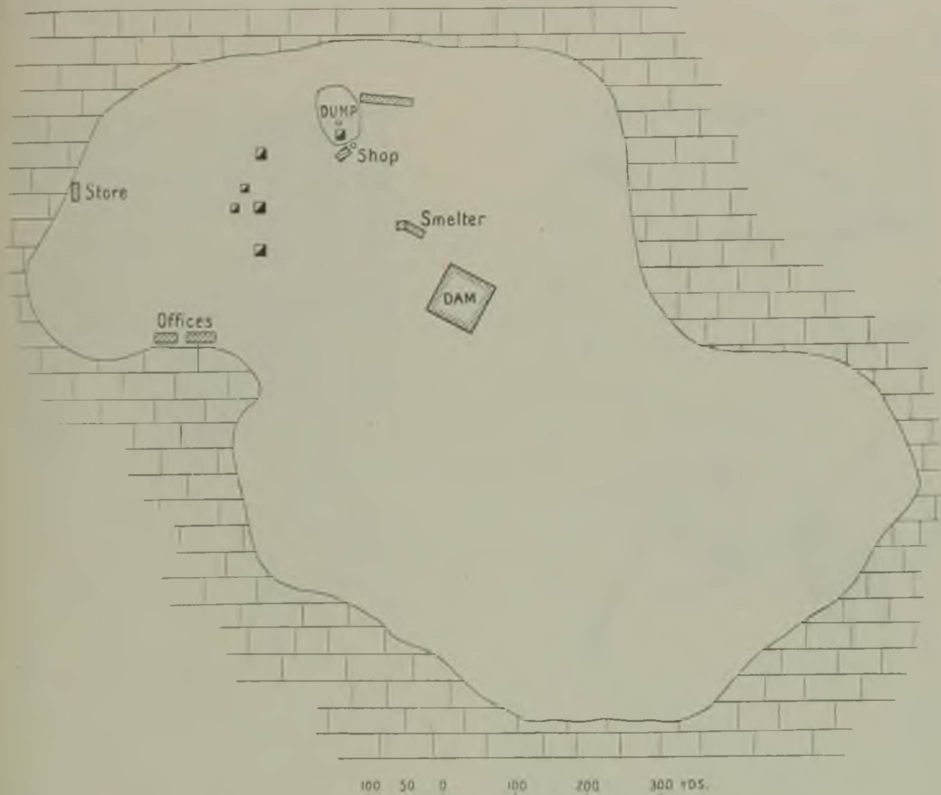


Fig. 3.—Plan of the Sable Antelope Pipe.

A typical assay of the black copper produced from smelting these ores is :—

	%	
Cu	96·00	
S	2·50	
Fe	0·50	
Mn	0·40	
As	0·20	
Bi	0·10	
Slag	0·30	
Ag	45	oz. per long ton
Au	0·0075	,, ,,

The geological history of the Silver King deposit, as revealed by a study of polished sections of the ores, is a complex one, but a feature which persists throughout is the occurrence of chalcocite as the only primary copper mineral. The more significant stages in the formation of the ore-bodies are summarized below.

(1) The country rocks—comprising limestones and siltstones of the Lusaka System, and intruded dykes of minette—were brecciated and compacted, the cementing being effected by rock-flour and a little solid chalcocite.

Fig. 4.—Showing composite Breccia-fragment encrusted with Quartz Crystals, and floating in Calcite carrying euhedral Chalcocite Crystals (black).

(2) The rock was re-brecciated, and the composite fragments floated in material which crystallized as pure white calcite, carrying euhedral crystals of chalcocite, which show various faces in oscillatory combination in the prism zone, terminated by several pyramidal and domatic faces (Fig. 4).

(3) The conditions of stress persisted, leading to bending, or more rarely fracturing of the soft chalcocite crystals.

(4) The numerous vugs and cracks remaining were filled with a black rhombohedral carbonate—ankerite—owing its colour to the presence of innumerable opaque needles. As this carbonate crystallized, chalcocite separated from it, the copper mineral becoming progressively more abundant, until the vug was finally lined with chalcocite crystals, or filled with solid chalcocite. At some stages the chalcocite and ankerite form a very intimate intergrowth giving an " embroidery " effect.

Replacement of the breccia fragments by chalcocite took place at the same time as these changes.

Locally, especially in the western part of the deposit, coarse siderite was deposited after stage (1), and cleavage fragments of it were broken off and floated into the black ankerite (Fig. 5).

Since the primary mineralization is in

Fig. 5.—Showing Composite Breccia-fragment on which has grown Siderite, which has been fractured and floated off into the Chalcocite-bearing Ankerite (black).

chalcocite, the only secondary changes are due to oxidation, secondary sulphide enrichment being impossible.

The first stage in the oxidation always takes the course indicated by the equation

$$\underset{\text{chalcocite}}{2Cu_2S} + H_2O + CO_2 + O_2 = \underset{\text{malachite}}{CuCO_3.Cu(OH)_2} + \underset{\text{covellite}}{2CuS.}$$

which may be considered as " secondary sulphide impoverishment."

The usual changes in this zone of copper ore-bodies, involving the migration of large quantities of sulphuric acid and copper and iron sulphates do not arise in the absence of pyrite and chalcopyrite, the small amount of sulphuric acid produced by the complete oxidation of chalcocite being quickly neutralized by the limestone gangue to form a little gypsum.

Some interesting veins occur which show an overlap of the secondary sulphide and oxidized zones. The minerals in order of crystallization are :—

(*a*) Chalcocite and covellite intergrown.

(*b*) Bornite with small specks of native silver.

(*c*) Chrysocolla, bluish-green, but becoming progressively whiter.

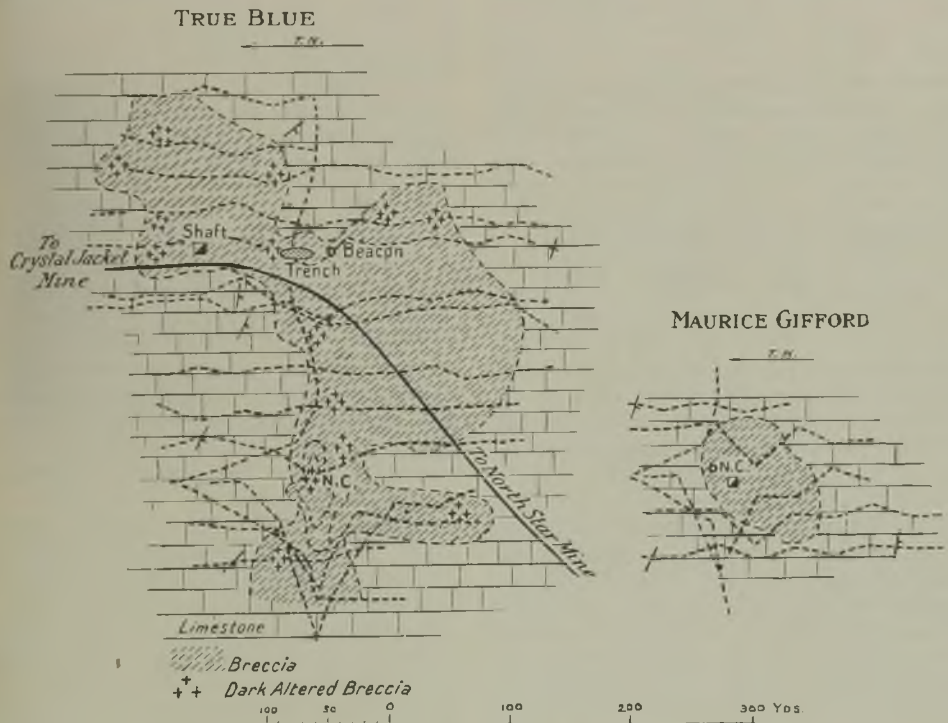


Fig. 6.—Plans of the True Blue and Maurice Gifford Pipes. The dotted lines represent electric traverses which are not mentioned in the paper.

(*d*) Malachite.

(*e*) Bornite, a little darker in colour than (*b*), and carrying no native silver.

The oxidized zone proper consists essentially of limonite, malachite, and calcite, but chrysocolla, cuprite, native copper, and iodyrite (AgI) also occur. The paragenesis of the last-named is in veins showing the following order of crystallization :—

(*a*) Coarse calcite.
(*b*) Malachite.
(*c*) Botryoidal chrysocolla.
(*d*) Cuprite.
(*e*) Finely granular calcite.
(*f*) Iodyrite.

The *True Blue* and *Maurice Gifford* (Fig. 6) deposits are similar to the Sable Antelope, though much smaller, and arsenical ores predominate. The Crystal Jacket deposit more nearly resembles the Silver King. The ores show no features not exhibited by the previously described deposits.

Genesis.—The metallization must be attributed to the neighbouring intrusive, the Hook Granite. Many features show that this granite is in an early stage of erosion ; roof pendants occur in the granite, and isolated peaks of granite in the wide area of contact metamorphism. The magma was rich in volatiles, including boron, fluorine, chlorine, carbon dioxide and others, giving rise to such minerals as tourmaline, scapolite, sodalite, and cancrinite. The volatiles also included iron, copper, silver, zinc, and small quantities of arsenic and bismuth ; sulphur was not very abundant. During the progress of the mineralization, the sulphur combined almost entirely with the copper in preference to the iron. Further evidence for the shortage of sulphur is afforded by the occurrence of willemite in the Sable Antelope deposit, a mineral whose appearance at Franklin Furnace, New Jersey, has been attributed to a lack of sulphur in the intrusive magma.[1]

The formation of primary chalcocite has been attributed by A. M. Bateman[2] to the deposit of ferric oxide either before or at an early stage of the intrusion. When, at a fairly late stage, copper and sulphur are given off together, the oxidizing action of the ferric oxide prevents the deposition of more sulphur than will suffice to form the cuprous sulphide, chalcocite. This hypothesis may apply to the deposits under consideration, for hematite is a characteristic high-temperature mineral of the Hook Granite; it occurs as specular hematite in the granite itself, and forms large conical hills in the metamorphic aureole just beyond the contact; Sanje Hill is one of these, about 600 ft. in height. Further, the mineralized breccias themselves are rich in iron (p. 137).

Regional Relationships.—The group of deposits under discussion (vide analyses of ore) falls into place in what appears to be a metallogenetic province, characterized by chalcocite of primary origin as its dominant mineral. This province, which is as yet imperfectly explored, includes a large part of Northern Rhodesia, but it extends also into the Belgian Congo, and there is some evidence of an extension into Southern Rhodesia. Over a large part of the province the chalcocite occurs in "bedded" deposits, as at the Roan Antelope.

The metallogenetic province here defined is approximately co-extensive with a petrographic province characterized by granites of the same type as the Hook Granite.

THE VOLUMETRIC ESTIMATION OF LEAD BY THE MOLYBDATE METHOD

By J. E. CLENNELL, B.Sc.(London), A.Inst.M.M.

Introductory.—The following notes form part of an investigation of various methods for the estimation of lead, undertaken by the writer on behalf of the Metallurgical Department of the Chelsea Polytechnic.

The object of this research was not so much to devise new methods of estimation as to determine, as exactly as possible, the conditions under which results of sufficient accuracy for practical purposes could be uniformly obtained by standard methods. The use of elaborate apparatus or expensive reagents was to be avoided as far as possible, the intention being to select methods which should be well within the capacity of ordinary students, and to define the conditions of working so that concordant results should always be obtainable.

Principle of the Molybdate Method.—This method is probably the one most frequently used at the present day for the estimation of lead in ores or alloys in which that metal occurs as a major or important constituent. The lead is precipitated from a hot acetate solution, or from a hot solution of lead sulphate in a soluble acetate, by means of a standard solution of ammonium molybdate, the end-point being ascertained by the use of tannin (tannic acid), as external indicator. The reaction between the lead salt and the molybdate may be represented as follows:—

$Pb(C_2H_3O_2)_2 + (NH_4)_2MoO_4 = PbMoO_4 + 2NH_4(C_2H_3O_2)$.

Standard Molybdate Solution.—About 9 grm. of crystallized ammonium molybdate is dissolved in water and made up to a litre. 1 cc. of this solution should be approximately equal to 0·01 grm. (10 mgr.) of lead, but the exact strength must be determined by standardizing as described below.

[*Note.*—The theoretical amount, assuming the salt to be $(NH_4)_2MoO_4$ would be 9·463 grm. per litre; Ibbotson and Aitchison, "Analysis of non-Ferrous Alloys" (1915) p. 58, give the formula $(NH_4)_6Mo_7O_{24}\cdot 4H_2O$, which might be written $3(NH_4)_2MoO_4\cdot 4MoO_3\cdot 4H_2O$, according to which 8·364 grm. per litre are required.]

Tannin Indicator.—0·5 grm. of tannic acid is dissolved in water and made up to 100 cc. This should be freshly prepared as required. It gives a yellowish-brown colour with the molybdate solution, but is unaffected by lead molybdate or by other salts ordinarily present in the solution. Iron salts, which give a black colour with tannic acid, must be absent. The indicator is used in drops placed on a smooth white porcelain tile, to which a small drop of the

[1] A. A. Fitch, *Mining Magazine*, vol. xxxix, p. 82, 1928.

[2] A. M. Bateman, *Econ. Geol.*, vol. 18, p. 152 et seq., 1923.

solution to be tested is added by means of a glass stirring rod or narrow-bore glass tube.

Standardization of the Molybdate Solution.—A convenient routine method, which has been thoroughly tested by the writer, is as follows:—If the amount of lead in the sample to be assayed is approximately known, weigh out a quantity of pure lead-foil about equal to the weight of lead in the portion of substance to be subsequently taken for assay. If the amount of lead in the assay sample is unknown, prepare a series of (say 5) standards, with amounts of lead-foil ranging from 0·1 to 0·5 grm. It is unnecessary to weigh closer than within ± 0·5 mgr.

Place the lead in a 200 cc. conical flask. Add 10 cc. dilute HNO_3 (1 vol. conc. HNO_3 to 4 vols. water). Heat till the lead completely dissolves, boil to expel red fumes, cool, add 5 cc. conc. H_2SO_4, boil to strong white fumes, allow to cool thoroughly, add 30 cc. water, boil, cool to room temperature, and allow to stand until thoroughly settled. Decant the clear liquid through an ordinary 9 cm. paper filter, leaving the precipitate as much as possible in the flask or beaker. [The washing with dilute H_2SO_4 which is necessary in the assay may be omitted in standardizing, as it does not affect the result.]

To the settled precipitate add 5 grm. of solid ammonium acetate, then about 3 cc. of water, which is just sufficient to dissolve it; warm gently, finally just to boiling and see that everything dissolves. This quantity of the acetate should be sufficient for amounts of lead up to 400 mgr. If the precipitate does not completely dissolve, add a little more ammonium acetate, but avoid using excessive amounts. Pass the hot undiluted solution through the filter just used, collecting the filtrate in a clean empty flask of about 300 cc. capacity; wash with hot water until the total volume of the filtrate is about 150 cc.

[An alternative, and perhaps more convenient method is as follows:—Prepare a solution, by weighing, roughly, 100 grm. of ammonium acetate and adding 50 cc. of distilled water; stir and warm gently till dissolved. On cooling, this forms a nearly saturated solution having a volume of about 138 cc., so that 7 cc. contains about 5 grm. of ammonium acetate. This quantity of solution may therefore be used in place of the 5 grm. of the solid salt specified in the above description.]

Heat the filtrate, which now contains the whole of the lead in solution, to boiling, and titrate immediately with the standard ammonium molybdate, as follows:—

If the approximate standard of the molybdate is unknown, set aside about 50 cc. (i.e. one-third) of the prepared lead solution, keeping this hot, but not necessarily boiling. To the remainder, run in the molybdate solution (say) 5 cc. at a time, testing after each addition by taking out a drop with a small glass rod or tube and applying it to a drop of the tannin indicator on a white porcelain tile. When a distinct brown colour is produced, add to the titrated solution a portion of the 50 cc. reserved solution, mix thoroughly, and test again with tannin.

If a colour is still produced, add more of the reserve; if not, add more of the standard molybdate, say 2 cc. at a time, testing after each addition till the end-point is again passed; again add some of the reserve and continue in this way approximating the end-point, using smaller additions of molybdate, until all the reserve has been added. Finally rinse out the vessel in which the reserve was contained, with a large volume of the titrated solution, add this to the remainder of the latter, and again test with tannin.

Another standardization should then be made, in which nearly the required amount of molybdate (now approximately known) is added at once to the hot lead solution, and the exact end-point ascertained by further additions of small volumes of molybdate.

[In our tests, with the strength of solution, quantities of lead, and degree of dilution shown below, it was not found possible to determine the end-point with a greater degree of accuracy than ± 0·2 cc. of molybdate, representing approximately 2 mgr. of lead.]

Blank Test to Determine Amount of Molybdate Required to Affect the Indicator.—As a certain amount of the molybdate must be added to the dilute solution before a visible coloration is produced with the indicator, it is customary to determine this quantity and deduct it from the result obtained in each assay. The same quantity of ammonium acetate is taken as in the assay, but without addition of any lead salt and is diluted to 150 cc. It is perhaps advisable to add, say, 0·3 to 0·4 grm. of ammonium sulphate, to correspond with the amount introduced by solution of lead sulphate in ammonium acetate.

The mixture is heated to boiling, and titrated by adding the molybdate drop by drop, mixing and testing after each addition, until a distinct colour is given with a drop of tannin solution on the white plate. About 0·2 to 0·3 cc. of molybdate will generally be required. This amount is deducted from the final reading in every assay made under the same conditions.

[According to Sacher (Chem. Zeit. (1909) *33*, 1257) this correction depends on the volume of solution to be titrated, and amounts to 0·45 cc. when the volume is 150 cc.; see Ibbotson and Aitchison, loc. cit. 57.]

If the molybdate solution be standardized on approximately the same quantity of lead as is present in the assay, if the same quantities of sulphuric acid and ammonium acetate be used, and if the volume of liquid before titration be the same, there is no necessity for a blank assay, as both the standard and the assay are affected to exactly the same extent.

Application of the Method for Estimation of Lead in an Ore (*Galena*).—A representative sample is finely crushed and well mixed. A quantity sufficient for several assays (say 5 to 10 grm.) is selected and ground, best in an agate mortar, until no gritty particles remain. This portion is preferably dried for several hours to constant weight in a steam oven, and preserved in a small stoppered bottle.

For ordinary high-grade ores 0·5 grm. is weighed out, accurately to $\pm$ 1 mgr., and placed in a 200 cc. conical flask. 10 cc. of conc. HCl is added, warmed gently for some time to decompose the mineral as much as possible, boiled to expel H_2S, 5 cc. conc. HNO_3 added, heated gently, finally to boiling for about 10 minutes. It is then cooled for a few minutes, 5 cc. conc. H_2SO_4 added, heated gradually to boiling, and boiling continued until the flask is filled with dense white fumes. Heating is continued for some minutes longer and the flask is then allowed to cool, gradually at first.

[Too sudden cooling may cause cracking, but after it has stood until it ceases to fume and can easily be touched by the hand, the cooling may be hastened by pouring water from a tap over the outside of the flask.]

30 cc. of distilled water is then added and heated to boiling with frequent agitation, which is generally necessary to prevent "bumping"; the flask is then cooled to room temperature and allowed to stand until the precipitate has completely settled.

Without disturbing the precipitate, pour the clear liquid through an ordinary 9 cm. paper filter. Test the filtrate with H_2SO_4 to see if precipitation of lead has been complete. If any further precipitate is formed, add more H_2SO_4, boil, cool and settle again before filtering.

Wash the precipitate, consisting of $PbSO_4$ and "insoluble", by decantation with 100 cc. of dilute H_2SO_4 (1 : 9), using about 15 to 20 cc. at a time, agitating, settling and pouring the nearly clear liquid through the filter, but retaining the precipitate as much as possible in the flask.

[The dilute H_2SO_4 is prepared by mixing 1 vol. of conc. H_2SO_4 with 8 or 9 vols. of water, cooling to room temperature and diluting the mixture with water to 10 vols. This is referred to in these notes as "H_2SO_4 (1 : 9)." Lead sulphate is practically insoluble in acid of this strength, and 100 cc. is usually sufficient to remove all iron, copper, or other metals soluble in H_2SO_4. In doubtful cases a further wash of H_2SO_4 (1 : 9) may be given, and the filtrate tested with ferrocyanide or thiocyanate. No blue or brown colour should be given by the former and no red colour by the latter.]

When the filtrate no longer shows a reaction with ferrocyanide or thiocyanate, allow the precipitate on the filter to drain thoroughly, then transfer it with a fine jet of hot water from a wash bottle to a clean beaker, or to the flask in which precipitation was made, using as little water as possible. Add to the bulk of precipitate 5 grm. of solid ammonium acetate or 7 to 10 cc. of the strong (2 : 1) solution described above. Warm gently with agitation, finally just to boiling; without dilution, pour through the paper filter, collecting the filtrate in a clean 300 cc. flask. Give one or two washes with small quantities of hot concentrated ammonium acetate, alternately with washes of hot water; finally wash thoroughly with hot water until the total volume of filtrate is about 150 cc., and heat to boiling.

Titrate with standard molybdate exactly as described under Standardization.

Alternative Method.—The chief difficulty in this process consists in getting the whole of the lead sulphate dissolved and separated from the "insoluble." It is essential to use a rapid filtering paper, and to use the ammonium acetate in the form of a very concentrated solution. As the method sometimes fails to remove the whole of the lead from the "insoluble," probably owing to some $PbSO_4$ being tenaciously retained by the paper or residue, the following method was tried, and proved convenient and effective.

After the wash with H_2SO_4 (1 : 9) has been given and allowed to drain off completely, remove the 9 cm. paper, containing the small amount of precipitate carried over during decantation, from the funnel and place it in the flask with the bulk of the lead sulphate precipitate. Add 10 cc. of ammonium acetate (2 : 1), warm gently with agitation, finally just to boiling. Decant through a fresh 9 cm. paper into a 300 cc. flask, leaving the original paper and any undissolved precipitate behind. Add 20 cc. of water, heat to boiling and decant the liquid through the same filter. It is as well to repeat this operation twice, using each time 10 cc. of ammonium acetate (2 : 1) and 20 cc. of water. Now rinse the first filter paper into the second and wash both together with hot water until the total volume of filtrate is about 150 cc.; boil and titrate as described above.

Further Treatment of the "Insoluble."—The residue usually consists chiefly of silica, but may possibly contain some undecomposed silicates, $BaSO_4$, SnO_2, Fe_2O_3, Al_2O_3, TiO_2, Cr_2O_3 or WO_3. To confirm the complete extraction of lead, it should be extracted with a further quantity of hot conc. ammonium acetate and the extract tested with potassium chromate. If this gives no yellow precipitate, the residue may be rejected.

Summary of Precautions to be observed in the Molybdate Titration of Lead.

(1) Avoid using an excessive amount of ammonium acetate, as the end-point is somewhat affected by varying amounts of this salt. For quantities of lead up to 250 mgr. 5 grm. of the solid salt or 7 to 10 cc. of concentrated solution (2 : 1) are sufficient; for 500 mgr. about 15 grm. of the salt or 20–25 cc. of solution (2 : 1) may be required.

(2) Add the conc. ammonium acetate (2 : 1) direct to the precipitate without dilution, heat gently, finally to near boiling point. Actual boiling is unnecessary. Extract the filter paper with a further quantity of hot ammonium acetate or preferably digest the paper with this after removing from the funnel, as described under "Alternative Method."

(3) If any white precipitate settles from the filtrate, allow to stand, decant the clear liquid carefully into another vessel, add to the precipitate a small quantity of ammonium acetate, heat till everything dissolves and pour into the decanted solution.

(4) Before titrating, dilute the solution to a constant volume (say 150 cc.). This allows of a constant correction for indicator being used. [See remarks under "Blank Test" above.]

(5) Heat to boiling immediately before titration and keep the titrated solution hot, near boiling, throughout the operation.

(6) Use a freshly-prepared solution of tannin of about 0·5% strength, in distilled water, as indicator.

(7) Stir the titrated solution thoroughly and allow to settle for a moment before taking out the drop for test.

Experiments on Standardization.—The following tests were made by the writer to determine the best conditions for standardization of the molybdate solution. They were carried out for the most part as described above under standardization, except that the precipitate of $PbSO_4$ was washed by decantation with 100 cc. H_2SO_4 (1 : 9), the washings being passed through a filter, as in the treatment of an ore sample. As much as possible of the small quantity of material collected on the filter was rinsed back into the precipitation flask with a little water, before adding ammonium acetate. About 5 grm. of the solid salt, roughly weighed, was generally used in the first instance, further quantities being added if this did not suffice for complete solution of the $PbSO_4$. The results are summarized in the accompanying table.

Notes on Table of Experiments on Standardization.—Tests 8 and 9 were made to observe the effect of varying amount of ammonium acetate. More molybdate appears to be consumed for the same amount of lead, when the amount of ammonium acetate is increased.

Tests 10 and 11 were made to observe the effect of the presence of a considerable amount of ammonium sulphate. An immediate precipitate of $PbSO_4$ was produced on adding $(NH_4)_2SO_4$ to the solution of $PbSO_4$ in $NH_4\bar{A}$; thus a much larger quantity of $NH_4\bar{A}$ would have to be used if the excess of H_2SO_4 were not removed by filtration or washing. Hence it would not be desirable merely to neutralize the solution with NH_4OH instead of decanting or filtering. The reaction :—

$$2NH_4 \cdot C_2H_3O_2 + PbSO_4 \rightleftharpoons (NH_4)_2SO_4 + Pb(C_2H_3O_2)_2$$

is reversible and its direction depends on the relative quantities of the salts present.

Tests 12 and 13 were made by adding the filter paper, after use in decantation of the settled solution and washing with H_2SO_4 (1 : 9), to the solution of the $PbSO_4$ in $NH_4\bar{A}$, diluting to the required volume and titrating in presence of the paper, the object being to ensure solution of every trace of $PbSO_4$ adhering to the paper. There seems to be no special advantage in this procedure; the results obtained were not particularly good.

Tests 14, 15, 16 were made under what appear to be the best conditions. After settlement and decantation, and washing by decantation with 100 cc. H_2SO_4 (1 : 9), 5 grm. of ammonium acetate was added to the settled precipitate, with a little water and warmed until the precipitate dissolved. [In test 16 it did not completely dissolve at this stage.] This filter paper was then extracted with a further 5 grm. of $NH_4\bar{A}$ dissolved in 20 cc. water and the filtrate united with the rest of the solution. In tests 14 and 15 the precipitate was thus completely dissolved; in No. 16 the small residue was dissolved by addition of another 2 grm. of $NH_4\bar{A}$. The mean factor, calculated from tests 14, 15 and 16 is as follows :—

1 cc. Standard Ammonium Molybdate =

Without correction	10·55 mgr. Pb.
Corrected by Blank	10·67 mgr. Pb.

Results obtained by Application of the Method to the Estimation of Lead in Galena.—A sample marked L9 was crushed to a moderate degree of fineness. Dry assays gave results ranging from 60 to 62% Pb.

The ore was tested as described above. The alternative method was not tried, but was used later for gravimetric estimations.

Test No. 1 was only a rough approximation to determine the limits between which the end-point would be found.

Experimental Work on the Volumetric Estimation of Lead by the Molybdate Method.

Conditions of Standardization and Summary of Results.

Test No.	Lead Foil taken mgr.	End Point of Titration with Molybdate. Un-corrected cc. ±0 1	Corrected by Blank cc.	Equivalent of 1cc. Molybdate in mgr. Pb. Without correction mgr.	With correction mgr.	Conditions. $NH_4\bar{A}$ used grm.	$(NH_4)_2SO_4$ added grm.	Volume before titration cc.	Remarks. [In all cases the $PbSO_4$ precipitate was washed by decantation with 100 cc. H_2SO_4 (1 : 9) before dissolving in ammonium acetate.]
1	200·7	19·3	19·0	10·40	10·56	5			
2	252·1	23·3	23·0	10·82	10·96	5			
3	201·1	19·1	18·8	10·53	10·70	5			
4	300·4	27·3	27·0	11·00	11·13	5			
5	202·8	19·1	18·8	10·62	10·79	5		140	
6	301·1	28·4	28·1	10·60	10·72	5		135	
7	401·1	37·7	37·4	10·64	10·72	5		160	
8	250·4	23·3	23·0	10·75	10·89	5+		96+	A little more $NH_4\bar{A}$ was added to dissolve a precipitate which separated on standing.
9	250·6	23·7	23·4	10·57	10·71	10+		96+	
10	251·4	23·9	23·6	10·52	10·65	17	5	150 -	5 grm. $NH_4\bar{A}$ was first added, then $(NH_4)_2SO_4$, and more $NH_4\bar{A}$ to dissolve the precipitate which was formed.
11	250·6	23·5	23·2	10·66	10·80	12	1	140	
12	200·9	18·7	18·4	10·74	10·92	7		145	Titrated in presence of the filter-paper.
13	401·8	38·3	38·0	10·49	10·57	10		130	Titrated in presence of the filter-paper.
14	200·9	19·1	18·8	10·52	10·69	10		150	
15	300·4	28·5	28·2	10·54	10·65	10		150	
16	400·9	37·9	37·6	10·58	10·66	12		150	
Blank	—	0·3	0·0			5		150	

Test No.	Galena taken grm.	Total $NH_4\bar{A}$ used grm.	Titration + cc.	to — cc.	Corrected cc.	Lead %
1	0·5	?	25	30	—	—
2	0·5	?	28·8	29·0	28·6	61·0
3	0·5	5	29·2	29·4	29·0	61·9
4	0·5	5	29·2	29·4	29·0	61·9

1cc. Molybdate = 10·67 mgr. Pb.

General Remarks.—The method appears to be capable of giving sufficiently accurate results on samples containing a fairly high percentage of lead. The end-point cannot be determined with great exactness; thus if it be assumed that the titration in the assays of galena 3 and 4 above is correct, the true percentage of lead lies between the limits :—

Molybdate cc. (corrected)		Lead %	Lead found Per cent of mean total
28·9	=	61·7	99·68
29·1	=	62·1	100·32

That is, there is an uncertainty of about 0·4%, or 0·7% of the total amount of Pb.

In the case of low-grade material the method can hardly be recommended. To get results of the required degree of accuracy, a large quantity of material would have to be treated. rendering the process very lengthy and tedious ; otherwise the variation due to uncertainty of the end-point would amount to too large a proportion of the total. Thus, in an assay made with 0·5 grm. of an ore containing 5% Pb, the amount of molybdate, corrected by blank, might lie between 2·3 and 2·5 cc., indicating a percentage of lead between 4·9 and 5·3, that is, a variation of about 8% of the total.

Somewhat better results might be obtained by using a weaker molybdate solution for low-grade material, but the sharpness of the end-point would be still further diminished.

Acknowledgement.—The writer desires to express his thanks to the authorities of the Chelsea Polytechnic, in particular to the heads of the Chemical and Metallurgical Departments, Dr. C. Dorée and Dr. W. A. Naish, for facilities accorded in carrying out the researches detailed in these notes.

THE SOUTH TERRAS RADIUM DEPOSIT, CORNWALL

By T. ROBERTSON, Ph.D., A.Inst.M.M., and H. G. DINES, A.R.S.M., A.Inst.M.M.

INTRODUCTION.—Though Cornwall is classed amongst the radium producing districts of the world, the mode of occurrence of its radium-bearing minerals does not appear to have received particular attention. Pitchblende, torbernite, autunite, and zippeite are recorded as accessory minerals in the metalliferous lodes of many of the Cornish mines. At Wheal Trenwith, St. Ives, for example, pitchblende occurred associated with copper ores. In this instance the pitchblende was for many years regarded as an undesirable gangue mineral, but when its economic value was discovered some work was done both underground and on the dumps, though there is no record of the output.

The deposit at South Terras is the only known lode in Cornwall in which the chief minerals are ores of uranium, and it has been regarded as the richest of the Cornish occurrences. The mine has been worked for the greater part of its career as a uranium producer, under private ownership ; and little information on the nature of the lode has hitherto been obtainable. The workings were unwatered recently, when the authors had the opportunity of examining the deposit. The following account is published by permission of the Director of H.M. Geological Survey. The mine is situated in the valley of the River Fal, five miles due west of St. Austell and two miles by road from Grampound Road station.[1]

[1] Maps :—One-inch new series Ordnance and Geological 347 ; six-inch Cornwall 50 N.W. and S.W.

HISTORY.—South Terras mine was first worked on an iron lode coursing slightly north of west and an intersecting tin lode coursing roughly north-east. The radium lode, bearing north, was first encountered in 1873 in the workings on the iron lode near its intersection with the tin lode (Fig. 2). It contained sufficient uranium ore to warrant development, and in 1878 stoping was commenced above adit level. Later the South Shaft was sunk to open up the lode in depth, and the 10 and 20 fm. levels (below adit) were driven, proving a shoot of ore pitching north at about 45°. About 1900 the North Shaft was sunk and the ore shoot between the 10 and 20 fm. levels worked out ; shortly afterwards the mine closed down. It was reopened again in 1906 and the 30 and 40 fm. levels driven, proving the ore shoot to peter out at about the 30 fm. level. The bunch of ore in the shoot was completely worked out by 1909 and development, which had always been costly owing to high pumping charges, was stopped.

The ore was exported for use in the manufacture of glass. Two grades of ore were sold, one averaging around 20% and one around 11% U_3O_8. These grades were made up by mixing high-grade ore, which was found up to 36% U_3O_8, with low-grade ores down to 3% U_3O_8. The waste remaining in the dumps and stope fillings, therefore, contained less than this last percentage.

At the beginning of 1913 the property was taken over by the Société Industrielle du Radium, Ltd., to recover the radium content, and at this time it was estimated that the dumps and stope fillings contained 36 gm. radium in all. During 1913 and 1914 the dumps were picked over and the best material sent to France for treatment. No work was done between 1914 and 1920, but in 1920 and 1921, £3,000 to £4,000 worth of mineral was sold from the stope fillings above the 10 fm. level. The best of the ore now having been picked from the dumps and fillings, there remained ore of such low grade that it did not pay the cost of shipment to France. A treatment plant was therefore erected at the mine in 1922, and radium was produced from March, 1923, till the end of 1925.

In 1927 the present company, the British and General Radium Corporation, Ltd., took over the property with the object of further developing the lode.

Mining Conditions.—The property is exploited by two vertical shafts 500 ft. apart (Fig. 3). The South Shaft is in the lode at surface, and the North Shaft passes through it between the 30 and 40 fm. levels. The shafts are connected by levels driven along the lode at 10, 20, and 30 fm. below adit level. At 40 fm. a level has been driven from the North Shaft towards the south for a distance of 430 ft., but it has not holed through with the corresponding drive from the South Shaft.

Stoping has been carried down to the 30 fm. level on the main ore shoot, and, to a small extent, north of the North Shaft. There are also stopes both north and south of South Shaft on the west branch of the lode. Two winzes connect the 30 and 40 fm. levels, but no stoping has been carried out in this block.

Both shafts are equipped with small hoists and the North Shaft has a single truck cage. The pump is situated at the North Shaft and raises water from the 40 fm. level. As there is no connection between the two shafts at this level, the South Shaft is under water below 30 fm.

The River Fal crosses the surface position of the lode about 120 yds. north of the North Shaft, and the underground water probably comes directly from this source. It should show considerable seasonable variation, but pumping costs must necessarily always be high.

Geology of the District.—The geology of the district is discussed under the following

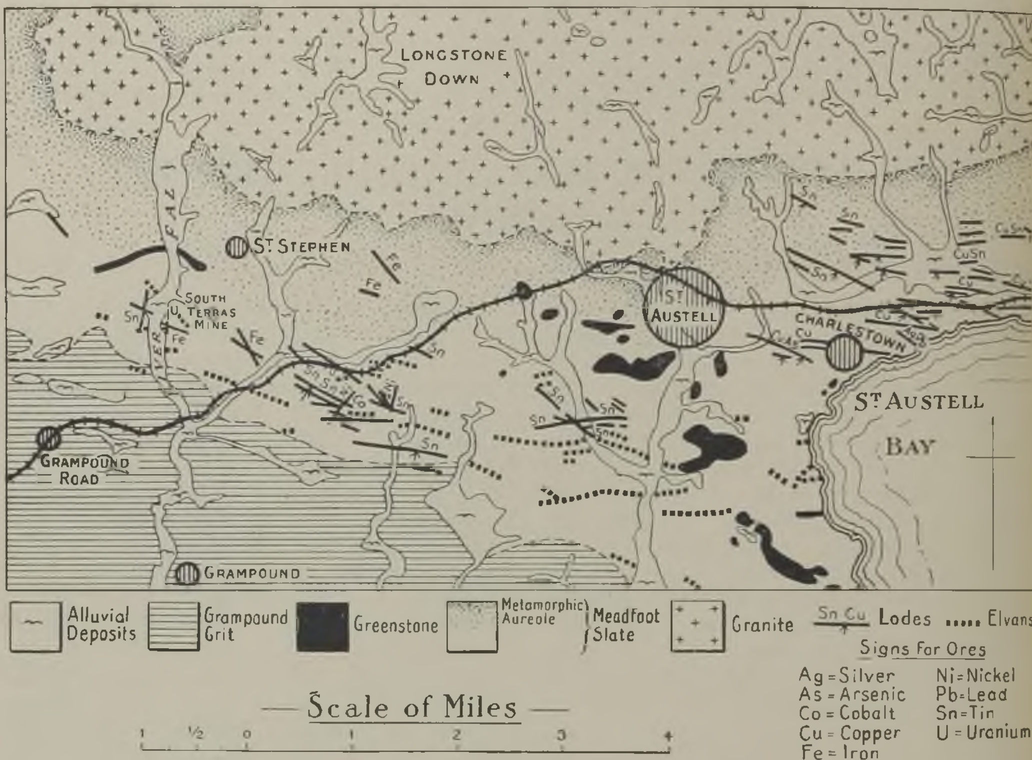


Fig. 1.

headings: (*a*) sedimentary rocks; (*b*) basic igneous intrusions; (*c*) elvans; and (*d*) lodes.[1]

(*a*) *Sedimentary Rocks.*—The lode is in grey and brown slate of the Meadfoot Group of the Lower Devonian, intruded by greenstone and elvan dykes (Fig. 1). The slate is overlain to the south by the Grampound the South Terras workings, parallel to the granite outcrop.

(*b*) *Basic Igneous Intrusions.*—An intrusion of altered greenstone outcrops at the north end of the property (Fig. 2) and it is probable that other smaller intrusions occur within the sett. The presence of garnet and axinite in the dumps of the old workings

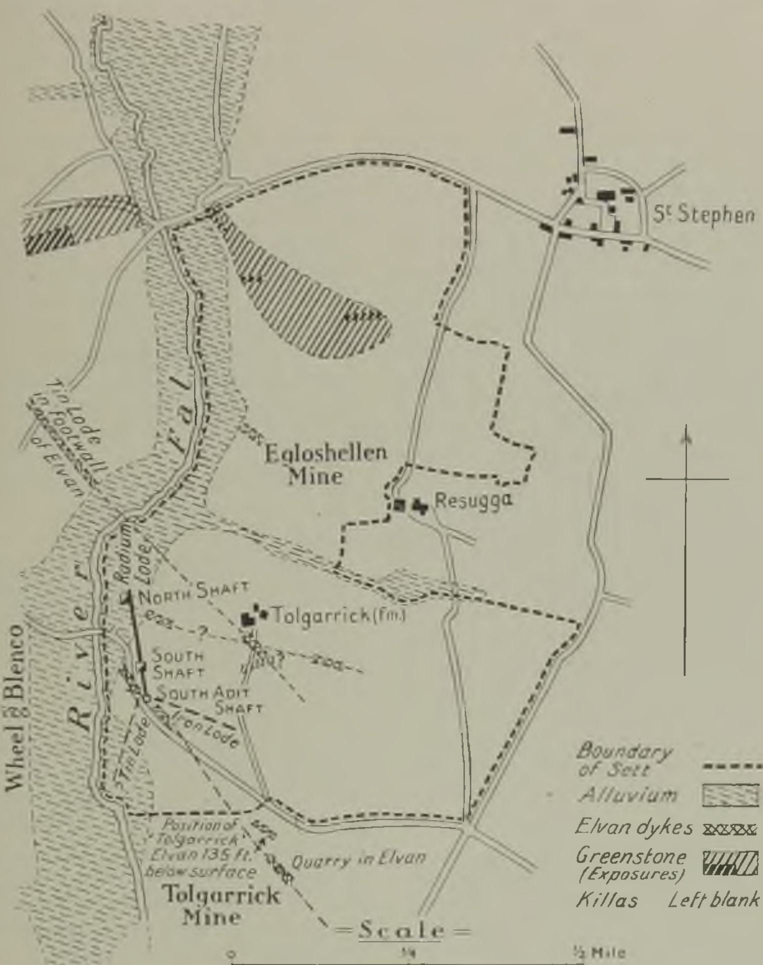


Fig. 2.

Grit, and on the north abuts against the St. Austell granite mass. The extent of the aureole of thermal metamorphism is not definitely traceable, but the southern boundary of sensible alteration in the slate probably runs about half a mile north of on the iron lode show that this lode was probably associated with a greenstone intrusion. For a limited area around the South Shaft at the 20 fm. level the country rock consists mainly of hornblende with quartz and small crystals of pyrite and mispickel. This suggests a tongue or minor intrusion of greenstone. Owing to the relative ages of the greenstone and the lode-filling it is unlikely that the presence

[1] Much of the information in this section is obtained from "The Geology of the Country around Bodmin and St. Austell" (*Mem. Geol. Surv.*), 1909.

of greenstone would have any effect upon the uranium deposits of the district except in the formation of secondary minerals.

Under the microscope these basic intrusions are seen to consist of diabase in various stages of uralitization. The Terras occurrence is ophitic in parts while in others it has a schistose structure. Residual augite is present but is mainly uralitized. The hornblende forms large paramorphs after the augite with occasional cores of pyroxene, and is often compact at the centre but surrounded by a frayed border of fine divergent green prisms. The felspar appears to be andesine. Contact alteration is shown by fresh prisms of green amphibole in the felspar but biotite is not common.[1]

The rock encountered in the workings of the old iron mine is garnetiferous amphibolite, in which the hornblende is dark greenish blue in colour, and occurs as fairly well formed crystals which are embedded in axinite and garnet. Dr. H. H. Thomas, who examined this rock for the Bodmin and St. Austell Memoir states that the axinite shows no crystalline boundaries, but is remarkable for its pleochroism, which locally is unlike any other axinite recorded in Cornwall. In some parts of the rock the mineral is colourless, and in others presents the usual pleochroism ranging from pale plum colour to yellow, but a good deal of the axinite has a most unusual pale blue colour, the pleochroism ranging from sky-blue to palest yellow. The garnet is a pale coloured variety, strongly birefringent especially in the outer layers of the crystals. The occurrence of magnetite in association with axinite, garnet, and abundant green hornblende points to metamorphism by pneumatolytic agencies.

(*c*) *Elvans.*—There are numerous small isolated exposures of elvan in the neighbourhood of South Terras. These dykes, which are associated with the granite intrusion, represent a later stage of igneous activity, and in age immediately precede the deposition of the metallic minerals in the vein fissures. The elvans are frequently looked upon as having some bearing upon the trend or continuity of the lodes associated with them. The area around South Terras is mainly agricultural, and exposures are too few and evidence too scanty to admit of precise correlation of the various known occurrences. At least two well-defined elvans cross the Fal valley near South Terras and pass through the property from south-east to north-west, and one of them is encountered underground in levels of the mine. It has been suggested [1] that the elvan quarried for road-metal at Brannel has an underground connection with the elvan at South Terras mine, and, possibly arising out of this suggestion, it has been said that a green incrustation, reputed to be torbernite, has been found in cracks in the Brannel elvan. An examination in the field has not, however, confirmed this.

Immediately south of the South Terras sett lies a property known as Tolgarrick mine, on which much development work has been done recently in hopes of picking up the southward extension of the South Terras uranium lode. The search for this lode has not as yet been successful, but an elvan has been encountered underground from which a considerable quantity of radioactive water enters the mine. As measured in the mine gallery this elvan has a bearing of about W. 40° N. and a thickness of 28 ft. It seems improbable that the elvan itself contains original radioactive minerals and the most likely explanation appears to be that the water, before finding its way into the mine workings, passes through a radium-bearing lode fissure, possibly that of South Terras.

The elvans are of the usual type, being granite porphyries of pale shades of pink, green, and grey. A microscopic examination shows that they consist of idiomorphic phenocrysts of quartz and felspar in a fine to medium grained quartz-felspar base. In all cases felspar occurs as inclusions in the quartz phenocrysts. The primary constituents in each of the occurrences examined are identical, but on their products of secondary alteration they can be divided into two distinct classes, one with abundant tourmaline, and the other with little or none. Specimens falling under the first class were obtained from quarries or open-workings on either side of the road, a third and a quarter of a mile north by west of the mine (Nos. 14514 and 14526),[2] from the lane just south of Tolgarrick farm (14524), and from a surface exposure on the west bank of the River Fal near Wheal Blenco (14505). In thin sections these are all seen to be highly

[1] "Geology of Bodmin and St. Austell District," *Mem. Geol. Surv.*, 1909, p. 48.

[1] Ussher, W. A. E. H. "The Geology of the Country around Bodmin and St. Austell" (*Mem. Geol. Surv.*), 1909, p. 71.

[2] Numbers in brackets refer to specimens and microscope slides in the rock collection of the Geological Survey.

tourmalinized and to contain many patches of gilbertite. No felspars are present, and the tourmaline, which includes both blue and brown varieties, occurs in clusters apparently replacing felspar phenocrysts, as well as being scattered through the fairly fine-grained ground mass. The positions from which specimens 14514, 14526, and 14524 were obtained are in alignment north-west by north and the occurrences may presumably be situated on the same elvan.

in small grains in the ground mass in varying amounts. The specimens (14506 and 14507) from the 20 fm. level in South Terras mine were taken near the lode and are heavily charged with pyrites, and these specimens as well as that from near the iron lode (14527) carry small phenocrysts of apatite. The elvan at Brannel, above referred to (14518), shows similar characteristics to this group but carries more chlorite after biotite.

The exposures from which Nos. 14506,

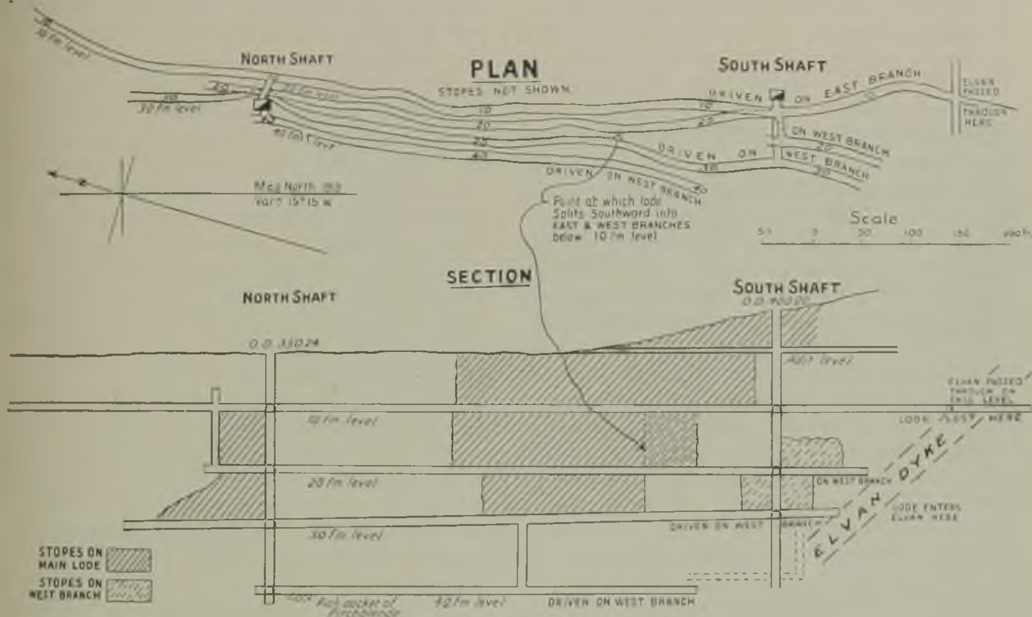


FIG. 3.

Specimens of the second class of elvan, containing little or no secondary tourmaline, were collected underground at South Terras mine (14506 and 14507), near the mine dressing plant (14512), just west of the quarry on the old iron lode (14527), underground in Tolgarrick mine (14515), from a quarry in a field, one third of a mile east of South Terras mine (14508), and on the east bank of the River Fal, one third of a mile north of the mine (14520). Under the microscope these show the usual fine-grained ground mass with well formed phenocrysts of quartz and felspar. The latter shows various stages of alteration to quartz and biotite, and in the less altered specimens exhibits multiple twinning in most cases. Blue tourmaline occurs in very small crystals usually associated with some biotite. The biotite is usually secondary, of greenish-brown colour, and in some specimens is associated with chlorite. Muscovite and biotite occur

14507, 14515, and 14527 were obtained lie on a straight line coursing north-north-west. This line includes both the elvan in the South Terras mine and that in Tolgarrick mine and suggests that these may be one and the same. The radioactive character of the water from the Tolgarrick elvan is significant in this connexion.

(*d*) *Lodes*.—In the area south of the St. Austell granite mass the Meadfoot slates are traversed by numerous mineral lodes (Fig. 1). These have a general trend approximately east and west, or parallel to the margin of the granite, but a number cross the general direction more or less at right angles. The lodes with an east and west trend are mainly tin and copper bearing and represent the earliest stage of mineralization, being characterized by minerals which crystallize out at relatively high temperatures. The lodes coursing north and south, on the other hand, carry such minerals as ores of cobalt, nickel, lead, uranium, and iron, with, in some instances, a little arsenic and copper pyrites. These lodes may be regarded as of later date than the tin and copper lodes, an assumption that is borne out by the fact that in many cases the north-south lodes are known to be mineralized cross-courses dislocating the east-west lodes. These later lodes fall naturally into two classes; namely, those carrying iron and those carrying cobalt, nickel, and uranium, and it is probable that the two classes are not contemporaneous.

A clear example of the relation between the north-south and the east-west lodes is afforded by St. Austell Consols mine,[1] 2 miles east-south-east of South Terras, where the main lode courses E.25°S. and is crossed by a series of north-south veins. The main lode carried tin and copper ores, with arsenic and some cobalt here and there, but no nickel or uranium ores. The nickel, cobalt, and uranium occurred mainly in the north-south cross-courses, the richest of which crosses the main lode in the western part of the sett, carrying cobalt and nickel as kupfernickel and smaltite. It is worthy of note that where copper ore occurred in the cross-courses, nickel was absent, and that the uranium occurred mainly at the sides of the cross-courses, but occasionally in the middle. This would suggest that the uranium was one of the latest minerals to be deposited, probably forming in cavities produced by widening of the mineralized fissure. The association of barytes with the minerals in this mine is also significant; there appears to be no record, however, as to whether it occurred in the main lode or in the cross-courses, though the probability is that it was found in the latter.

The South Terras uranium lode courses north and south, and there are records of uranium ores having been found at New Crowhill mine, about three-quarters of a mile to the south, and at Egloshellen mine to the north. In the latter it is said that torbernite occurred at the intersection of a north-south iron lode and an east-west tin lode, and not as a lode mineral.

The Radium Lode.—Details of the radium lode are discussed under the following headings:—(*a*) the lode, (*b*) the effect of the igneous intrusions on the lode; (*c*) the lode filling; (*d*) development work on the lode.

[1] Williams, H. R., *Rep. Roy. Inst. Corn.*, 1858, Appendix vii, p. 32; and D. A. MacAlister in "The Geology of the Country around Bodmin and St. Austell" (*Mem. Geol. Surv.*), 1909, pp. 155, 156.

(*a*) *The Lode.*—The trend of the lode is a few degrees west of north, and the underlie about 10° west, although in some places it is nearly 30°.

The lode is a typical fissure vein with a quartz gangue. It is well developed and persistent and, in general, shows well defined slickensided walls. The width varies between ½ and 3½ ft. and averages 2 ft. About 100 ft. north of the South Shaft, below the 10 fm. level, the lode splits southward, and south of the shaft the workings follow the west branch, the east branch having pinched. The 30 and 40 fm. levels are also driven on the west branch, the east branch at these levels not having been traced (Fig. 3).

(*b*) *The Effect of the Igneous Intrusions on the Lode.*—The south end of the sett is traversed by an elvan, already referred to. This courses roughly south-east and north-west and underlies north-east at about 45°. It was driven through at the south end of the workings on the 10 fm. level and touched on the 30 fm. level. On the 10 fm. level the elvan is 50 to 70 ft. thick and is mineralized on both walls with sulphides. On this level the lode (east branch) is poorly mineralized, if at all, for some 60 ft. north of the elvan, and has not been traced through the elvan or on its south side. The 30 fm. level is driven just into the elvan and the lode is here seen to penetrate it still carrying low values. This, however, is the west branch of the lode.

The altered greenstone, referred to above as forming the country rock on the 20 fm. level near the South Shaft is hard, and the lode in passing through it appears to split up into at least two narrow parallel branches a few feet apart.

(*c*) *The Lode Filling.*—Quartz generally occupies the full width of the lode and shows a comb structure indicating successive stages of deposition. In places there are inclusions of killas, often silicified, occurring either as a fault breccia or as shear lenticles. On the foot-wall, in many places, occurs one or two inches of soft greenish clayey material (flucan). In one or two places, notably near the elvan on the 10 fm. level, the infilling consists solely of crushed killas.

Apart from the ore-shoot, metallic minerals are scanty. They occur usually as small scattered crystals either in the quartz or lining vughs. There is no indication of the pitchblende having been confined to any particular portion of the width of the lode, though it is said to have occurred as stringers near the walls.

The metallic minerals recorded are as follows :—Pitchblende, torbernite, autunite, and zippeite, together with iron and copper pyrites, mispickel, galena, and traces of nickel, cobalt and chromium ores. The only published information regarding the occurrence of radium ore in the shoot is by J. H. Collins.[1]

Regarding the lode above the 20 fm. level he states as follows :—" The Jim lode is from 2 to 4 ft. wide. Only a small leader, however, consists of this valuable ore (of uranium). Up to the present the leader has been traced for about 150 fathoms, varying from a mere knife-edge up to 7 or 8 inches in thickness. The ore occurs in beautiful light green, yellow, and brown flakes, scales, and crystals, mostly as phosphates of uranium, copper, and lime (autunite and torbernite), or as the hydrated oxide known as zippeite. . . . . Some specks of the hard and heavy pitchblende have, however, been seen, . . . " He also states that pitchblende was the only uranium mineral found in the lode at 30 fm. This is due to secondary alteration of the original pitchblende in the higher levels to calcium and copper uranites. Only small incrustations and stains of autunite and torbernite are now found in the dumps but good specimens were formerly obtained.

(*d*) *Development Work on the Lode.*—All the known payable uranium ore from the lode was obtained from the ore-shoot. Beyond this all the exploratory work has been done in ground which shows sporadic values of radium, but, on the whole, the average run of the proved lode is below the minimum workable value. The prospects of the mine therefore depend on the discovery of further shoots.

(1) Northward.—Except for a drive on the 10 fm. level which extends 320 ft. north of the North Shaft, and almost reaches the boundary of the sett, little exploratory work has been done in this direction. At the north end of the mine the lode is well developed and varies in width between 2 ft. 5 in. and 3 ft. The present company has now started to drive northwards on the 30 fm. level.

(2) Southward.—On the 10 fm. level the lode is pinched on the north side of the elvan, and the drive through to the south side has not proved the lode either in the elvan or in the killas beyond. This drive, however, is on the east branch which was abandoned on the lower levels, and it is uncertain whether the drive actually follows the branch.

On the 30 fm. level the lode (west branch) is seen to penetrate the elvan, but the drive does not enter the elvan sufficiently to show in what manner the lode is affected by it. There are some 900 ft. of ground, in the plane of the lode between the present workings and the south boundary of the sett. It is intended shortly to develop the mine in this direction.

(3) In Depth.—In view of the richness of the ore-shoot already exploited and of the fact that the workings extend to no great depth, there are possibilities in sinking deeper on the lode. This is, to some extent, supported by the occurrence of a small bunch of rich ore which was found in the floor of the 40 fm. level near the North Shaft.

[1] " West of England Mining Region," *Trans. Roy. Geol. Soc. Corn.*, vol. xiv, 1912, p. 242.

BOOK REVIEWS

Applied Geophysics in the Search for Minerals. By A. S. Eve and D. A. Keys. Cloth, octavo, 250 pages, illustrated. Price 12s. 6d. Cambridge: The University Press.

Even a casual glance at the periodical literature devoted either to mining or to geophysics will reveal the growing importance of the recently developed science of Applied Geophysics. Hundreds of articles scattered throughout numerous journals and transactions of societies testify to the widespread interest evoked by the attempts now being made to peer into the crust of the earth by geophysical methods. The mining engineer is anxious to assess the exact significance of each of the many methods employed, and is confronted by a mass of literature much of which is indigestible and incomprehensible theory poured forth by pure geophysicists, while the remainder is largely propaganda by the technical representatives of the many commercial organizations engaged in executing surveys on a remunerative and competitive basis. The need was urgent therefore for an authoritative exposition of the principles and practice of Applied Geophysics, written by someone free from commercial entanglements, and yet having sufficient technical knowledge to appreciate thoroughly the scientific basis of the various methods and the technical difficulties involved in the field procedure, together with actual experience of each method. The book under review admirably fulfils this requirement. The authors are scientists of established reputation and have no commercial axe to grind. They have produced a work which is sufficiently comprehensive to merit the title "treatise," yet which is eminently readable and intelligible ; which is, in short, just what the mining engineer requires. Certainly, if he is to appreciate fully the principles of the methods, he will need to be something of a physicist and a mathematician. Alternatively he will have to take the formulae for granted, with the assurance that they are more reliable than the average engineering formulae in which he is wont to put his trust. Nevertheless, he can scarcely fail to recognize the fundamental sincerity of the authors' judgments regarding the applicability of each method.

This book, however, is more than an exposition of methods designed to assist the mining engineer and geologist. It is definitely a carefully arranged treatise suitable to serve as a text-book for applied geophysicists in embryo, for whom there is a growing demand. Having for some years deplored the non-existence of such a text-book, the reviewer can testify to the valuable assistance which this publication will afford.

Finally, even the expert practising geophysicist, who is familiar with the current literature on the subject, will find much to interest him in this work. To him it will serve as a useful digest of all the methods, particularly of those which have been most recently developed. Several of these latter are more elaborately expounded than in any previous account ; for example, the Earth Resistivity Method, which is one specially tested by the authors.

The only criticism which might be applied to the book is the tendency to over-elaborate the electrical methods, as compared with the gravitational and seismic methods, the two latter methods conjointly only occupying about one half the space devoted to electrical methods. This apparent bias on the part of the authors may not unjustly be attributed to the nature of their practical experience, since their actual tests have been for the most part restricted to regions where electrical methods were most suitable. On the other hand they might claim that the variety of electrical methods justifies the special allocation of space to their exposition.

H. Shaw.

Geophysical Prospecting. Cloth, octavo, 676 pages, illustrated. Price 30s. New York : American Institute of Mining and Metallurgical Engineers.

Two years ago the American Institute of Mining and Metallurgical Engineers established a Committee on Geophysical Methods of Prospecting, which, in an effort to bring together existing data concerning geophysical prinicples, methods and results, presented its first programme at the New York meeting of the Institute in February, 1928. So active was the discussion on this occasion, that it was decided to make "Geophysics" the main subject at the Boston meeting in the following August. The papers and discussions presented at these two meetings form the basis of the publication under review.

In selecting the papers for this volume, the aim of the Committee has been "to make available to the mining public sound information concerning the principles underlying the various methods now in active use, to provide examples of current practice and results, and to afford opportunity to specialists to publish recent achievements and to receive the benefit of criticism and discussion by their colleagues."

The book, which contains a collection of 27 individual papers, is divided into separate sections dealing respectively with the general, electrical, magnetic, gravity, and seismic methods. Papers are included in each group on the general principles and theory of the methods, on instrumental development, and also on the results of recent practical surveys. The interpretation of results, a branch of the subject upon which little has hitherto been published, is also considered, while in nearly every case the discussion which followed the presentation of the paper is added, forming a most interesting and instructive feature.

As may be expected, there is a noticeable unevenness in the standard of the papers ; a few frankly address the specialist, while others aim to present the fundamental principles of the subject to mining men who desire merely a general acquaintance with the methods, in order to judge of their economic value in particular cases. To those interested in applied geophysics the book is to be recommended, for it contains much detailed information on many branches of the subject which is not obtainable elsewhere.

H. Shaw.

Ore Deposits of Magmatic Origin: Their Genesis and Natural Classification. By Prof. PAUL NIGGLI, Zurich. Translated by Dr. H. C. Boydell from the original German edition, revised and supplemented by Prof. Niggli and Dr. R. L. Parker, Zurich. Cloth; octavo, 104 pages. Price 9s. 6d. London: Thomas Murby and Co.

By making accessible to a wider circle of English-speaking mining geologists this important contribution to the study of ore deposits, the translator has rendered a valuable and disinterested service to his profession. The translation itself has been done extremely well. The dozen or so errata are mainly typographical and call for no special comment.

On a consistently genetic basis Niggli re-classifies ore deposits of magmatic origin only. For ore deposits in general, no classification hitherto devised is wholly "systematic": morphological, genetic, and other criteria are not applied consistently. Niggli indicates the possibility of applying one general geological principle as the criterion whereby any type of mineral deposit may be assigned to a perfectly definite position in a system. Dealing specially with ore deposits of magmatic origin, he re-examines the world's occurrences from a physico-chemical view-point and shows that the problems such deposits present are inseparable from those with which the petrologist is primarily concerned.

In Chapter 1 he expounds the physical chemistry of ore-generating magmas and the various stages in the evolution of residual solutions, etc. He proceeds (Chapter 2) to a minero-chemical classification of ore deposits genetically related to magma, and distinguishes between plutonic (intrusive) and volcanic (extrusive) types and associations. In Chapter 3 he applies this classification to a general review of such deposits: their distribution in time and space; their emplacement in relation to the earth's major structural features and, finally, their provincial and regional relationships, thus bringing the problems of magmatic ore deposits in parallel with those of petrogenesis. In a brief preface to the translation Dr. Boydell admonishes mining companies for "their present attitude of indifference towards, and neglect of, geological research with respect to their chief asset, their ore deposit." Not a few British mining companies may be acquitted of the general charge. Nevertheless, the issue raised merits the consideration of all who are directly or indirectly concerned with the location and development of ore deposits. The particular needs of the case might conceivably be met by the formation, ad hoc, of yet another Scientific and Industrial Research Association. A. BRAMMALL.

Structure and Surface: A Book of Field Geology. By C. BARRINGTON BROWN and F. DEBENHAM. Cloth, octavo, 168 pages, illustrated. Price 10s. 6d. London: Edward Arnold and Co.

Ability to read a geological map does not necessarily imply ability to visualize sub-surface structures in relation to surface relief over an *area*, as distinct from a prescribed traverse or section line. Difficulty in "seeing solid" is experienced by most beginners and in occasional cases it may prove chronic. So long as the difficulty persists it is a serious hindrance to progress in field-mapping, for ability to recognize the possible significance of surface features may define purpose and govern procedure in the field.

To the difficulties peculiar to this aspect of field geology the authors of *Structure and Surface* have applied themselves with complete understanding, and, we would add, with consummate skill. By means of "solid perspective" drawings (stereograms or block diagrams) showing both landscape and depth-structures, they present structural features in ideal relation to major and minor land forms. The device is not of course new; its utility was demonstrated in masterly fashion by W. M. Davis, whose influence the authors generously acknowledge; but outside American publications it has been only sparingly used hitherto. It is, however, the outstanding feature of this book, which contains at least 133 original stereograms; of these, a score illustrate actual areas and include sixteen based essentially on sheet maps published by the Geological Survey of Great Britain. A dissected block diagram of England and Wales appears as an Appendix.

The scope of the book covers a liberal "first course" in structural geology and the evolution of landscape. The first ten chapters carry the beginner to a stage at which he may enter upon the study of complex tectonics such as are exemplified by the Scottish Highlands or the Alps. The last two chapters expound the simple laws of perspective drawing which must be obeyed if a block diagram is to look " natural " : instructive chapters indeed to the draughtsman, (who, it is assumed, must be something of an artist too). Two appendices, covering 13 pages, are devoted to field equipment and practice, though it may be stated that every chapter bears the stamp of the practical field man. Chapter VI (on faulting and fault features) is a particularly good example of lucid exposition based on field experience. A brief reference to the horizontal (blatt or tear) component of some fault movements would have rendered this section complete.

Both style and presentation (sequence and treatment alike) are beyond criticism, and only a few printer's errors have escaped the proof reader. Interest and breadth are added by passing reference to various physiographical facts and features not directly related to subsurface structure.

A slip occurs in the text matter referring to Figs. 104 and 105 : the compass-bearing on X from station B cannot be as stated. The approximation on page 46, and the orientation-symbols in Figs. 60, 64, and 82 lead to ambiguity. In connection with normal faulting, the expression " downthrow is down the dip " (Fig. 48) is misleading, but " downthrow up the dip " is surely inadmissible (Fig. 49) ; throw " with " or " against " dip conveys a clearer idea, and this expression is used in the text (pp. 76–84). Other errata are few and trivial.

A. Brammall.

Sintern, Schmelzen und Verblasen sulfidischer Erze und Hüttenprodukte. By Dr. Ernst Hentze. Paper covers, 405 pages, illustrated. Price 46.50 reichsmarks. Berlin : Julius Springer.

This work treats of the smelting of sulphide ores in very much detail, the processes dealt with being essentially those of smelting matte and blowing the matte up to metal. The author deals exclusively with sulphide ore and is thus led to a somewhat unusual definition of direct and indirect smelting. He defines the reduction of a metallic oxide by reducing agents in the furnace as indirect reduction, and the production of metal by the reaction between metallic sulphide and oxide in an oxidizing furnace atmosphere as direct reduction, the reason apparently being that in the former case it is necessary to convert the sulphide of the original ore into an oxide, while in the latter case the process can be applied to sulphides such as exist in the natural ore, although the operation is generally preceded by an enrichment of these sulphides, namely their conversion into matte. It is quite in line with this treatment of the subject that the author does not describe the blast-roast processes, such as those of Huntington-Heberlein, and treats of the Huntington-Heberlein appliance merely as a method of sintering. As such he describes the last named process, the Greenawalt and Dwight-Lloyd appliances in considerable detail, but does not consider them as processes for converting sulphides, for example, galena, into oxides which are subsequently to be reduced by carbonaceous matter. The author divides his book into eight main chapters ; the first deals with general considerations, the second describes the various sulphide ores and metallurgical products together with the necessary fuels and fluxes and the preparation of these ores for direct smelting. He devotes a few pages to the flotation process, particularly to selective flotation, but it cannot be said that the very superficial treatment of this subject is of any real value. The third chapter deals with briquetting, agglomerating, and sintering fine ore. The fourth chapter deals with slags, the fifth chapter with mattes, while the sixth chapter, the longest in the book, deals with the blast-furnace in which the ores are smelted. He begins by the statement that at the present day only water-jackets are used for smelting these ores, and describes the construction, the principles, and the working of these furnaces in much detail. The seventh chapter is devoted to the conversion of matte into metal in the converter, or analogous appliances ; incidentally he devotes a few pages to the Knudsen process introduced in the beginning of this century at the Sulitjelma mines in Norway. The last chapter is devoted to the gases and flue-dust given off from the furnace and their treatment. The work is written from a thoroughly practical as well as from a scientific standpoint, and although many portions might be condensed with advantage, the book must, nevertheless, be looked upon as a valuable contribution to the subject and one which will be of use to all engaged in such operations. At the same time it must be borne in mind that the author has kept strictly within the limits which he has laid down for himself, and omits altogether, for example, the subject of smelting in the reverbertory furnace. The illustrations are clear and most of them are fully dimensioned, though in many cases the addition of a scale would undoubtedly be an advantage.

HENRY LOUIS.

Gmelin's Handbuch der anorganischen Chemie, 8. Auflage. Eisen, Teil A, Lieferung 1. Paper-backs, quarto, 224 pages. Price 33 marks, to subscribers 26 marks. Berlin: Verlag Chemie.

The publishers of this handbook evidently intend it to be a reference book for geologists and metallurgists as well as for chemists. The section now published (224 pages) is a portion of the first of two parts of the volume on "Iron"; the remainder will be published from time to time as soon as it is ready. Part A should be of great value to those connected with the mining, manufacture, and use of iron, for it deals with its history and occurrence, and with the properties of the metal and its alloys; Part B will be devoted to the chemistry of iron.

The historical section of Part A contains a complete bibliography of the literature dealing with this metal. It traces the growth of knowledge about it from prehistoric time to the present day, and is classified into a number of sub-sections, under headings such as "centuries," "countries," and "processes," which make reference easy. The bibliography occupies 59 pages.

In the section dealing with the occurrence of iron, the various modes of ore-genesis are discussed, and a detailed account is given of the distribution of iron-ore throughout the world. The crystallographic, petrological, and physical properties of iron minerals, and of all minerals containing a substantial proportion of iron, are fully described.

A chapter is devoted to a full description of methods of preparing pure iron electrolytically from various kinds of baths, and chemically by reduction of salts. The final chapter of the present section of Part A describes the various forms in which pure iron can be prepared.

The text is fully annotated, every statement of importance being accompanied by references to the sources from which the data was obtained.

M. S. FISHER.

NEWS LETTERS

JOHANNESBURG

August 8.

NITRATE DEPOSITS IN SOUTH-WEST AFRICA.—According to a statement made by Professor Smeath Thomas of the Capetown University during the British Association discussions in that city, the nitrate deposits in South-West Africa have been traced over an area of 10,000 square miles, but further investigations and prospecting are necessary to establish the actual extent and richness of the deposits. Samples of the primary deposits analysed have been found to contain from 2 to over 20%, and in the secondary deposits up to as much as 86% of sodium nitrate. Professor Thomas stated: "The area starts from Mariental in the north, and moving fifty miles eastward towards the Kalahari you come to a place called Stampriet in the Auob River Valley. As you go along farther eastwards towards Bechuanaland you come across two more rivers, the Elephant and the Nossob. These rivers cut into a regular plateau, forming channels, and in these places you find lines of cliffs, and that is where the discoveries of nitrates have been made. The presumption is that the deposits are really continuous along the plateau, but that is a point which has yet to be proved. But we have at any rate traced the deposits in each of the river valleys and the nature of the rock is continuous, and it is therefore a pretty strong assumption that the nitrates will also be found along the whole of the area mentioned. The deposits are very free from iodine, so far as we have tested them, and the phosphate content is low.

"With regard to transport," Professor Thomas added, "the railway is at a distance of about 50 miles, but I think it safe to say that the South-West Administration is sufficiently interested in the deposits that the question of railway transport, once the deposits are proved to be economically workable, will offer no great difficulties. With regard to the cost of working the material, it is not for me to say, but I think from comparative figures that have been prepared, that, once it is proved that you have extensive deposits containing from 10% sodium nitrate upwards, you can get a reasonable margin of profit, anything up to £3 or £4 per ton."

DIAMOND FIELDS OF TANGANYIKA.—Prospecting operations in the Shinyanga district, Tanganyika Territory, within the last twelve months have resulted in the discovery of eleven pipes, eight of which contain diamonds, but so far no payable kimberlite deposit has been proved. There is much thick bush in this area, also big stretches of sticky black turf, which are material handicaps to geological exploration. At the present time, the Administration has a large force of native labour employed in clearing stretches of bush country. It appears to have been proved locally that the tsetse fly is a bush dweller and does not attack game or cattle in the open, so that clearing the bush is partly an attack on this pest. A very big percentage of the soil thus overgrown is arable land, and very soon after clearing is done the land is available for pasture or agriculture. A bigger area of such land is required for the support of the increasing native population. Incidentally, clearance makes it possible for the geologist to examine an increasing area, so that mining as well as agriculture and pastoral pursuits will benefit.

Two discoveries of kimberlite are reported to have been made lately on the Central Diamond Mines areas at Iduhe, about 37 miles north-east of Shinyanga, and at Negesi, about 20 miles from the latter place. The hope has been expressed by the Controller of Mines that this company and Tanganyika Diamonds, Ltd., will continue to devote some capital to the work of prospecting. He informed Mr. H. S. Harger, consulting geologist, that the Governor would grant permission to make any surface inspections desired in Shinyanga district. As the Governor and Controller of Mines have evinced a desire to meet all requests and help in every possible way, Mr. Harger has no hesitation in recommending the board to provide up to £10,000 for this purpose. The work shows that Shinyanga district contains many kimberlite occurrences, and diamonds of large size and good quality. Further search for a payable diamond mine is therefore fully justified.

The diamondiferous alluvial gravels on the Central Diamond Mines' Block A property in the Shinyanga district were exhausted by the end of January this year, having lasted six months and proved highly payable. The total number of loads washed was 14,469, after deducting rough screenings, and the yield was 1,607·89 carats, or 11·1 carats per 100 loads. The average value per carat was £6 9s. The quality was of high grade. Coloured stuff such as yellows, browns, and greens were almost absent. The prices for individual stones reached up to £50 per carat. No less than 27 stones of 10 carats and over were found, the largest being 39 carats. The origin of the diamonds is a matter which has given Mr. Harger a great deal of thought on account of the perplexing fact that neither the Sultan mine nor the Baobab mine yielded anything larger than 4½ carats. The very high quality of the large white stones in the gravel makes the discovery of the source a matter of the first importance.

The New Coalfield.—Many blocks of claims have been pegged by South African and Rhodesian mining groups in the new coalfield near the Kafue River, Northern Rhodesia. This region which is situated some 140 miles west of Broken Hill, is commonly known as the Hook of Kafue. It contains the Silver King, North Star, Hippo, Wonder Rocks, and other copper mines which figured prominently in the mineral industry of Northern Rhodesia some years ago. In this area the Kafue Copper Development Company controls a large block, and the S.A. Townships Company has a concessionary area, which was thrown open to prospecting a few years ago. Hitherto the region has engaged attention almost entirely on account of its copper-producing possibilities, but the prospects of opening up a coalfield there appear recently completely to have overshadowed the base metal outlook. Preliminary reports as to the quality of the coal are not of a very optimistic nature. Nevertheless, it is a fact worth noting that the Wankie Colliery Company, the only coal-producing concern in Rhodesia, has pegged 44 blocks of claims in the Northern Rhodesian field, and that many other companies have secured large holdings there.

A New Extraction Process.—A syndicate has been formed in Johannesburg with the object of introducing to the mining industry an extraction process devised by Mr. G. P. Davidson. A testing plant has been erected in Johannesburg, and it is proposed to receive samples from those mines where difficulties are met with in the matter of recovery. The process itself has been tested upon a considerable quantity of Black Reef material, mainly sands which have already passed over the mill plates. Mr. Davidson states that this test has demonstrated that "all the metallic contents of Black Reef ores can be economically recovered in one amalgam by chemico-electrolytic amalgamation, even the very minutest particles of both gold and the metals of the platinum group being caught by this means, no free metal whatever being allowed to escape into the residues." All this can be done, he adds, at a cost for chemicals of less than 6d. per ton of ore treated, and with a comparatively speaking inexpensive plant and without the necessity of any preliminary concentration. The principle involved is that of a galvanic current generated by a suitable acid solution upon a copper plate coated with zinc amalgam. There is thus no external current required and the amalgamating surface is kept clean and active. The smallest particles of gold and platinoids, which usually resist all effort to catch them by ordinary means, are said to travel quite definitely towards the plate and to be effectively amalgamated, as far as Black Reef ores are concerned. It remains to be seen how far the process will be efficient upon other ores in this country and Rhodesia that are commonly described as refractory.

Important Discovery of Asbestos.—What is believed to be a particularly important discovery of chrysotile asbestos has been made on the farms Rietfontein and Victoria's Poort, in the Carolina district, Transvaal. Some of the fibre is described by experts as the highest grade of white spinning material ever produced in Africa and worth at least £150 per ton. Extensive deposits have been opened up on either side of a valley running through the farms. On the left bank at least five valuable horizons have been disclosed, succeeding one another at intervals of about 20 ft. These contain a high percentage of somewhat coarse fibre, which, starting practically as a fine ribbon rock at the outcrop, makes into longer lengths up to three and four inches when driven on. On the right bank a lower horizon than those mentioned has lately been uncovered and contains the soft white fibre referred to. Geologists apparently object to the occurrences because they are in what was originally dolomite, though the latter has since been so completely serpentinized that chemically there is no evidence now of origin. Improvement in depth as shown in this case rather weakens their objections, and it looks as though exploitations will negative them altogether.

A Railway to the Chrome and Asbestos Fields.—A representative of the South African Railway Administration has been investigating the areas in the Lydenburg district, Transvaal, where the chrome and asbestos mines are situated, with a view to making a report on a proposed extension of the line which terminates at Steelpoort Station. It is stated that about fourteen miles of line will be added, and the route favoured is that from Steelpoort Station in the direction of Mooihoek. The Railway Department will be asked for 20 miles instead of 14, as this would bring the Penge asbestos mine within nine miles of the railway, whereas the distance is now 20 miles to Burgersfort siding. The Chrome Corporation, which is working the farm De Grootboom, 4½ miles from the railway, will be able to double its output should the line be extended to that farm.

Aeroplanes for Mining Engineers.—It seems likely that the Anglo-American Corporation will follow the example of the Lewis and Marks Group and purchase an aeroplane to enable its officials to save time in visiting properties controlled by the Corporation in Northern Rhodesia and in Namaqualand and South-West Africa. The railway journey from Johannesburg to the copper fields of Northern Rhodesia occupies six days, whereas the distance could be covered by a large aeroplane in one day.

BRISBANE

July 16.

Mount Morgan.—The advertising for sale of the Mount Morgan assets has resulted in real business being done and in the definite announcement that this famous mine will be again started. These assets have been bought as a whole for £70,000 by a syndicate, which plans working the mine in a manner that will, it is believed, result in its profitable operation once more. The purchasers are apparently those who endeavoured to form the third company to take over the property, and the negotiations that have now reached finality have been in progress for eight months. The board of the syndicate includes a well-known Queensland grazier (Mr. J. H. Kessell), several Sydney investors, and Mr. A. A. Boyd, who was for many years manager of the Mount Morgan Company, as well as Mr. R. T. Thompson, the former secretary of the company. The new owners have already taken possession of the property from the liquidators. A new company, floated with a capital of £100,000, is to take over from the syndicate all its rights in the purchase of the mine.

The capital of the old Mount Morgan Company was £1,000,000, on which it was proved for several years that operations could not be profitably carried on ; but the new company believes that, with its much smaller capitalization, a satisfactory return can be realized. Ever since the old company went into liquidation a small quantity of copper has been regularly obtained by precipitation from the mine water, and this production is to be continued, probably on a larger scale. It is intended that operations will at first be carried on upon a small, but gradually increasing, scale. When normal productive operations ceased eighteen months ago, it was estimated that 8,000,000 tons of ore remained in the mine. It is now pointed out, however, that there are at least 700,000 tons of this ore, considered to be of a payable quality, available under the open-cut system proposed in a scheme formulated by the old company, and available for immediate treatment. This ore is said to be now in sight, and will be worked by the present owners under the supervision of Mr. Boyd. It is intended to gradually extend these operations, and to work into richer ore.

Chillagoe Ore Treatment.—Since the closing down by the late Government of the Chillagoe State smelters, in North Queensland, mining in this important mineral belt has been greatly handicapped by the absence of any local ore treatment works, necessitating the material mined being sent away in its crude state either overseas or to New South Wales. To relieve this position, the newly appointed Minister for Mines (Mr. A. E. Atherton) has arranged to restart a portion of these works. The Government will not, however, continue to operate certain mines which formerly supplied ore to the smelters, but will depend upon private customers to keep the smelters going.

The Whitworth Finance and Mining Co., the English enterprise which is operating at Irvinebank, in the adjoining field of Herberton, the chief tin mining district of the State, likewise intends to restart the Irvinebank treatment works, which it lately bought from the Government. These works are also to be available for dealing with ore raised from mines other than those of the Whitworth Company.

North Queensland Mining.—Mr. Robert Travers, of the Whitworth Finance and Mining Co., has been in North Queensland since January last. The holdings of the Whitworth Company in the Cairns hinterland embrace three mines at Irvinebank, four at Gurrumbah, three at Mount Albion, and six at Koorboora, all old tin-mining centres that have been neglected of late years. Mr. Travers is desirous of recommending to financial circles in London the formation of a company, with a capital of £1,000,000 or £1,500,000, to exploit the various properties in the Northern Queensland field. Since February last a good deal of work has been done by the Whitworth Company at Irvinebank, and it is expected that crushing there will begin in August. Directors of the company are stated to be on their way from London to Queensland, on a visit to the company's holdings.

Mount Isa.—There are now at work at the Mount Isa silver-lead mines 600 men, 450 of them on construction and the remainder underground. At the annual meeting of the Mount Isa Company, held in Sydney the other day, reference was made to the enormous development that had taken place at Mount Isa of late, and it was stated that much greater progress might be expected during the next few months.

Latest reports regarding operations on the field are to the end of June. On the Rio Grande lode, the Lawlor shaft has been unwatered to the 200 ft. level, where water is making at the rate of 5,000 gallons an hour. Assays of core from 7A diamond-drill bore-hole, now down to 825 ft., on the Black Star lode, show :—

	Lead. %	Zinc. %	Silver. oz. per ton.
From 710 ft.–725 ft.	7·1	10·4	4·3
From 765 ft.–775 ft.	5·3	6·8	1·0

The Mount Isa Deep Levels No. 1 bore is down as far as 2,287 ft., in greenstone schist, with veins of calcite. On the same lode the air shaft, at a depth of 142 ft., gave average assay-values at 4·9% of lead and 3 oz. of silver to the ton, over a width of 12 ft. The average values from No. 8 "glory-hole" (No. 36 shaft), down to 139 ft., were 6·9% of lead and 6·2 oz. of silver over a width of 64 in. The erection of surface plant at these mines is still in progress. Connection has been made by pipe-lines between a water bore sunk by the company and the central compressor plant, as well as to the Davidson, O'Doherty, and Lawlor shafts, for boiler use ; also to the southern settlement group, for domestic use. The erection of the staff quarters has been finished, and that of other buildings is making good progress.

THE COAL INDUSTRY.—There has of late been somewhat of an improvement in the coal trade of Queensland, probably due mainly to the stoppage of so many coal mines in New South Wales. The trouble there is still at a dead end. The threat, however, of the associated engine-drivers and firemen of that State to leave work in all the coal mines in which they are engaged, which might mean the flooding of those mines, has not yet been carried out, and it is believed by those who probably know that it will not be. There is just now talk of another conference, but whether anything will come of it or not it is impossible to say. The representatives of the miners say nothing about the possibility of their accepting a reduction in wages, and without that there can be no settlement. One of the Japanese boats (the Tango Maru), which usually coals at Sydney, and which called at Brisbane a few days ago from Japan, had instructions to take in enough coal at Manila to carry her to Melbourne and back to the former port. Further orders are being sent abroad for coal for Victoria and South Australia and in other directions the coal trade of New South Wales is being lost, much of it possibly never to return.

NEW GUINEA LEASES.—Six leases held at Edie Creek, New Guinea, by the New Guinea Gold Deposits, N.L., a company lately formed in Sydney, have been sold to the Ellyou Gold Corporation, of London. Under the terms of the sale the Sydney company will receive 10,000 fully paid shares of 20s. each in the new company being formed by Mr. Leslie Urquhart in London. The directors of the New Guinea Gold Deposits, in making this announcement, add that the company's three prospectors are now at Edie Creek, and have in view an area adjacent to the leases held by the Ellyou Company. It is its intention to prospect and develop this area should payable gold be discovered. New Guinea Gold Deposits has a capital of £20,000.

VANCOUVER

August 10.

THE KOOTENAYS.—The Standard Silver-Lead Mining Co., which operated the old Standard mine at Silverton so profitably for a quarter of a century, has taken a lease and option on the Wonderful mine at Sandon. When Standard handed the old mine over to lessees in 1919, as worked out for large scale operation, it invested $400,000 of its profits, the interest of which has been used to search for another big mine. It bought a 51% interest in Slocan Consolidated Silver Mines, and brought its McAllister mine at Three Forks to production and a dividend-paying basis. The chief attraction of the Wonderful is in prospect rather than in past achievement, though the mine has produced a fair tonnage of ore which has been milled in the Alamo mill. Some huge pieces of float have been found on the property, and though a large amount of ground-sluicing has been done, which has always uncovered more float, the lode whence the float came has not been located. The possibility of finding this lode is what has attracted Standard.

Consolidated Mining and Smelting of Canada has announced that its metal production for the second quarter of this year was 38,594 tons of lead, 22,783 tons of zinc, 32 tons of copper, 3,040 oz. of gold, and 1,495,424 oz. of silver. The smallness of the lead output was unexpected, as it is less than the average quarterly output for last year and the company has been milling about 1,000 tons more ore daily. The zinc output on the other hand is larger, so the explanation probably is that with its larger milling capacity the company has been able profitably to treat a lower grade of ore in which the ratio of zinc to lead is higher than in the ore treated last year. Except for the cleaning up of material on hand, the copper department at the smelter has been closed since the Granby Consolidated Mining, Smelting, and Power Company has been shipping concentrate from its Allenby concentrator to Tacoma.

Reeves-McDonald Mines has cut another unexpected ore-body with its main haulage tunnel. Exploration by diamond-drilling gave no indication that ore would be cut until the tunnel had been driven 3,200 ft., but the first body was cut near the portal of the tunnel and that cut a few days ago at 1,200 ft. from the portal and at a depth of 1,100 ft. It probably is an unrelated deposit, as was the one cut near the portal. Pend Oreille Mines and Metals Co., which owns a majority of the outstanding stock of Reeves-McDonald through an interchange of shares, and which will mill its ore, has started on the construction of a hotel at Metaline Falls, Washington, to accommodate those employed on its 2,000 ton mill and 300 ton electrolytic zinc plant and officials of the company. As soon as the hotel is finished, work on the first 1,000 ton unit of the zinc plant will be started and both are expected to be in operation by September 1930. By this time Reeves-McDonald will be in a position to ship ore to the plant. There still are 1,000,000 shares in Reeves-McDonald treasury, which gives Victoria Syndicate, of London, control of the company, Victoria Syndicate being the promoter.

Lucky Jim Lead and Zinc Co., another concern controlled by Victoria Syndicate, has found ore by diamond-drilling from No. 5 level, having failed to find commercial ore by driving and cross-cutting from No. 6. It appears that the dip of the strata enclosing the limestone in which the ore occurs had flattened with depth, hence the failure of exploration from No. 6 level. When this new ore has been opened up, the mill, which has been idle for several months, will be restarted.

An unusual accident, which caused the death of two men and serious injury to a third occurred in the acetylene burner shop at the Tadanac smelter. The men were filling the tanks for the day's use, when without visible flame one exploded and was hurled through the roof and in falling crashed through the roof of a nearby wash-house. Considering the large number of men employed, few accidents have occurred at Tadanac. The record for last year was only 0·98 per 1,000 shifts, only two of which resulted fatally. Investigations show that the chief cause of accidents has been the dropping of objects from men's hands either while in use or being carried.

Lead bullion to the value of $65,000 was recently recovered from Slocan Lake, where it has reposed for 27 years. The truck of bullion ran off the end of the wharf, carrying a man with it, and effort failed at the time to locate either the body of the man or the bullion. It was located recently 300 ft. from the wharf in 120 ft. of water, while dragging the lake for the body of a boy, and was recovered by a diver.

Britannia Beach.—The Howe Sound Co., the holding company for the Britannia Mining and Smelting Co. increased its dividend rate from $1 up to $1·50 per share on the 496,038 outstanding shares, covering operations for the second quarter of this year. The net earning of the company, after providing for depreciation, was $1,028,682. Britannia's contribution to the company's metal production for the quarter was 10,904,510 lb. of copper, 3,683 oz. of gold, and about 60,000 oz. of silver. The silver production is not separated from that of the company's Mexican properties, so the exact amount is not known. The recent increase of the company's mill to 6,000 tons daily is reflected on the quarter's production, which was 310,471 lb. of copper more than in the previous quarter.

Portland Canal.—The Consolidated Mining and Smelting Co. has bonded the A and T group, adjoining the Independence group, is making a trail to connect the group with the Independence trail, and is building a short tramway across a deep gully to make accessible some excellent surface showings of high-grade copper ore. Assays of the ore run up to 20% of copper, $8 in gold, and $2 in silver per ton. A diamond-drill has been shipped to the property and will be put into operation as soon as the preliminary work has been done. The company is reported to be negotiating for a bond on the Dalhousie group, which adjoins.

The Premier Gold Mining Co. has purchased Cascade No. 5 claim. It is reported that underground work in the Premier mine has developed a shoot of good ore up to the boundary of this claim. The company has recently found some unexpected ore in the deep levels, which is likely appreciably to lengthen the life of the mine. No official statement has been made and whether this refers to ore near the Cascade claims or in some other part of the mine is not known.

Vancouver Island.—Mr. L. E. Kinman and associates, who have been exploring around Nimkish Lake, in the northern part of Vancouver Island, have located between 40 and 50 claims, covering what appears to be an important discovery of copper ore. The property has recently been examined by Mr. George Clothier, Provincial resident mining engineer for the district, who states that the surface showings are remarkable and if they extend to any depth, he believes the property can be developed into one of the big copper producers of the Province. At the time of writing, the Consolidated Mining and Smelting Co. is negotiating for an option on the property. The discovery has caused a good deal of interest ; more than 250 claims have been staked around Mr. Kinman's locations.

Peace River Region.—The D'Arcy Exploration Co., Ltd., which is the prospecting company of the Anglo-Persian

Oil Co., is seeking exclusive rights for oil over a large area in the neighbourhood of Hudson's Hope. Pending the decision of the Cabinet, details of the application are being withheld from the public. The D'Arcy company made a similar application 10 years ago to a former Administration, which refused it.

Report of Progress.—The Provincial Department of Mines has issued an interim report, giving an estimate of the mineral production and the outstanding mining events during the first half of the current year. Mr. J. D. Galloway, Provincial Mineralogist, who compiled the report, makes the following estimate of the mineral production for the six months ended June 30, 1929 :—Gold, 90,000 oz., silver 5,250,000 oz., copper 51,000,000 lb., lead 145,000,000 lb., zinc 91,000,000 lb., coal 1,172,645 long tons, structural material to the value of $1,700,000, and miscellaneous minerals to the value of $788,630. The value of the production is estimated at $35,256,063. Mr. Galloway characterizes as outstanding events of the period the extraordinary activities of the Consolidated Company, both in the acquirement of new mining and railway properties and in the extensions—actual and prospective—at its smelter ; the entry of Mr. N. A. Timmins into the British Columbia field ; the discovery of stannite at the Snowflake, which, though at present of mineralogical interest only, may ultimately prove commercial ; extension of the Britannia mill to 6,000 tons daily ; the bringing to production of the Bonanza mine by the Granby Consolidated Mining, Smelting, and Power Co., the mine now producing 11,000 tons of ore monthly, a tonnage that will be increased considerably when development now under way is completed ; development at the Ferguson group, which bids fair to add another important silver-lead-zinc district and possibly another copper district to the Province ; new developments in the West Kootenay district, which eventually will add a considerable tonnage of silver-lead-zinc ore ; new mill construction at the Monarch, which is expected to add some 600 tons to the daily output of the Province next year ; and the discovery of the Kinman copper deposit, to the north of the Old Sport Mine, on Vancouver Island. The importance of the last cannot yet be gauged. Mr. George Clothier, Government mining engineer for the district, in a report to the Department of Mines states that stripping and trenching have exposed a mineralized zone, 100 ft. wide, for 3,000 ft. in which occur lenses of almost solid chalcopyrite and sphalerite from 10 to 15 ft. in width. The Consolidated Mining and Smelting Co. is negotiating for the control of the property at what is reported to be an astonishingly large figure. The report may be obtained by application to the Department of Mines at Victoria, B.C., or to B.C. House, Regent Street, London.

TORONTO

August 17.

Sudbury District.—The production of copper and other base metals is attracting much more attention than that of gold and silver, and this district is rapidly growing in importance as a mining centre, a great stimulus having been given to the industry by the construction of the customs copper refinery at Copper Cliff, which is making rapid headway. The total expenditure involved in the expansion programme of International Nickel, the objective of which is to provide a capacity of from 8,000 tons to 10,000 tons daily is roughly estimated at about $17,000,000. A force of about 350 men is at work on the refinery, which will consist of three main buildings, the electrolytic tank house and two furnace buildings, one for blister copper and the other for refined copper. The tank house will have dimensions of 480 ft. by 340 ft. and will be 45 ft. high. It is expected that construction work will be sufficiently advanced for the steel contractors to commence raising steel in September. The gross earnings of the company for the six months ended June were $14,683,522, and after making all deductions the net profits were $11,238,176. The Falconbridge is also making rapid progress with the erection of its smelter. A chimney has been constructed 175 ft. in height, and steel is going up on the main furnace building. All the foundations are in for the blast-furnaces and converters and the completion of the power house is expected in September. Underground development is being aggressively pushed. At the 1,000 ft. level where good ore has been encountered a double width drift is being run, and the vein will be opened up by cross-cutting. At the 250 ft. level a drift is being run in preparation for stoping and mining so as to be ready to operate the smelter on its completion this fall or early next year.

The Canadian National Railways have begun work on the construction of the extension of the Garson branch line into the Falconbridge smelter yards. The Sudbury Basin has proved by diamond-drilling an ore deposit under the bed of Vermillion Lake about 1,500 ft. in length, with a width of from 20 to 100 ft. Vertically the ore is known to extend practically from the bed of the lake to a depth of at least 500 ft. The company has optioned two claims adjoining its original holdings into which a mineralized zone is believed to extend. It was expected that before this the production stage would have been reached but as the ore resembles that of the Treadwell Yukon in its refractory character the company is waiting for the results of experiments which are being made by the latter company for ascertaining the best process for its treatment. Underground work on the Lake Geneva property of the Towagmac Exploration Company has confirmed the indications of diamond-drilling, encountering ore carrying lead, zinc, and copper, of which test shipments have been made. Explorations by diamond-drilling are being actively carried on by the Sudbury Crater, McGinn, and other companies.

Porcupine.—The production of bullion in this field during July was valued at $1,549,104, as compared with $1,529,598 during June. Development in the eastern section of the Hollinger Consolidated has been attended with favourable results, considerable good ore having been encountered following the downward dip of the lower porphyry in this direction. Ore reserves of around $50,000,000 as at the beginning of 1929 have been declining somewhat during the year, but with this large reserve adequate for close on five years, at the current rate of output, the company has ample time to carry out a comprehensive programme towards the east and with favourable prospects of finding further important tonnage. At the McIntyre a long drive is being run across the property at the 3,850 ft. level, from which an extensive exploration and development programme will be carried out. The drive lies north of the favourable area, which it is proposed to open up by cross-cutting. The results of operations at this horizon will enable the management to decide the question as to mill replacement and the construction of a new plant. The Dome Mines is now treating ore of a higher grade than at any previous time. Its ore reserves are believed to exceed 1,500,000 tons. While the life of the mine appears assured for several years to come its further continuance apparently depends on the question as to whether gold deposition continues to important depths in the greenstone formation, and later development is stated to be of a reassuring character. The Vipond closed the most successful year of its history on July 31, production having largely increased. The output during June was valued at $75,500, and that for the whole year (partly estimated) was $804,200. The Coniaurium Mines, Ltd., the finances of which were exhausted, has been reorganized and will resume operations, ample capital having been secured to carry the workings to greater depth, where there is promise of considerable high-grade ore. The Hayden, on which a shaft was sunk for 700 ft. and a vein system encountered when lack of funds prevented further operations, is being unwatered, and active development work will be carried on.

Kirkland Lake.—The output of bullion from the six producing mines of the Kirkland Lake area during July was valued at $1,165,124, as against $1,358,690 for the preceding month. The Lake Shore has established a new high record by its production for June, which amounted to $800,000, giving it the first place among Canadian gold mines. The extension of the high-grade ore found on the 1,800 ft. level has been encountered on the 2,000 ft. level, the vein having a width of 15 ft., and having an average value of $40 per ton across a width of 8 ft. At present tonnage is ranging between 1,225 and 1,260 tons per day. When the mill extension now under construction is completed, it is expected to have it in operation before the end of the current year on a basis of 2,000 tons a day. The Teck-Hughes has encountered good-grade ore at the 2,980 ft. level. The new shaft has reached a depth of 1,250 ft., its objective being 3,700 ft. The first lateral work will be undertaken at 2,980 ft., where a connection will be made with the present main shaft. The present main shaft will also be sunk to the 3,605 ft. level. This programme will involve work until about the end of next year. The Wright Hargreaves has substantially improved its position by the discovery of good-grade ore at the 500 ft. level. This is being opened up, and has enabled the company to increase somewhat the tonnage treated and the mill is now handling between 400 and 450 tons daily, with better recoveries than for some time past. Surface work has disclosed ore of good grade and important width at a point further east than any previously found. The Kirkland Lake gold mine has struck rich ore on the 3,600 ft. level, the deepest working in the mine. The vein is 16 ft. wide and more in some places, and it is believed to be the apex of a new lens of ore. The Canadian Kirkland, which has obtained good results from a test pit sunk on an ore shoot which yields high values, is carrying on an active diamond-drilling campaign. In the Boston Creek section of the camp the Barry Hollinger is opening up a vein at the 1,500 ft. level, which carries values of $15 to $18 a ton over a width of 10 ft. The Telluride has sufficient ore on hand to supply the mill for two years, and is planning the extension of lateral work on the upper levels and the opening up of the downward continuation of the ore-body on the 350 ft. level. The Patterson Copper is maintaining steady production and making regular shipments to the Noranda smelter.

ROUYN.—The Noranda has secured a substantial interest in the Rhyolite together with an option for a further purchase of shares which will give it a controlling interest, the total amount involved being $591,500. The property embraces a large area adjacent to the Waite-Montgomery on the West. The strike of the diabase dyke with which the ore of the Waite-Montgomery is associated appears to be towards Rhyolite. The Amulet has awarded a contract to the General Engineering Company, Salt Lake City, for the construction of a concentrator with 300 tons capacity, which will be built as rapidly as possible. The plant is now completely electrified, the shaft has been increased to three compartment and put down to a depth of 250 ft., and a double drum hoist has been installed. Recent discoveries of ore at depth show a considerably larger proportion of copper than occurs on the upper levels. An agreement has been arrived at with the Canadian National Railways under which a spur line will be run to the property. The Newbec, on which good ore has been encountered on the 125 and 250 ft. levels, is planning for exploration on a more extensive scale by diamond-drilling to depth. The Granada has opened up a length of 400 ft. of high-grade ore on the 625 ft. level. The drift has encountered the fault, on the other side of which the vein is believed to continue for 1,800 ft. According to a report of Harrison E. Clement, general manager of the Abana, the mine has now developed and partly developed ore to the amount of 155,000 tons, and indicated possible ore to the amount of 223,000 tons. No. 2 shaft will be deepened to 575 ft., and lateral work undertaken on the lower levels.

PATRICIA DISTRICT.—At the Howey development has been actively carried on at the four lower levels and the drift at the 625 ft. level has cut the vein, which shows much free gold. Steady progress has been made in preparation for the construction of the mill; most of the foundation work has been completed and all the electrical equipment and mill machinery has been ordered. Central Patricia has obtained favourable results from diamond-drilling to a depth of 200 ft. and surface explorations have encountered a new vein having a width of 12 ft. The machinery for shaft-sinking will be brought in over the winter roads. The Dunkin Gold mine at Narrow Lake and the Jackson-Manion at Woman Lake have been closed down owing to the lack of funds.

MANITOBA.—The efforts of the management of the Sherritt-Gordon, Ltd., are at present concentrated on the construction of a mill. It is expected that the railway will have reached the mine before the end of August, about five months ahead of the scheduled time, which will enable the machinery ordered for the mill to be delivered in good time before the winter. Lateral work from the two shafts is far enough advanced to put in sight ore to the value of $150,000,000 in the area so far opened up. A third shaft is now being put down on the claims well to the west of the central shaft to open up the ore-bodies indicated by diamond-drilling. Development work on the tin properties of the Jack Nutt Mines, Ltd., is making good progress. The company owns upwards of 200 claims. At the Bernic Lake group, which is the main camp, a complete mining plant has been installed and a 10 ton test mill is working at capacity. An assay plant has also been established. The shaft is down 125 ft., and cross-cutting at this horizon has encountered good ore. On the Rush claims of the company a pegmatite dyke 3 miles long and 200 ft. wide has been discovered, on which about a mile of cross channelling has been done. On this group there are also rich showings of zinc.

Chibougamou : Que.—Further rich discoveries have aroused renewed interest among mining men in the Chibougamou area of Northern Quebec. Chibougamou Prospectors, Ltd., the pioneer company, report the discovery of a 20 ft. vein on their property north of Cedar Bay. Assays show values of \$28·94 per ton, the principal ingredient being copper with small values in gold and silver. The company has four diamond-drills in operation. On the creek claims of the Blake Syndicate good showings of mineralization have been uncovered. A number of prospectors have gone in, including representatives of established Canadian and American mining companies and many claims are being staked.

CAMBORNE

September 6.

There is a growing impression in Cornwall that the position and the prospects of the tin metal market hardly justify the expectation of early material improvement in the price of tin metal. This impression is reflected in the policy manifested by the present and the recent economic administration of the leading Cornish mines, evidently a policy of caution, in pursuit of which returns are kept at a reasonably constant level, month by month, resources are not unduly encroached upon, and costs, including those of development on a sufficiently generous scale, are covered by the sales of produce.

It is gratifying that the managers of the leading mines find themselves in a position to adopt such a rational and commendable policy, for it assures a present independence, and must eventually reward the patience exercised, for the time must come when the tin market will be freed from the baneful influences of bull and bear operators to which it has for some time been subject.

From the usual monthly reports it may be seen that East Pool uniformly maintains an output of 85 tons of black tin a month, Geevor Mine 70 tons, South Crofty 65 tons and Levant 40 tons.

Amongst the more recently-formed companies Wheal Kitty produces 50 tons, Polhigey 35 tons and Jantar 25 tons. In the case of Wheal Kitty there was a drop to 36 tons in July, but that is reasonably accounted for by hindrances caused by the necessity for expediting the communication of the deeper workings in the two mines, Wheal Kitty and Wheal Friendly. There is reason to expect that the 50-ton monthly output of the earlier months of the year will be soon resumed. Development in all the above-named mines is vigorously conducted, and ore reserves are being steadily augmented in each of the seven properties.

There is no necessity to refer specially to either East Pool, Geevor or South Crofty, for they are simply pursuing the schemes of development which, followed for some years past, have secured for them the sound positions they now hold, and are able to maintain. Levant has creditably struggled through unusual difficulties caused by a chapter of unfortunate accidents.

Wheal Kitty.—This mine has just reached one of the main points aimed at from the formation of the present company, in December, 1925, namely, the communication of Wheal Kitty to Wheal Friendly at the deepest levels. This was recently effected by drill-hole, thus establishing the relative positions of the workings. A very short time will suffice to secure the permanent advantages of open communication. Thus the ore-ground in Wheal Friendly will be accessible from Wheal Kitty, the ventilation of both mines will be greatly improved, and drainage will be simplified and rendered less costly.

It is the expressed intention of the executive to proceed with the exploration of the northern area of the property from Turnavore shaft. The way to undertaking this important work would now seem to be clear. The future of the property will depend upon the results obtained in the exploration of this northern area towards the sea.

Polhigey.—A depth of 400 feet has been attained in this mine, and development at that depth shows that both values and widths of lodes are more than maintained, when compared with those at shallower levels.

Work is in hand at the adjoining sett of Calvadnack, a portion of the property which was recently holed into from Polhigey. Polhigey may be congratulated upon its development results from the beginning, but the new mill, so far, hardly does justice to the development. Amplification appears to be required before its performances can be favourably compared with those of other Cornish mills, especially in the treatment of slimes.

Jantar.—This property has gradually increased its monthly sales, from 15 tons in the early months of the year to 25 tons in recent months. Here, as in the other cases referred to, development has been, and is being, systematically conducted, and reserves of productive ground are being gradually increased.

UNEMPLOYMENT IN THE MINING DISTRICTS.—It is not surprising, under existing circumstances, when, realizing that within 6 years the black tin output of Cornwall has been increased from less than 1,000 tons a year to over 5,000 tons a year, due to the steady revival of the industry from war and post-war difficulties, that special efforts are being made further to extend the tin industry, and in making the effort, to obtain if possible financial assistance from the Government. The roll of the unemployed in Cornwall is still a long one. There are over a thousand unemployed in the Camborne and Redruth mining area, about a thousand in St. Just, Penzance and Hayle, while in St. Austle, in Callington and other mining districts the numbers are still considerable. A conference, to discuss the Cornish mining industry in relation to unemployment, was held at Camborne, on August 23, and, arising out of this, a scheme for the further resuscitation of the industry is being prepared for presentation to the Government.

PERSONAL

JULIAN BOYD has been examining a gold dredging proposition in Alaska.

F. P. CADDY, who recently left for Vancouver, has been appointed assistant Government mining engineer in Northern British Columbia.

DR. J. MORROW CAMPBELL has left for Burma.

E. J. DANIEL has left for Iraq.

M. W. L. DEMPSTER has returned from Panama.

CHARLES JANIN has left for Russia.

W. KUPFERBURGER has been appointed mineral technologist to the South African Board of Trade. Dr. Kupferburger is a South African by birth and obtained his D.Sc. at the University of the Witwatersrand.

A. D. LUMB has left for West Africa.

DR. MALCOLM MACLAREN is home from South America.

A. F. MAIN, who recently resigned as manager of the El Oro company, is on holiday in Europe.

EDWARD T. MCCARTHY has entered into a partnership agreement with RAY ELLERTON BINNS, the firm name being McCarthy and Binns, Friars House, 39–41, New Broad Street, London, E.C. 2.

GEORGE MELLOR has left for Brazil.

T. W. C. NORTH has left for Colombia.

S. R. POTTER has returned to South Africa.

C. A. REMINGTON left New York on August 7 for the Cape Copper Co.'s properties in Namaqualand.

GEORGE S. RICE, Chief Mining Engineer, United States Bureau of Mines, has been awarded the medal of the Institution of Mining Engineers "in recognition of his eminence in all matters relating to the safe working of coal mines and the well-being of mine-workers, with special reference to the practical application of scientific knowledge."

DR. A. W. ROGERS, Director of the South African Geological Survey, has been elected President of the International Geological Congress for the next four years.

PETER G. TAIT has returned to Australia.

JOSEPH F. THORN has been appointed general manager of the Lake View and Star.

W. E. THORNE has returned from New Guinea.

J. H. VINCENT has left for Brazil.

A. STANLEY WILLIAMS has returned to Northern Nigeria.

GORDON WILSON has resigned the management of the Compañia Minera y Beneficiadora de Inde, Durango, Mexico, and is visiting California.

J. C. WARD died on August 8. For many years Mr. Ward had been a director of Edgar Allen and Co.

SIR JULIUS JEPPE died in London on September 2 at the age of 70. He went to the Transvaal in 1870 and subsequently became closely associated with the development of Johannesburg where he owned substantial amounts of land. To the end he took a keen interest in local governments and sports. In the mining world he was an important member of the Bailey group.

PROFESSOR L. H. COOKE.

We record with great regret that PROFESSOR L. H. COOKE died on August 23 as the result of a bicycle accident. He was at the Royal School of Mines from 1889 to 1892, taking his A.R.S.M. and winning the De la Beche medal. He became demonstrator in surveying in 1892, and from 1893 to 1896 he was lecturer on mining in the Glasgow and West of Scotland Technical College. In the latter year he returned to the Royal School of Mines, and from then onward to the time of his death he was identified with the teaching of mine surveying at South Kensington. It is probable that no one had such a complete knowledge of the subject as he had, and it was always his endeavour to give his students the full benefit thereof. He was an enthusiastic and exacting teacher, who succeeded in imparting his knowledge in quite an unrivalled manner. Always an upholder of precision in his methods, it was largely due to his influence that the theodolite as an instrument of precision is now used so widely in metalliferous mines. He was the inventor of a number of improvements in surveying instruments, among which may be mentioned the precision plumb-bob and the fine centring device for theodolites. It was due to his representations that the Meteorological Office undertook the publication of figures for magnetic declination, by means of which the method involving magnetic orientation became more readily applicable to mining problems. He was a frequent contributor of papers to societies and technical journals, his name at times appearing in this MAGAZINE. In 1925 he was awarded the Consolidated Gold Fields gold medal by the Institution of Mining and Metallurgy for his paper on underground orientation by exact and approximate alignments of plumb-wires in one shaft. It is to be hoped that his contemplated book on Mine Surveying had arrived at a stage at which publication will be justified, for it would in itself constitute a suitable memorial of his efficiency and thoroughness.

TRADE PARAGRAPHS

Hadfields, Ltd., of Sheffield, issue a leaflet describing the use of their Era and Hecla brands of heat-resisting steels for boiler plants operating at high temperatures.

Head, Wrightson and Co., Ltd., of Stockton-on-Tees, have prepared a booklet describing their coal screening and sorting plant giving photographs of a number of installations.

Steel, Peech, and Tozer, Ltd., associated with United Steel Companies, Ltd., of Sheffield, issue a leaflet describing their steel forgings and other products.

Fry's (London), Ltd., 24–26, Water Lane, London, E.C. 4, send us a complete catalogue of their Enox hack saws and other tools and two samples of their saw blades.

United Steel Companies, Ltd., of Sheffield, issue an illustrated booklet giving particulars of the steel products of their subsidiary organization United Strip and Bar Mills, Ltd. From these mills they are able to turn out all shapes and sections of steel rods, bars, rounds, angles, etc., etc.

The Premier Lamp and Engineering Co., Ltd., of Armley, Leeds, issue a catalogue of their portable and stationary acetylene lamps, which include several types of miners' lamps. A feature is the brass water vessel base, which resists corrosion and gives thus a greatly-increased working life.

Longmans Green and Co., Ltd., of 39, Paternoster Row, London, E.C. 4, send us a catalogue of monographs on industrial chemistry which series includes the following of interest to mining men: The Electric Furnace; The Zinc Industry; and Lead: Its Occurrence in Nature, Extraction, etc., etc.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, send us their *Edgar Allen News* for September, which contains an illustrated description of their equipment at the Chinnor Cement and Lime Company's works and also a note on the opening of a new branch office at Detroit—704, Fisher Building.

Robey and Co., Ltd., of Lincoln, issue a 67 page, fully illustrated catalogue of their air compressors, both horizontal slow-speed and vertical high-speed types. These are made for operation by drop valve, Uniflow or other type of Robey steam engine or, in the case of the vertical types, for coupling to an electric motor or a crude-oil engine.

International Combustion, Ltd., Grinding and Pulverizing Offices of 11, Southampton Row, London, W.C. 1., report that new orders have been received for the following equipment:—For England: Three 8 ft. by 60 in. Hardinge ball-mills and three 6 ft. Hardinge air units for coal; one 5-roller Raymond mill for chalk; one 3 ft. by 5 ft., type 39, Hum-mer screen for extracting flour dust from slag; one 4 ft. by 5 ft., type 39, Hum-mer screen for screening coal; one rotary filter installation for caustic lime sludge; and one Rovac filter unit for caustic lime sludge. For Scotland: Three 6 ft., type 31, Hum-mer screens for clay. For Holland: One 4 ft. by 7 ft., type 39, Hum-mer screen for coal. For France: One 5-roller Raymond mill for fine limestone. For Belgium: One No. 0 Raymond pulverizer for litharge and two, type 39, Hum-mer screens for coal. For Italy: One 3-roller Raymond mill for talc.

United Engineers, Ltd., of Singapore, Straits Settlements, send us the June 27 issue of the *Straits Budget* which contains an illustrated description of the first of two bucket dredges which this firm has under construction for Penawat (Malaya) Tin Dredging Co., Ltd. This dredge has worked without trouble, it is stated, since May 18 last. The second is nearing completion. They are duplicates, electrically operated by power from the new Perak Station. They dig to 85 feet below the water line and have tray-connected, self-cleaning type buckets of 11 cu. ft. capacity capable of delivering 130,000 cu. yds. per month of 600 hours. The pontoons are 194 ft. by 52 ft. by 10 ft. Motors and transformers are manufactured by **Crompton, Parkinson, Ltd.,** high tension switchgear by **A. Reyrolle and Co., Ltd.,** low tension by **George Ellison** and controllers by **Allen West and Co., Ltd. Hadfields, Ltd.,** manganese steel is used for all parts subjected to abrasion.

The Woodhall-Duckham Vertical Retort and Oven Co. (1920), Ltd., of 136, Victoria Street, London, S.W. 1, have published a booklet describing the Peale-Davis system for the dry-cleaning of coal. The cleaning plant consists of two tables:—A large primary table which takes the whole of the feed from a storage hopper and gives two products, (*a*) clean coal and (*b*) a primary refuse, and a smaller retreatment table which takes as its feed the primary refuse. This retreatment table discharges (*a*) a clean coal product that is mixed with the clean coal from the primary table, and (*b*) refuse, which is sent to the tip. This arrangement ensures a minimum loss of coal in the refuse and a maximum yield of clean coal. The table consists of two decks separated by a series of air-tight compartments that in effect divide the table into a number of separately controlled units, and thus cleaning without pre-screening is secured. The top deck which carries the bed of coal is covered with perforated sheets. The area of opening of these perforations decreases towards the end of the table. Running diagonally across the deck there are a number of separating partitions, formed by small angles. The table is mounted above a stationary air duct which, in turn, is connected with a fan. The table is supported by a number of rocking arms and it is given a reciprocating motion by means of an eccentric drive. This motion causes the bed of coal to travel along the upper deck towards the discharge end of the table. Each table is adjustable for side and end inclination in order to get the best results with any class of coal. When operating, the current of air passes from the air duct through the decks and through the bed of coal. The quantity of air passing through each separate compartment can be individually regulated. The initial adjustments for table inclination and air distribution are only modified when changing to a coal of entirely different characteristics. The bed of coal is agitated by the motion of the table and the current of air. A stratification of the bed takes place and the lower layer of the bed is trapped behind the angle separating partitions, which convey it to the high side of the table whilst the upper layers pass over these partitions and have a tendency to travel to the low side of the table. Running along the high side of the table are a number of refuse boxes from which the refuse is discharged, the quality of the refuse being finally controlled by an air back-pressure device attached to each refuse box. If a very large table were designed, it would be possible definitely to reach a point where the coal and the refuse would separate completely, and it would thus be possible to make a clean cut between the two products. In practice this same result is achieved by having two tables. From the second table three fractions are made. (1) A clean coal, (2) a coal-free refuse which is discharged to the tip, and (3) a middlings product which consists of the stream of material where separation is not complete. This middlings product is recirculated over the table and thus eventually is discharged as clean coal or refuse. This retreatment table is similar to the large primary table in construction but smaller. The current of air leaving the bed of coal is naturally heavily laden with dust. The dust and air mixture is conducted into a large expansion chamber where it is subjected to a very considerable decrease in velocity, with consequent precipitation of the dust. In this manner most of the dust in suspension settles out into pockets from which it is conveyed and mixed either with the clean coal or the refuse, according to its quality. Alternatively, it may be used as pulverized fuel. As it is impossible to remove the finest dust particles in this manner, the air is recirculated through the fan and table by means of a return air duct, and thus any pollution of the outside atmosphere is prevented. Tables can be constructed with capacities from 50 to 300 tons per hour, according to individual requirements.

THE BRIDGE-MEG RESISTANCE TESTER

Evershed and Vignoles, Ltd., of Action Lane Works, Chiswick, London, W. 4, recently demonstrated a new electrical testing instrument which they have evolved. This is in effect a combined Wheatstone bridge and an insulation measuring instrument which combines compactness with light weight and cheapness. It is as well to recall that this firm devised seven years ago the Meg insulation tester to supplement their well-known Megger. This instrument, although it was originally designed for insulation testing alone, was later adapted for use in measuring resistances by Wheatstone bridge methods, but with the employment of a separate resistance box. The present instrument is thus a further advance towards simplicity, being a combined Ohmmeter and generator of the Meg type built into one case with a set of adjustable resistances. By the turn of a single switch the instrument serves either for measuring high resistances—testing insulation—or for the determination of conductor resistances by the Wheatstone Bridge method.

The chief features of the new instrument may be thus summarized: It measures both insulation

THE BRIDGE-MEG RESISTANCE TESTER OPEN FOR USE.

and conductor resistances, having a continuous range of readings from 100 megohms down to 0·01 ohm. The "Meg" range is 100 megohms to 10,000 ohms. The "Bridge" range is 999,900 ohms down to 0·01 ohm. A 500 volt constant-pressure generator is employed. It has a case of aluminium alloy and moulded bakelite which is proof against dust, damp and vermin. The movement is mounted on spring-urged jewels. A single switch changes from "Meg" to "Bridge" and *vice versa*. On the "Meg" setting direct readings are given on a dial. The adjustment for balance on the "Bridge" setting is simple and the results are in plain figures. The instrument is self-contained; its weight is 12¾ lb., and its dimensions are 7 in. by 8¾ in. by 12 in. It can be carried by hand or slung from the shoulder.

NEW EQUIPMENT AT THE BARNSTONE CEMENT WORKS

The Barnstone Cement Works, which is engaged on the manufacture of portland cement, has been established for many years at Barnstone, Nottinghamshire. Recently the company has installed an entirely new plant with up-to-date machinery and modern labour-saving devices, which is electrically operated throughout. The contract for the supply and erection of the new machinery was carried out by **Edgar Allen and Co., Ltd.,** of Sheffield, while the electrical equipment was manufactured and supplied by the **General Electric Co., Ltd.,** Magnet House, Kingsway, London, and Witton Works, Birmingham. Some indication of the extent of the electrical equipment may be gathered from the fact that the total normal capacity of the motors is approximately 2,000 h.p., ranging in individual outputs from 5 h.p. to 450 h.p.

Electric power is taken from the 11,000 volt mains of the Derbyshire and Nottinghamshire Electric Power Co. It is transformed down in the Power Co.'s sub-station at the works and fed at 440 volts to a General Electric Company's truck-cubicle switchboard, consisting of 3 units. Two of these control the low tension side of transformers, each being equipped with type 4 G.E.C. oil circuit breakers of maximum breaking capacity of 100,000 kva, fitted with overload protection, together with isolating links, measuring instruments, instrument transformers, etc. The third truck is an outgoing metering cubicle equipped with maximum demand watt-hour meter, voltmeters, and the necessary instrument transformers. The outgoing cables from this cubicle are led to a truck cubicle feeder board, which distributes the power required to the motors driving the machinery, via ironclad distribution boards, control pillars, etc., as required. The principal equipment of each of the trucks comprises an oil circuit breaker of suitable breaking capacity fitted with overload protection, watt-hour meter, ammeter, and necessary accessories.

The cement produced in these works is manufactured on the wet or thick slurry process, burning in a rotary kiln. The raw materials used in the process mainly consist of the Blue Lias limestone, which is quarried on the site, with the admixture of a certain quality of stone containing a high percentage of calcium carbonate. These raw materials are delivered in full-gauge trucks to a large jaw crusher, which reduces it in one operation to about 3 in. and under. The stone is mechanically fed to the crusher by means of a finger feeder, consisting mainly of heavy grid bars with spaces between them, and arranged at a slight slope to the horizontal. Some of these bars have a rocking movement backwards and forwards given to them by a driving shaft carrying eccentrics and by this means the stones move forwards towards the crushers jaws. This crusher and feeder is belt-driven by a 125 h.p. Witton motor, running at 580 r.p.m. The crushed stone falls on to a troughed band conveyor which is slightly inclined and is fed into a rotary screen, the rejects from the screen passing on to a set of medium speed crushing rolls, 30 in. diameter by 20 in. wide, where they are reduced to about 2 in. cube and under, which is a suitable feed for the grinding mill. The crushed stone is elevated by a continuous bucket elevator and deposited on to a steel band conveyor over two large ferro-concrete storage silos, containing the two qualities of raw stone. These silos are hoppered at the bottom, and rotary table feeders are fitted at the outlets, by which means the raw stone is

General View of Barnstone Cement Works.

measured in the proportions required to give the correct chemical composition. A band conveyor takes the raw stone to the grinding mill, which is a Stag combination ball and tube mill, 6 ft. diameter by 32 ft. 6 in. long, grinding wet, water being fed in with the stone. The mill is of sufficient capacity to prepare the ground slurry for the plant. It is driven by a 300 h.p. Witton motor running at 244 r.p.m., direct coupled to the mill countershaft. The motor is housed separately from the mill, and the power for supplying this motor is controlled by a G.E.C. draw-out oil-immersed ironclad pillar.

The slurry as it comes from the mill is elevated by a slurry wheel, 28 ft. diameter, carrying buckets on its periphery, and runs by gravity to 2 triple mixers. These mixers are provided with stirrers carried on vertical shafts which keep the slurry agitated and prevent the solids from settling out. Samples are taken from these mixers at frequent intervals by the works chemist and tested, and any adjustment as to chemical composition is made at the table feeders under the raw stone silos to correct the mixture. The finished slurry runs by gravity into a large storage mixer of the sun and planet type, from whence it is pumped by means of three-throw plunger pumps direct to the kiln, which is belt-driven by a 30 h.p. Witton variable speed motor, with a range of 357 to 715 r.p.m.

The kiln is fired by means of pulverized coal, which is delivered from trucks direct into a feed hopper and elevated to a large storage hopper over the pulverizers. Two turbo pulverizers are installed, each driven by an 80 h.p. Witton motor, running at 1,450 r.p.m., which is direct-coupled to the pulverizer shaft, and carried on the same bedplates as the machine. One pulverizer is of sufficient capacity to provide powdered coal for firing the kiln, the other machine being used as a standby. The coal is pulverized, air-separated, and blown into the kiln in one operation, and coal up to 10% moisture content is used.

The kiln is fitted with the Rigby-Allen patented slurry atomizing equipment at the feed end, and an induced draught fan is provided for dealing with the waste gases. The hot clinkers as they come from the kiln pass through a rotary cooler, 5 ft. diameter by 55 ft. long, and are handled from the cooler end by means of an Allen swing-tray conveyor, which either delivers the clinker to the storage silos or direct to the cement grinding mill.

The cement mill consists of a Stag combination tube mill, 6 ft. 6 in. diameter by 36 ft. long, driven by a 450 h.p. three-phase Witton motor running at 244 r.p.m. direct-coupled in a similar manner to the raw mill.

A small plant is provided for crushing and feeding gypsum, and automatic table feeders are used for regulating the feed of clinker and gypsum to the mill in the right proportion. The ground cement is elevated and conveyed to three large ferro-concrete silos, whence it is extracted and packed mechanically into bags for despatch.

METAL MARKETS

Copper.—Price fluctuations on this market were of very meagre significance during August. There seemed to be a rather better demand for copper in America and European interest also tended to expand at the end of the month, following the close of the Hague Conference. So far, however, the widespread industrial revival which, it is hoped, will materialize in the early autumn, has not yet made its appearance. It remains to be seen to what extent it will be checked as far as copper is concerned by the curtailment in consumption due to the maintenance of high prices. Meanwhile, thanks to the reduction in smelting operations, the statistical position of the metal has become rather more favourable. The export quotation for electrolytic metal remained throughout the month at 18 cents per lb.

Average price of copper: Standard Cash: August, 1929, £73 16s. 8d.; July, 1929, £72 3s. 11d.; August, 1928, £62 10s. 2d.; July, 1928, £62 18s. 4d.

Tin.—There was a rather easier tendency on this market last month, values losing several pounds. Despite the bullish propaganda, the formation of the incomplete Tin Producers' Association, the favourable monthly statistics and good industrial advices from America, the market has lacked backbone. The fact is that consumers realize that the situation is not as good as the statistics would suggest, having regard to the existence of the "invisible supplies" held by operators. In addition, there is an uneasy feeling that, excellent though consumption may be, it is not likely to reach a scale which will enable it fully to take care of production for some time to come. In such circumstances, the task of the bull group—powerful though the latter may be—is extremely difficult.

Average price of tin: Standard Cash: August, 1929, £209 17s. 11d.; July, 1929, £209 11s. 6d.; August, 1928, £212 19s. 10d.; July, 1928, £212 10s. 11d.

Lead.—After slipping back in the earlier part of the month, values rallied on the announcement that a Lead Producers' Association had been formed which would control the European position. The Canadian, Mexican, Australian, and Burmese interests are apparently in the scheme. The latter part of the month witnessed heavy buying, probably partly on behalf of apprehensive consumers and partly on account of operators who thought that in the circumstances lead would be a profitable investment. Although, of course, the action taken by producers is likely to provide the market with some backbone, the situation will not be really healthy until, with the arrival of autumn, we witness distinctly more active industrial conditions than have prevailed during the summer. German industry should, of course, begin to benefit now from the settlement of the Reparations problem.

Average mean price of soft foreign lead: August, 1929, £23 4s. 5d.; July, 1929, £22 16s. 10d.; August, 1928, £21 12s. 7d.; July, 1928, £20 15s. 5d.

Spelter.—This market was fairly colourless throughout August, but although prices lost a certain amount of ground, the position was really better maintained than might have been hoped for. Industrial interest was subdued and it was clear that but for the curtailment of output undertaken by producers the situation would have been much worse. The improvement on the lead market seemed to have no sympathetic beneficial effect on sentiment in the spelter market. With the approach of autumn, conditions should begin to improve, however, particularly as the increased rate of output-reduction should soon begin to make itself felt.

Average mean price of spelter: August, 1929, £25 0s. 7d.; July, 1929, £25 7s. 6d.; August, 1928, £24 12s. 6d.; July, 1928, £24 19s. 2d.

Iron and Steel.—August was naturally rather a quiet month, owing to holiday influences, and the Cleveland blast-furnaces were consequently able to deliver rather more promptly. Output of pig iron on the North-East Coast is still being increased so that the situation is likely to become even less stringent in the near future, unless the autumn demand proves so insistent that delivery delays again tend to lengthen. Prices were steady, with No. 3 Cleveland foundry quoted at 72s. 6d. per ton. Hematite was rather firmer at 76s., but makers declared that even 80s. would barely have returned them a profit. Finished iron and steel was dull but works in this country were busy on old contracts and could afford to adopt a stiff attitude; the outlook for the autumn is regarded favourably. Continental steel continued rather easy and neglected.

Antimony.—The tendency during August was not particularly firm. At the close of the month English regulus commanded between £47 10s. and £52 10s. per ton. Chinese regulus was quoted at £32 10s. to £32 15s. ex warehouse for spot material and £30 10s. c.i.f. for forward shipment.

LONDON DAILY METAL PRICES

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard.		Electrolytic.	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	Forward.	
Aug.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
12	73 13 9	74 13 9	84 5 0	—	209 3 9	213 11 3	24 10 0	23 3 9	24 10 0	24 3/16	24 5/16	84 11½
13	73 19 4½	74 18 1½	84 10 0	77 15 0	208 11 3	212 11 3	24 17 6	23 5 0	24 10 0	24 5/16	24 7/16	84 11⅜
14	74 6 10½	75 1 10½	84 10 0	—	208 6 3	212 11 3	24 16 3	23 1 3	24 10 0	24¼	24⅜	84 11⅛
15	73 11 3	74 8 9	84 10 0	—	208 11 3	212 11 3	24 15 0	23 1 3	24 10 0	24¼	24⅜	84 11⅛
16	73 16 3	74 13 9	84 5 0	77 15 0	209 2 6	213 3 9	24 16 3	22 18 9	24 5 0	24 5/16	24 7/16	84 11½
19	74 3 1½	74 15 7½	84 10 0	—	210 11 3	214 8 9	25 1 3	22 16 3	24 5 0	24 5/16	24 7/16	84 11⅛
20	74 1 3	74 14 4½	84 10 0	77 15 0	209 18 9	213 16 3	25 1 3	22 17 6	24 5 0	24 5/16	24 7/16	84 11⅜
21	73 16 9	74 11 3	84 10 0	—	208 8 9	212 6 3	24 18 9	23 0 0	24 5 0	24 5/16	24 [illegible]/16	84 11⅛
22	73 19 4½	74 14 4½	84 10 0	—	209 16 3	213 11 3	24 18 9	23 2 6	24 10 0	24 7/16	24 [illegible]/16	84 11⅜
23	73 18 9	74 10 7½	84 10 0	77 15 0	210 11 3	214 1 3	25 1 3	23 2 6	24 10 0	24 5/16	24 7/16	84 11½
26	73 17 6	74 11 3	84 10 0	—	209 7 6	213 8 9	25 1 3	23 2 6	24 10 0	24 5/16	24 7/16	84 11½
27	73 16 3	74 11 3	84 10 0	77 15 0	208 8 9	212 8 9	24 17 6	23 6 3	24 10 0	24⅜	24 7/16	84 11⅜
28	73 16 3	74 11 10½	84 10 0	—	208 2 6	212 2 6	24 16 3	23 6 3	24 15 0	24 5/16	24 7/16	84 11½
29	73 18 9	74 15 7½	84 10 0	—	208 0 0	212 1 3	24 16 3	23 8 9	24 15 0	24 5/16	24 7/16	84 11⅛
30	74 11 3	75 6 3	84 10 0	78 5 0	208 17 6	212 6 3	24 13 9	23 8 9	24 15 0	24¼	24⅜	84 11½
Sept.												
2	75 3 9	75 19 4½	84 10 0	—	206 7 6	210 7 6	24 1 3	23 11 3	25 0 0	24 3/16	24 5/16	84 11½
3	75 11 10½	76 8 1½	84 10 0	79 0 0	204 11 3	208 11 3	24 5 0	23 11 3	25 0 0	24 1/16	24 3/16	84 11⅛
4	78 18 1½	79 19 4½	84 18 9	—	206 2 6	210 2 6	24 8 9	23 12 6	25 0 0	24 3/16	24¼	84 11⅛
5	78 0 0	79 1 3	84 7 6	—	206 17 6	210 17 6	24 16 3	23 12 6	25 0 0	24⅛	24 5/16	84 11½
6	76 2 6	77 1 3	84 17 6	80 5 0	205 2 6	209 3 9	24 15 0	23 12 6	25 0 0	24	24 1/16	84 11½
9	76 2 6	76 18 9	84 17 6	—	205 3 9	209 3 9	24 10 0	23 10 0	25 0 0	24	24 1/16	84 11⅛
10	75 13 1½	76 6 10½	84 17 6	80 0 0	204 6 3	208 8 9	24 7 6	23 6 3	25 0 0	24	24 1/16	84 11½

Iron Ore.—There seems little or no buying still to be done for this year, and mines are fully sold. Indeed, with so much forward buying recently many producers have very little to offer for 1930. Prices can only be called nominal, on the basis of 24s. 6d. to 25s. per ton c.i.f. for best Bilbao rubio.

Arsenic.—A small but steady business is passing at about £16 per ton f.o.r. mines for high-grade Cornish white.

Bismuth.—Leading interests continue to quote 7s. 6d. per lb. for merchant lots, although the tone of the market has been rather uncertain owing to some disorganization in the bismuth salts trade.

Cadmium.—Rather quiet conditions have prevailed recently and quotations are easier at 3s. 9d. to 3s. 10d. per lb., with even less accepted on the Continent.

Cobalt Metal.—A very fair demand is maintained, and the official price is still 10s. per lb.

Cobalt Oxides.—Quotations are unaltered at 8s. per lb. for black and 8s. 10d. for grey.

Platinum.—August is, of course, one of the quietest periods of the year in this market, but the tone remains steady with prices unchanged at £13 10s. to £13 15s. per oz.

Palladium.—Interest in this commodity remains slight, and current quotations reflect an easier tone at about £7 to £7 5s. per oz.

Iridium.—Owing to the absence of any appreciable demand prices have been marked down slightly, and sponge and powder now stand at about £48 per oz.

Tellurium.—Quotations can only be called nominal at around 12s. 6d. to 15s. per lb.

Selenium.—A steady turnover is reported in high-grade material at 7s. 8d. to 7s. 9d. per lb.

Manganese Ore.—The most important feature of the past month has been the contract made between the Soviet manganese authorities and the United States Steel Corporation for the supply of between 80,000 and 150,000 tons a year for the next five years. Otherwise business has been slow, with prices fractionally easier at about 1s. 1d. to 1s. 1½d. per unit c.i.f. for best Indian, and 1s. 1d. for washed Caucasian ore.

Aluminium.—Rather quiet conditions have prevailed during the past month, but the price remains at £95 per ton, less 2%, delivered for ingots and bars, or £95 c.i.f. for export.

Sulphate of Copper.—Current quotations for British material stand at about £27 to £27 10s. per ton, less 5%.

Nickel.—This market wears a firm appearance, with the official price unchanged at £175 per ton.

Chrome Ore.—Prices do not vary much, but there seems plenty of material available. Good average 48% Rhodesian might be called about £4 5s. per ton c.i.f.

Quicksilver.—A firmer tone has developed here, and for material on spot £22 10s. per bottle is now quoted.

Tungsten Ore.—There has been a marked absence of buying interest recently, and although producers have not pressed sales, prices have receded appreciably. Spot and nearby material is still rather scarce, but for October-December shipment the current quotation is only about 35s. to 36s. per unit c.i.f.

Molybdenum Ore.—Demand has quietened down somewhat and prices are easier at about 39s. to 40s. per unit c.i.f., for 85% Australian concentrates.

Graphite.—Business is none too brisk but prices are quotably unchanged at £27 to £29 per ton c.i.f. for 85 to 90% raw Madagascar flake, and £25 to £26 for 90% Ceylon lumps.

Silver.—On August 1 spot bars closed at 24 5/16d., the market ruling very quiet. America was a seller in a small way, while China worked both ways. There was a little bear covering from India and prices moved within narrow limits. On 15th ult. spot bars were 24¼d., but subsequently India showed a little more interest and with sellers reserved quotations improved a trifle although towards the end of the month the market again wore a very quiet appearance, and spot bars closed at 24 3/16d. on August 31.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
August, 1928	854,172	37,691	891,863
September	819,341	38,390	857,731
October	858,945	38,775	897,720
November	832,461	40,023	872,484
December	821,582	38,179	859,761
January, 1929	840,344	36,108	876,452
February	778,559	36,725	815,284
March	830,829	35,700	866,529
April	836,474	35,649	872,123
May	858,991	38,607	897,598
June	821,352	34,677	856,029
July	853,370	36,110	889,480
August	850,952	38,649	889,601

TRANSVAAL GOLD OUTPUTS.

	July.		August.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	85,500	£144,109	83,500	£141,846
City Deep	89,000	25,002	91,000	25,023
Cons. Main Reef	62,700	22,495	61,000	22,616
Crown Mines	237,000	75,312	240,000	75,650
D'rb'n Roodepoort Deep	40,200	13,610	41,600	14,251
East Rand P.M.	147,000	39,804	148,500	40,218
Geduld	86,000	27,071	86,100	27,174
Geldenhuis Deep	66,000	14,999	67,500	15,210
Glynn's Lydenburg	6,600	2,226	6,600	2,116
Government G.M. Areas	207,000	£394,820	210,000	£397,551
Kleinfontein	52,100	10.352	50,900	10,496
Langlaagte Estate	86,000	£114,566	87,000	£113,987
Luipaard's Vlei	23,800	6,099	24,800	6,213
Meyer and Charlton	17,200	£19,328	17,300	£19,866
Modderfontein New	153,000	73,941	154,000	74,477
Modderfontein B	71,500	25,191	71,500	25,429
Modderfontein Deep	45,900	24,225	45,900	24,237
Modderfontein East	69,500	21,152	68,500	20,744
New State Areas	81,000	£140,442	79,003	£139,673
Nourse	63,000	18,660	61,400	17,801
Randfontein	216,000	£220,371	218,000	£223,396
Robinson Deep	79,100	21,199	80,000	21,401
Rose Deep	59,000	12,369	60,000	12,432
Simmer and Jack	75,600	18,917	74,600	18,301
Springs	70,500	£149,227	71,500	£148,033
Sub Nigel	25,000	20,812	26,000	23,764
Transvaal G.M. Estates	15,160	5,366	15,100	5,035
Van Ryn	40,000	£39,003	40,300	£40,481
Van Ryn Deep	64,000	£103,743	62,000	£104,565
Village Deep	60,000	16,058	60,000	15,929
West Rand Consolidated	90,000	£96,487	90,000	£96,691
West Springs	65,000	£80,440	66,000	£81,264
Witw'tersr'nd (Knights)	57,000	£48,593	57,000	£49,412
Witwatersrand Deep	43,200	13,106	45,200	12,934

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
June, 1928	2,500,100	28 2	19 10	8 4	1,038,851
July	2,528,600	27 11	19 8	8 3	1,048,432
August	2,580.700	27 11	19 7	8 4	1,079,152
September	2,485,700	27 11	19 7	8 4	1,040,368
October	2,612,500	27 9	19 5	8 4	1,092,162
November	2,539,700	27 9	19 7	8 2	1,041,713
December	2,505,500	27 10	19 8	8 2	1,024,654
January, 1929	2,627,320	28 1	19 9	8 4	1,095,070
February	2,403,720	28 6	20 3	8 3	990,942
March	2,581,600	28 3	20 0	8 3	1,062.331
April	2,606,420	28 1	19 11	8 2	1,068,103
May	2,694,610	28 0	19 10	8 2	1,100,461
June	2,543,550	28 3	19 10	8 5	1,065,191
July	—	—	—	—	1,112,246

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
August 31, 1928	194,788	16,553	4,839	218,578
September 30	194,936	16,724	4,535	215,843
October 31	193,147	16,767	4,807	216,362
November 30	190,870	16,803	4,889	216,628
December 31	187,970	16,059	4,444	208,473
January 31, 1929	192,526	15,845	50,56	213,427
February 28	196,150	15,940	5,635	217,725
March 30	197,646	16,065	5,787	219,498
April 30	197,412	15,900	5,554	218,866
May 31	195,733	15,852	5.473	217,058
June 30	192,595	15,928	5,029	213,552
July 31	190,031	15,914	4,845	210,790
August 31	190,062	15,867	5,071	211,000

PRODUCTION OF GOLD IN RHODESIA.

	1926	1927	1928	1929
	oz.	oz.	oz.	oz.
January	48,967	48,731	51,356	46,231
February	46,026	46,461	46,286	44,551
March	46,902	50,407	48,017	47,388
April	51,928	48,290	48,549	48.210
May	49,392	48,992	47,323	48,189
June	52,381	52,910	51,762	48,406
July	50,460	49,116	48,960	46,369
August	49,735	47,288	50,611	—
September	48,350	45,838	47,716	—
October	50,132	46,752	43,056	—
November	51,090	47,435	47,705	—
December	48,063	49,208	44,772	—

RHODESIAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,000	12,075	24,000	11,079
Globe and Phœnix	6,031	4,906	6,003	4,474
Lonely Reef	5,300	4,105	5,300	4,096
Rezende	6,400	2,908	6,400	2,904
Shamva	45,600	£24,049	46,000	£23,789
Sherwood Starr	5,000	£8,621	5,000	£8,864

WEST AFRICAN GOLD OUTPUTS.

	July.		August.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	—	—	—	—
Ashanti Goldfields	9,189	10,356	9,063	10,709
Taquah and Abosso	8,300	£13,483	8,410	£13,893

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.	New South Wales.
	Oz.	Oz.	Oz.	Oz.
August	37,991	2,637	690	3,447
September	32,397	3,366	644	364
October	36,565	2,632	820	256
November	31,466	3,111	865	550
December	36,097	—	493	208
January, 1929	27,384	—	260	445
February	28,177	1,997	117	474
March	25,848	2,974	816	—
April	39,166	—	617	—
May	28,026	3,018	493	467
June	33,139	2,368	465	—
July	28,086	—	—	—
August	37,032	—	—	—

AUSTRALASIAN GOLD OUTPUTS.

	July.		August.	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	5,155	7,617	5,250	9,028
Blackwater (N.Z.)	3,100	4,905	3,230	5,538
Boulder Persev'ce (W.A.)	6,117	15,205	6,100	17,208
Grt. Boulder Pro. (W.A.)	10,248	28,957	9,836	27,776
Lake View & Star (W.A.)	8,010	15,722		
Sons of Gwalia (W.A.)	14,250	9,804	14 220	11,367
South Kalgurli (W.A.)	9,060	17,390	8,962	16,791
Waihi (N.Z.)	17,594	6,110* 27,333†	17,945	6,083* 37,851†

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	July.		August.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	4,300	2,405	3,500	2,745
Champion Reef	8,285	5,072	8,510	5,616
Mysore	18,521	9,380	18,552	8,405
Nundydroog	10,510	6,652	11,000	6,677
Ooregum	13,500	6,683	14,000	6,237

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	July.		August.	
	Tons	Value £	Tons	Value £
Chosen Synd. (Korea)	8,700	12,990		—
Frontino& Bolivia (C'lbia)	1,493	4,903	1,790	4,823
Lena (Siberia)	—	—	—	27,800
Lydenburg Plat. (Trans.)	3,620	801*p*	—	—
Marmajito (Colombia)	700	4,317	710	£3,690
Mexican Corp. Fresnillo	92,693	151,203*d*	—	
Onverwacht Platinum	2,488	423*p*	2,440	452*p*
Oriental Cons. (Korea)	—	72,000*d*	17,488	87,500*d*
St. John del Rey (Brazil)	—	39,000	—	41,000
Santa Gertrudis (Mexico)	52,139	120,238*d*	—	—

d dollars. *p* Oz. platinoids.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1929	5,840	July, 1929	5,802
February	4,896	August	5,610
March	5,236	September	—
April	5,433	October	—
May	5,405	November	—
June	5,523	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Batu Caves	36	46	31
Changkat	25	75	120
Chenderiang	24	27	30
Gopeng	83	83	80
Hong Kong Tin	—	—	42
Idris Hydraulic	41¾	35¾	32¾
Ipoh	25¾	41¾	37
Jelapang	35	36	42
Kamunting	103	103	83½
Kent (F.M.S.)	48	48	36
Kepong	34	36	34
Kinta	30	31	30
Kinta Kellas	26¾	47½	38¾
Kramat Pulai	19	17¾	19½
Kuala Kampar	115	115	120
Kundang	30	15	—
Lahat	13⅔	12⅔	11½
Larut Tinfields	72½	82	81
Malaya Consolidated	55	41¾	70½
Malayan Tin	125	119	125
Meru	13	25	27
Pahang	222	222	222
Pengkalen	77½	89	86
Petaling	46	184½	202½
Rahman	71⅓	53½	53½
Rambutan	13½	11	11
Rantau	38	35	43
Rawang	55	55	50
Renong	60½	66½	49¾
Selayang	29	23	17½
Southern Malayan	190½	184½	184½
Southern Perak	95¼	86¼	65½
Southern Tronoh	30	21	18
Sungei Besi	46	48	45
Sungei Kinta	39½	28	42¼
Sungei Way	89¼	89¼	89¼
Taiping	45	75	40
Tanjong	32	34	27
Teja Malaya	14	20¾	18¼
Tekka	45	45	46
Tekka-Taiping	48	45	39
Temoh	37	37¾	43
Tronoh	113½	108	133

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Amari	5¾	9¾	14
Anglo-Nigerian	50	47	—
Associated Tin Mines	260	260	250
Baba River	4¾	3	—
Batura Monguna	2	2	—
Bisichi	70	76	90
Daffo	7	9	—
Ex-Lands	50	50	—
Filani	2½	5	11½
Jantar	45	52	45
Jos	17½	19	—
Juga Valley	17	20	20
Junction	6	4	2½
Kaduna	29	31¾	—
Kaduna Prospectors	23¼	21¼	—
Kassa	18	20	—
Lower Bisichi	6½	6¼	—
Mongu	40	40	60
Naraguta	27¾	45	—
Naraguta Durumi	15¼*	12	—
Naraguta Extended	20	25	—
Naraguta Karama	16½	21	—
Naraguta Korot	13	20	—
Nigerian Base Metals	47	34	—
Nigerian Consolidated	20	20	20
N.N. Bauchi	180	140	120
Offin River	6¼	4¾	5½
Ribon Valley	13	15	—
Ropp	81	90	105
Rukuba	4¼	5½	—
South Bukeru	13½	9½	—
Tin Fields	5	7	8
Tin Properties	13	20	20
United Tin Areas	17½	23	—
Yarde Kerri	9	10	—

* May and June.

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	June.	July.	August.
Anglo-Burma (Burma)	8¾	20½	30¼
Aramayo Mines (Bolivia)	338	374	332
Bangrin (Siam)	67¼	64½	76½
Berenguela (Bolivia)	38	38	31
C'nsolidated Tin Mines (Burma)	82	150	200
East Pool (Cornwall)	85½	85½	—
Fabulosa (Bolivia)	105	124½	120
Geevor (Cornwall)	70	71	72
Jantar (Cornwall)	25¼	25½	—
Kagera (Uganda)	23	28	28
Polbigey (Cornwall)	32	33	30
San Finx (Spain)	40½*	39½*	37½*
Siamese Tin (Siam)	154¼	169	159¼
South Crofty (Cornwall)	62¾	65½	69
Tavoy Tin (Burma)	41	40	41
Theindaw (Burma)	5½	8	9
Tongkah Harbour (Siam)	110	85	97
Toyo (Japan)	—	—	—
Wheal Kitty (Cornwall)	50	36	36
Wheal Reeth (Cornwall)	—	13½	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		July.	August.
Broken Hill South	Tons lead conc.	9,109*	—
	Tons zinc conc.	7,624*	—
Burma Corporation	Tons refined lead	6,500	6,505
	Oz. refined silver	580,923	600,194
Bwana M'Kubwa	Tons copper oxide	626	663
Electrolytic Zinc	Tons zinc	3,895	3,925
Indian Copper	Tons copper	162	185
Messina	Tons copper	596	587
Mount Lyell	Tons concentrates	3,006†	—
Namaqua	Tons copper	215	200
North Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Poderosa	Tons copper ore	1,450	1,352
Rhodesia Broken Hill	Tons lead	80	—
	Tons slab zinc	1,081	1,085
San Francisco Mexico	Tons lead conc.	3,300	2,567
	Tons zinc conc.	4,145	3,091
Sulphide Corporation	Tons lead conc.	1,780	1,834
	Tons zinc conc.	2,527	2,425
Tetiuhe	Tons lead conc.	398	577
	Tons zinc conc.	886	1,182
Union Minière	Tons copper	11,800	—
Zinc Corporation	Tons lead conc.	5,377	—
	Tons zinc conc.	4,416	—

* Six weeks. † Four weeks to Aug. 14.

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

		June.	July.
Iron Ore	Tons	410,950	480,858
Manganese Ore	Tons	41,446	21,583
Iron and Steel	Tons	234,208	237,220
Copper and Iron Pyrites	Tons	33,960	21,805
Copper Ore, Matte, and Prec.	Tons	1,817	4,869
Copper Metal	Tons	15,240	13,798
Tin Concentrate	Tons	9,984	5,150
Tin Metal	Tons	1,443	1,639
Lead Pig and Sheet	Tons	19,319	22,943
Zinc (Spelter)	Tons	8,691	10,634
Zinc Sheets, etc.	Tons	1,755	1,577
Aluminium	Tons	2,162	2,259
Quicksilver	Lb.	4,0[illegible]	16,777
Zinc Oxide	Tons	1,059	1,054
White Lead	Cwt.	12,733	9,996
Red and Orange Lead	Cwt.	3,885	5,355
Barytes, ground	Cwt.	66,142	64,046
Asbestos	Tons	3,178	1,440
Boron Minerals	Tons	600	1,298
Borax	Cwt.	12,155	17,133
Basic Slag	Tons	7,303	1,515
Superphosphates	Tons	5,751	3,303
Phosphate of Lime	Tons	25,501	19,647
Mica	Tons	209	187
Sulphur	Tons	3,[illegible]	12,649
Nitrate of Soda	Cwt.	99,342	22,626
Potash Salts	Cwt.	54,700	160,052
Petroleum: Crude	Gallons	45,813,186	63,607,149
Lamp Oil	Gallons	14,147,716	11,355,771
Motor Spirit	Gallons	59,560,[illegible]	70,054,633
Lubricating Oil	Gallons	8,972,599	7,941,437
Gas Oil	Gallons	10,017,854	9,670,655
Fuel Oil	Gallons	31,347,554	39,165,639
Asphalt and Bitumen	Tons	21,301	20,544
Paraffin Wax	Cwt.	122,757	101,569
Turpentine	Cwt.	52,670	49,221

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	June.	July.	August.
Anglo-Ecuadorian	15,630	16,047	16,085
Apex Trinidad	38,290	38,040	34,200
Attock	4,653	4,839	7,329
British Burmah	5,415	6,021	5,930
British Controlled	31,871	33,174	34,547
Kern Mex	827	736	—
Kern River (Cal.)	3,344	5,074	—
Kern Romana	2,605	3,771	—
Kern Trinidad	3,441	4,006	—
Lobitos	26,147	27,763	27,805
Phœnix	38,178	41,853	44,271
St. Helen's Petroleum	27,515	19,887	—
Steaua Romana	68,040	75,920	83,480
Tampico	2,940	2,753	—
Trinidad Leaseholds	30,400	31,000	33,550
Venezuelan Consolidated	2,190	5,128	4,224

QUOTATIONS OF OIL COMPANIES SHARES.

Denomination of Shares £1 unless otherwise noted.

	Aug. 9, 1929			Sept. 9, 1929		
	£	s.	d.	£	s.	d.
Anglo-American	3	0	0	3	2	6
Anglo-Ecuadorian	1	0	0	1	0	6
Anglo-Egyptian B	2	10	0	2	12	6
Anglo-Persian 1st Pref.	1	7	6	1	6	0
„ „ Ord.	4	2	0	4	5	6
Apex Trinidad (5s.)	1	8	0	1	10	0
Attock	2	16	3	2	19	6
British Burmah (8s.)		6	6		6	9
British Controlled ($5)		5	0		5	3
Burmah Oil	4	2	0	4	5	6
Kern River, Cal. (10s.)		7	9		7	9
Lobitos, Peru	2	1	3	2	3	0
Mexican Eagle, Ord. (4 pesos)		14	0		16	9
„ „ 8% Pref. (4 pesos)		12	0		15	9
Phœnix, Roumania		11	6		11	6
Royal Dutch (100 fl.)	31	12	6	34	17	6
Shell Transport, Ord.	4	10	0	4	17	6
„ „ 5% Pref. (£10)	9	15	0	9	15	0
Steaua Romana		10	0		10	9
Trinidad Leaseholds	4	1	3	4	5	6
United British of Trinidad (6s. 8d.)		8	9		9	6
V.O.C. Holding	3	10	0	3	15	0

PRICES OF CHEMICALS. September 6.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		16	6
„ 80%	„	1	16	0
„ Glacial	per ton	66	0	0
Alum	„	8	10	0
Alumina, Sulphate, 17 to 18%	„	6	15	0
Ammonia, Anhydrous	per lb.			10
„ 0·880 solution	per ton	15	10	0
„ Carbonate	„	27	10	0
„ Nitrate	„	24	0	0
„ Phosphate	„	40	0	0
„ Sulphate, 20·6% N.	„	9	9	0
Antimony, Tartar Emetic	per lb.			10¾
„ Sulphide, Golden	„			7
Arsenic, White	per ton	16	0	0
Barium Carbonate, 94%	„	5	10	0
„ Chloride	per ton	12	0	0
„ Sulphate, 94%	„	5	0	0
Benzol, standard motor	per gal.		1	9½
Bleaching Powder, 35% Cl.	per ton	7	0	0
„ Liquor, 7%	„	3	5	0
Borax	„	14	0	0
Boric Acid	„	25	0	0
Calcium Chloride	„	5	10	0
Carbolic Acid, crude 60%	per gal.		2	3
„ „ crystallized, 40°	per lb.			8¾
Carbon Disulphide	per ton	24	0	0
Citric Acid	per lb.		2	1½
Copper Sulphate	per ton	26	10	0
Cyanide of Sodium, 100% KCN	per lb.			7
Hydrofluoric Acid	„			6
Iodine	per oz.		1	0
Iron, Nitrate	per ton	6	10	0
„ Sulphate	„	1	17	6
Lead, Acetate, white	„	39	10	0
„ Nitrate	„	34	0	0
„ Oxide, Litharge	„	37	10	0
„ White	„	38	0	0
Lime, Acetate, brown	„	8	0	0
„ „ grey, 80%	„	16	10	0
Magnesite, Calcined	„	9	0	0
Magnesium, Chloride	„	6	15	0
„ Sulphate	„	3	0	0
Methylated Spirit 64° Industrial	per gal.		1	5
Nitric Acid, 80° Tw.	per ton	21	0	0
Oxalic Acid	per cwt.	1	13	0
Phosphoric Acid	per ton	29	15	0
Potassium Bichromate	per lb.			4½
„ Carbonate	per ton	24	15	0
„ Chlorate	per lb.			2¾
„ Chloride 80%	per ton	9	0	0
„ Hydrate (Caustic) 90%	„	32	5	0
„ Nitrate, refined	„	20	10	0
„ Permanganate	per lb.			5¼
„ Prussiate, Yellow	„			6¾
„ „ Red	„		1	9
„ Sulphate, 90%	per ton	11	5	0
Sodium Acetate	per ton	21	0	0
„ Arsenate, 45%	„	26	0	0
„ Bicarbonate	„	10	10	0
„ Bichromate	per lb.			3⅝
„ Carbonate (Soda Ash)	per ton	6	0	0
„ „ (Crystals)	„	5	5	0
„ Chlorate	per lb.			2½
„ Hydrate, 76%	per ton	14	10	0
„ Hyposulphite	„	9	0	0
„ Nitrate, 96%	„	9	9	0
„ Phosphate	„	11	0	0
„ Prussiate	per lb.			4¾
„ Silicate	per ton	9	10	0
„ Sulphate (Salt-cake)	„	2	10	0
„ „ (Glauber's Salt)	„	2	5	0
„ Sulphide	„	9	0	0
Sulphur, Roll	„	10	10	0
„ Flowers	„	12	0	0
Sulphuric Acid, 168°	„	6	5	0
„ „ free from Arsenic, 144°	„	4	0	0
Superphosphate of Lime, 35%	„	3	0	0
Tartaric Acid	per lb.		1	4½
Turpentine	per ton	45	10	0
Tin Crystals	per lb.		1	6½
Titanous Chloride	„			10
Zinc Chloride	per ton	12	0	0
Zinc Dust	„	32	0	0
Zinc Oxide	„	42	0	0
Zinc Sulphate	„	9	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	August 9, 1929. £ s. d.	Sept. 9, 1929. £ s. d.
SOUTH AFRICA:		
Brakpan	4 7 6	4 6 3
City Deep	11 3	13 3
Consolidated Main Reef	19 3	18 6
Crown Mines (10s.)	3 4 6	3 4 6
Daggafontein	1 0 6	1 2 6
Durban Roodepoort Deep	10 0	11 3
East Geduld	1 15 6	2 0 0
East Rand Proprietary (10s.)	12 9	13 9
Ferreira Deep	6 3	6 3
Geduld	3 8 9	3 8 9
Geldenbuis Deep	4 6	5 0
Glynn's Lydenburg	2 6	2 6
Government Gold Mining Areas (5s.)	2 0 0	1 17 6
Langlaagte Estate	1 1 6	1 0 9
Meyer & Charlton	10 0	10 0
Modderfontein New (10s.)	5 6 3	5 3 0
Modderfontein B (5s.)	17 0	16 3
Modderfontein Deep (5s.)	1 8 9	1 7 6
Modderfontein East	1 10 6	1 7 6
New State Areas	1 12 6	1 12 6
Nourse	10 0	9 6
Randfontein	6 0	8 0
Robinson Deep A (1s.)	13 9	13 9
" " B	8 0	9 0
Rose Deep	5 0	6 3
Simmer & Jack (2s. 6d.)	3 3	3 9
Springs	3 5 6	3 4 6
Sub Nigel (10s.)	2 0 0	2 0 0
Van Ryn	8 0	8 0
Van Ryn Deep	1 18 0	1 16 3
Village Deep	5 0	7 0
West Rand Consolidated (10s.)	6 9	7 6
West Springs	18 3	18 0
Witwatersrand (Knight's)	7 3	7 6
Witwatersrand Deep	4 6	5 0
RHODESIA:		
Cam and Motor	1 13 9	1 7 6
Gaika	6 6	4 3
Globe and Phœnix (5s.)	10 0	10 0
Lonely Reef	1 2 6	1 1 3
Mayfair	1 0 0	1 0 0
Rezende	1 0 0	16 3
Shamva	5 0	6 3
Sherwood Starr	16 3	17 9
GOLD COAST:		
Ashanti (4s.)	1 5 0	1 4 6
Taquah and Abosso (5s.)	2 0	2 0
AUSTRALASIA:		
Golden Horseshoe (Pref., 5s.), W.A.	13 3	14 3
Great Boulder Proprietary(2s.),W.A.	1 9	2 0
Lake View and Star (4s.), W.A.	12 6	13 6
Sons of Gwalia, W.A.	2 3	2 3
South Kalgurli (10s.), W.A.	16 0	14 3
Waihi (5s.), N.Z.	11 6	13 0
Wiluna Gold, W.A.	1 1 3	1 3 6
INDIA:		
Balaghat (10s.)	4 6	5 0
Champion Reef (10s).	8 0	9 9
Mysore (10s.)	12 6	12 0
Nundydroog (10s.)	16 0	17 0
Ooregum (10s.)	9 0	8 0
AMERICA:		
Camp Bird (2s.), Colorado	1 9	2 9
Exploration (10s.)	9 0	9 0
Frontino and Bolivia, Colombia	7 6	7 6
Mexican Corporation, Mexico	16 0	17 9
Mexico Mines of El Oro, Mexico	5 0	6 3
Panama Corporation	18 3	19 0
St. John del Rey, Brazil	15 6	15 9
Santa Gertrudis, Mexico	9 9	9 6
Selukwe (2s. 6d.), British Columbia	6 0	5 9
MISCELLANEOUS:		
Chosen, Korea	1 1 3	1 0 0
Ellyou (5s.), New Guinea	1 4 0	1 7 0
Lena Goldfields, Russia	3 9	3 6

COPPER:	August 9, 1929. £ s. d.	Sept. 9, 1929. £ s. d.
Bwana M'Kubwa (5s.) Rhodesia	1 1 6	1 14 9
Esperanza Copper, Spain	19 6	1 1 6
Indian (2s.)	2 6	2 6
Loangwa (5s.), Rhodesia	8 0	9 6
Luiri (5s.), Rhodesia	6 0	7 0
Messina (5s.), Transvaal	16 6	19 9
Mount Lyell, Tasmania	2 1 6	2 3 9
Namaqua (£2), Cape Province	18 9	18 9
N'Changa, Rhodesia	3 7 6	3 17 6
Rhodesia-Katanga	1 18 0	2 2 0
Rio Tinto (£5), Spain	53 0 0	53 0 0
Roan Antelope (5s.), Rhodesia	2 4 6	2 10 0
Tanganyika, Congo and Rhodesia	3 0 6	3 3 0
Tharsis (£2), Spain	5 15 0	5 12 6

LEAD-ZINC:	August 9, 1929. £ s. d.	Sept. 9, 1929. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	15 6	15 0
Broken Hill Proprietary, N.S.W.	1 9 6	1 9 3
Broken Hill North, N.S.W.	5 10 0	5 17 6
Broken Hill South, N.S.W.	3 8 9	3 10 0
Burma Corporation (10 rupees)	18 0	18 0
Electrolytic Zinc Pref., Tasmania	1 17 6	1 17 6
Mount Isa, Queensland	1 17 6	2 0 0
Rhodesia Broken Hill (5s.)	3 9	4 3
San Francisco (10s.), Mexico	1 14 6	1 15 3
Sulphide Corporation (15s.), N.S.W.	18 6	1 1 3
ditto, Pref.	1 6 0	1 7 0
Zinc Corporation (10s.), N.S.W.	2 8 9	2 11 3
ditto, Pref.	4 12 6	4 15 0
TIN:		
Aramayo Mines (25 fr.), Bolivia	3 0 0	2 18 9
Associated Tin (5s.), Nigeria	9 0	9 0
Bangrin, Siam	1 16 3	1 15 0
Bisichi (10s.), Nigeria	8 3	8 9
Chenderiang, Malay	8 9	9 0
Consolidated Tin Mines of Burma	10 0	9 6
East Pool (5s.), Cornwall	1 6	1 6
Ex-Lands Nigeria (2s.), Nigeria	2 6	2 6
Geevor (10s.), Cornwall	8 0	7 3
Gopeng, Malaya	2 3 9	2 3 9
Idris (5s.), Malaya	13 9	13 6
Ipoh Dredging (16s.), Malay	1 9 0	1 7 3
Kaduna Prospectors (5s.), Nigeria	11 0	10 0
Kaduna Syndicate (5s.), Nigeria	1 0 0	17 6
Kamunting (5s.), Malay	14 3	14 6
Kepong, Malay	1 7 6	1 6 3
Kinta, Malay	12 6	12 6
Kinta Kellas, Malay	1 13 9	1 13 9
Kramat Pulai, Malay	1 7 6	1 8 6
Lahat, Malay	14 0	13 6
Malayan Tin Dredging (5s.)	1 7 0	1 7 6
Mongu (10s.), Nigeria	8 3	8 0
Naraguta, Nigeria	18 9	18 9
Nigerian Base Metals (5s.)	3 6	3 6
N.N. Bauchi, Nigeria (10s.), Ord.	1 3 9	1 4 0
ditto (10s.), Pref.	1 8 9	1 8 9
Pahang Consolidated (5s.), Malay	10 3	10 3
Penawat ($1), Malay	2 3	2 6
Pengkalen (5s.), Malay	19 6	1 0 0
Petaling (2s. 4d.), Malay	13 3	13 0
Rambutan, Malay	18 0	16 9
Renong Dredging, Malay	1 13 9	1 11 3
Ropp (4s.), Nigeria	9 0	9 0
Siamese Tin (5s.), Siam	14 0	14 3
South Crofty (5s.), Cornwall	4 9	4 0
Southern Malayan	17 0	17 3
Southern Perak, Malay	2 15 0	2 15 0
Southern Tronoh (5s.), Malay	11 9	12 0
Sungei Besi (5s.), Malay	14 3	14 6
Sungei Kinta, Malay	1 1 0	1 1 0
Tanjong (5s.), Malay	15 6	15 9
Tavoy (4s.), Burma	10 0	10 9
Tekka, Malay	1 0 9	1 1 6
Tekka Taiping, Malay	1 3 3	1 4 0
Temengor, Malay	1 13 0	1 14 6
Toyo (10s.), Japan	10 0	10 6
Tronoh (5s.), Malay	1 1 3	1 0 9
DIAMONDS:		
Consol. African Selection Trust (5s.)	1 10 0	1 8 9
Consolidated of S.W.A.	1 5 0	1 5 3
De Beers Deferred (£2 10s.)	12 7 6	12 8 9
Jagersfontein	2 6 3	2 10 0
Premier Preferred (5s.)	5 17 6	5 15 0
FINANCE, ETC.:		
Anglo-American Corporation	2 0 0	2 3 9
Anglo-French Exploration	1 2 6	1 2 0
Anglo-Continental (10s.)	10 0	10 0
Anglo-Oriental (Ord., 5s.)	11 0	10 0
ditto, Pref.	1 0 0	19 0
British South Africa (15s.)	2 0 0	2 2 9
Central Mining (£8)	18 5 0	18 15 0
Consolidated Gold Fields	2 12 0	2 17 6
Consolidated Mines Selection (10s.)	17 0	18 9
Fanti Consols (8s.)	14 9	14 9
General Mining and Finance	1 0 0	1 0 0
Gold Fields Rhodesian (10s.)	10 0	11 6
Johannesburg Consolidated	2 7 0	2 9 6
London Malayan	14 9	17 3
London Tin Syndicate	3 0 9	3 0 6
Minerals Separation	6 7 6	6 10 0
National Mining (8s.)	3 3	3 6
Rand Mines (5s.)	3 1 3	3 2 0
Rand Selection (5s.)	17 0	17 6
Rhodesian Anglo-American (10s.)	1 12 6	2 9 6
Rhodesian Congo Border	10 0 0	10 5 0
Rhodesian Selection Trust (5s.)	3 11 3	4 2 6
South African Gold Trust	1 10 0	1 10 0
Southern Rhodesia Base Metals	1 1 3	1 5 0
Tigon (5s.)	1 7 6	1 7 6
Tin Selection Trust	1 6 0	1 4 6
Union Corporation (12s. 6d.)	4 0 0	4 3 9
Venture Trust (10s.)	7 6	8 3

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

CONCENTRATION BY JIGS ON TIN DREDGES

In the course of an article on practice in Malayan Tin-Dredging, which was summarized in the August issue of the MAGAZINE, A. J. Kelman gave a short account of the history of jigging concentration on tin dredges. It was stated that several dredges, after installing the Newsom classifier and jig system, found the classifier unnecessary, as the jigs would work equally well if the material feeding them had been passed through a screen. Recent jigging practice is well covered by a paper of O. B. Williams, of Southern Malayan Tin Dredging, Ltd., which was read before the Malayan Tin Dredging, Mining and Research Association on April 24 last. The writer after stating that the choice of the dredge will be decided mainly by economic factors goes on to say that, prior to considering the final method of concentration, the screen must be considered, as it controls the amount and quality of feed coming to the plant. It may be treated as a trommel and the various considerations in regard to it are as follows :—(*a*) Slope, (*b*) Diameter, (*c*) Length, (*d*) Speed, (*e*) Size of screen hole. The capacity of the screen is dependent on factors *a*, *b*, *c*, and *d*.

The influence of these factors may be summarized as follows :—(*a*) *Slope*. For the same quantity of ore with a steeper slope the bed will be thinner with consequent improved screening. (*b*) *Diameter*. Provided that the lengths and slopes are the same, and the speeds are such as to equalize the centrifugal force, the capacities are proportional to the diameters. (*c*) *Length*. The shorter the length the higher the slope required. (*d*) *Speed*. Increase of speed means increased capacity. It also increases the centrifugal force tending to blind the screen, but the effect of this is not serious with peripheral speeds up to 140 ft. per minute.

The fifth factor *e* (size of screen opening) is generally decided by previous experience after careful examination of the wash. It is usual to make this opening slightly larger than the largest particle it is desired to pass through. The openings are usually circular, and it would be interesting to investigate whether a slotted hole, set with the longer axis parallel to the path of travel of a particle in the screen, would not give a more efficient screening area. Edison pointed out that the trajectory of a moving particle requires a hole to be lengthened in the direction of the path of the particle in order that the grain of maximum permissible size may pass through.

The whole question of screening seems worthy of investigation. An average " karang " or rather " wash " weighs approximately 3,000 lb. per cubic yard, and with ground averaging 0.5 lb. per cubic yard the endeavour is to save 1 in every 6,000 parts by weight. The present method is to treat the majority in the concentrating machines, whereas, could the majority be discarded and a small portion only treated, the problem would be simplified. The advantages would be that there would be smaller quantities to concentrate, with consequently fewer machines to operate, that the feed could be controlled more easily, and that there would be a higher grade feed with better concentrating conditions as a natural corollary. The primary screen, as at present, may have to be retained but it is possible that a secondary battery of vibrating screens may offer a solution.

There are two methods of concentration in use with dredges, namely, sluice boxes (palongs) and jigs, and the main points to be considered in deciding which method to use are the following :—

1. *The quality of the tin present*. The term " quality " is used here to describe whether the tin be coarse or fine, and so far there has been no agreement arrived at as to exactly what constitutes a " fine " tin. Some arbitrary standard has therefore to be taken, and for the purposes of this paper " fine " tin is understood to represent the through product of a 40 mesh I.M.M. screen.

Both machines will do good work on coarse tin, but it is doubtful whether, even with coarse tin, the sluice box losses can be reduced to 1% or under, whereas a properly set and operated jig should be capable of such work.

In regard to fine tin, apart from the losses which are normal to sluice boxes while operating, the losses of fine tin during washing up are a factor against the adoption of this machine. It is doubtful whether cutting up the ground in the sluice boxes is not a source of loss, and in many Chinese properties visited recently, the usual Australian practice of dispensing with this work has been adopted, one man only being employed to place the necessary stops in position, and to see that the water does not channel.

The jig has shown good recoveries on feeds with a mineral content as low as 0·25 mm. diameter. Further, the operator has definite control of the work, and is able, during operation, to control irregularities by various adjustments easily made.

2. *The associated wash*. If the wash is " free " no particular difficulty is encountered in concentrating but should the wash contain clays a source of loss is established. With such a feed many experienced dredge-masters would install sluice boxes, but it has been demonstrated that the jig is capable of making good recoveries under such conditions, and as stated above, the operator has a degree of control in operation denied to the sluice box.

3. *Capacity*. The results shown by dredges equipped with jigs have been invariably higher than sluice box dredges under similar operating conditions, and this increased capacity has been attained without detriment to the recovery of tin.

In summing up, the various factors considered above all indicate that the jig is a more efficient machine, and possesses greater flexibility.

The main factors to be considered in the installation of jigs are the following :—

1. *Methods of operation.* Jigs may be operated in any one of three ways, namely, (*a*) To make a concentrate and residue only. (*b*) To make a concentrate, a hutch product and a residue, the hutch product or "middling" being retreated. (*c*) To make a hutch product for further treatment and a residue. Dealing with such large quantities of low grade material as are encountered in dredging would entail a great amount of care and attention, and a large staff, if operated under either of the first two methods. The third method has been adopted in certain Malayan dredges as the primary treatment, followed by a secondary treatment to clean up the product. This secondary treatment is operated under method *b*. By this arrangement the final treatment is carried out on a much smaller quantity of a higher grade and, under conditions capable of better supervision.

2. *Method of distribution of feed to the jigs.* The method of distribution to the jigs is of paramount importance, as unless the jig has a regular uniform feed it is impossible to attain the best results. In the majority of cases the feed is drawn from the screen hopper, through a series of gates on each side of the hopper, each gate supplying a separate jig, and a certain length of hopper being allotted to each jig. The screen tends to throw more feed to one side than to the other, according to the direction of rotation, one set of jigs therefore being more heavily loaded than the other. The screen also discharges a heavier feed at the top than at the bottom and the jigs opposite the top end are consequently liable to heavy overloads whereas the later jigs are starved.

The sparge pipe also gives an excess of water, much of which is run off at the bottom of the hopper, but there is a danger of some jigs having excess water while the others have too little. The feed is also intermittent, the hopper not having sufficient capacity to control this condition. From the above it will be seen that the conditions ruling are such as to militate against efficiency.

To rectify the first two defects longitudinal and latitudinal baffles are placed in the hopper to control the distribution of the feed, but owing to the currents set up by the excess water even the best system is inefficient. The solution would appear to be the placing of a control system between the screen hopper and the jigs which will act,—(*a*) As an equalizer of the quantity of feed. (*b*) A distributor, delivering an equal load of similar quality to each jig. (*c*) A de-waterer to eliminate the excess water.

3. *Classification.* The question of classification or otherwise is still on trial. The primary screen acts as a rough classifier, and other types, principally on the lines of hindered settling, have been introduced between the screen and the jigs. This type of machine may act as a de-slimer and, to some extent, a de-waterer and feed control. Acting on the principles of hindered settling it produces a feed of equal specific gravity and unequal size, which is not an ideal type of feed to the jig. Water is added also at a time when it is necessary to reduce. The ideal feed for a jig is equally sized particles of different specific gravity, and this can only be obtained by screen sizing. Sufficient research has not as yet been done, or if so the data have not been published, to determine whether screen sizing would be economic, but it is an attractive field for investigation, and is common mill practice on most mining fields. It may be pointed out in passing that the term "classification" is used comprehensively to include classification by water, and screen sizing, though the results of the two operations are the opposite of each other.

4. *Capacity.* The capacity is influenced by a number of considerations. The most important is the width of the screen. Other things being equal, the capacity is nearly proportional to the width of the screening area, which has a fixed ratio to the size of the plunger cell area. The length also affects the capacity but not proportionately. The rate of settling of the mineral grains varies, from the quick settling heavy compact grains to the slowly settling fine grains. It follows that the longer the sieve the more of these finer grains will be caught, but, on the other hand, each additional inch of length catches less than the previous one while it calls for its full proportion of hydraulic water. Partially to overcome the difficulty is one of the reasons for the use of a series of shorter sieves. The area of the sieve surface is an important factor, as within certain limits the length and width are, perhaps, interchangeable ; that is, the capacity is proportional to the area.

5. *Flat or sloping jigs.* Both types have been introduced and opinions as to the merits of the respective types vary considerably. The sloping jig is said to have a higher capacity, but more data on the subject are required. Speaking generally, the capacity of a flat sieve jig is governed by the current of transporting water and the drop between screens. A large current of water is apt to lead to losses of fine tin, and therefore a high drop between screens has been adopted in an endeavour to avoid the losses due to high velocity and depth of this supernatant water. It has been shown that the depth of supernatant water above the sand on the jig is an important factor in tin saving, and unless this depth is kept within limits, losses of fine tin will occur. With a flat sieve, sorting commences when the feed enters the jig, and just when settled conditions of sorting are attained, the pulp is precipitated over the end dropping on to the next sieve. With the consequent splashing and disturbance the sorting is broken up and has to commence afresh. With a sloping jig the higher the slope the less the transporting current of water required, and once the feed enters the jig sorting is carried on continuously. The disadvantage with the sloping jig is that once pulsation starts the bottom bed or "ragging" at once takes a horizontal position and becomes a flat bed. This causes a creeping of the ragging with the slope, the ragging collecting at the tail end, leaving the head end almost bare. The conditions established cause boiling at the head and absolute deadness at the tail. To correct this cross baffles are placed in the jig.

6. *Size of sieve opening.* The opening in the sieve is usually slightly larger than the diameter of the largest permissible particle, and it has been shown that a slotted hole blinds less than a round one.

7. *Ratio of diameter of bottom bed or "ragging" to diameter of mineral particle.* Investigation carried out on various materials tends to show

that with an unclassified feed this ratio lies between 1·06 and 3. However no work has been done under local conditions and the operator generally judges the correct size from his previous experience.

8. *Speed.* The speed varies with the size of the feed. Coarse feeds require slow speeds while with fine material high speeds are necessary. With a natural or unclassified feed when clays are present, a matting of the bed is often experienced, and it may be found that an increase of speed will break up this matting and establish fluid conditions.

9. *Plunger clearance.* As clearance increases, the action of the plunger becomes less positive; for example, a jig with a heavy, tight, whole bed, will be less moved by a loose than by a tight fitting plunger; the millman overcomes this difficulty by giving it more movement. The advantage in a tight fitting plunger is that it will recover quickly from overloads. More clearance will be required when the hutch water is admitted above the plunger than when fed from below.

10. *Adjustments for control.* The following are the adjustments which control the product of the machines: (1) Depth of bottom bed. (2) Stroke. (3) Added water in hutch, or hydraulic water. (4) Feed water. They are used by the practical jigman working under normal conditions almost from moment to moment, and, although on dredges it is not always possible to utilize them to the same extent, they are the usual correctives of such irregularities as occur in working. These four headings are considered separately as follows:—

(1) *Depth of Bottom Bed.* The thicker the bottom bed of ragging the less freely the concentrates pass through, therefore the concentrate will be of a cleaner or higher grade. With a thin bottom bed the opposite is true. If the bottom bed is too thick a portion of what should go to the hutch fails to do so and may be lost in the tailings. For a high grade ore a thin bottom bed is required, and for a low grade feed a thick bed.

General practice under normal mill conditions seems to indicate that the bottom bed is usually half the height of the tail board. Under dredge conditions not sufficient work has been done to allow of any definite decision, and it would seem best to adhere to the above practice when starting up and to decrease or increase as the work demands.

(2) *Stroke.* There are two considerations under this head, namely, speed and the amount or length of stroke. Some few remarks on the speed have been made above and the length of stroke is controlled by the work the jig is doing, and being adjustable, may vary frequently. It is adjusted according to some arbitrary rule when the jigs are set up, and the jigman varies the throw from time to time until the jigs are doing the best work. Provided the conditions remain constant, once the throw giving the best results has been established, it is not customary to change it.

The considerations affecting the amount of throw are as follows:—

(*a*) The coarser the grains the longer the throw as coarse grains settle faster than fine and require a higher velocity of current and a greater quantity of water to lift them. For similar reasons the heavier the grains the greater the stroke.

(*b*) A deeper bottom bed or a high tail board resulting in a deeper bed of sand on the jig, will generally call for a longer stroke as there is more resistance to be overcome.

(*c*) If the amount of plunger clearance is large a longer stroke is necessary to counterbalance the leak back and loss of power. Further a plunger that is smaller than the sieve will require its stroke lengthened in proportion to the diminution.

(*d*) If there is any restriction in the water passage between the plunger and the sieve greater stroke is necessary to overcome this resistance.

In a general way the less the hydraulic water used the larger must be the stroke, but since hydraulic water contributes to pulsion and subtracts from suction, while increased stroke increases both pulsion and suction equally, it follows that increasing the hydraulic water is not the same as increasing the stroke. This is often overlooked. It is generally accepted that the millman must judge the condition of his jig by the appearance and feel of his whole bed, and must vary the throw of his plunger, or hydraulic water or some other adjustment until he gets it correct. The whole bed must be loose and soft during pulsion so that the fingers will settle into it without any effort as into quicksand, and when the tips of the fingers have reached the sieve, a decided suction will be felt on the return stroke. The particles of the top layer must be lifted during pulsion, yet the movement must not be so strong as to cause the breaking through or boiling of large water currents in spots, nor the suction so strong as to cause hardened banks which pulsion finds difficulty in softening. There is far more danger of finding these adverse conditions in jigging fine material than with coarse. When the jig is run with a bottom bed which is added from some outside source, in order to obtain the full benefit of the suction the bottom bed should be lifted during pulsion. Generally it may be said that if the corners and edges of the whole bed are right, the middle will take care of itself.

(3) *Hydraulic Water.* In general, jigs on course feed require more water than those on fine, this being due to the faster settling of large grains over small, to the fact that there is less friction in the passage of the water in the large interstices of a coarse bed, and because larger discharge openings are required above and below. It should be repeated that increase of water increases pulsion but decreases suction, the product being less in bulk but higher in grade. Too much water may even blow values into the residues.

(4) *Feed Water.* This may be necessary to obtain the required velocity of flow of the pulp over the jig, especially in times of overload. It should however be used with discretion, as it increases the depth of water above the bed of sand. This supernatant water, as it has been called, has its greatest velocity at the surface, and it has been demonstrated on sloping jigs that the critical depth of this stream above the bed of sand, beyond which losses of fine tin occur, is within the region of 3 in. It is a question as to whether it is not even more so in the case of a flat or stepped screen jig. In the run down a sloped jig the fines may just reach safety in the sand bed towards the end, under certain conditions of water velocity. With a stepped jig, with its drop between screens, and consequent stir up and rearrangement of particles between screens, the sorting is upset, and under similar water velocity conditions, it is questionable if some of the fines reach the safety of the sand bed.

General.—It will thus be realized that on our primary jigs strong suction is a necessity, and pulsion takes but a minor place. To obtain this the hydraulic water can be reduced and the depth of the bottom bed decreased.

On the clean up jig, a comparatively high-grade product is required from the first hutch, with again a free running jig on the remaining cells which are returned for retreatment. The first hutch therefore requires strong pulsion, which means increase of hutch water, or a deep bottom bed or both, while the remaining hutches are treated as in the primary jigs.

In bringing the hutch product from the primary jigs to the clean up jig there are two factors which require attention; these are the grade of the launders, and the de-watering and control system at the head of the clean up jig. From experience in various mills it has been demonstrated that for a lively free travelling material, such as quartz tailings, the minimum allowable slope is 1 in 8 if excess water is not to be added to wash the material down the launder. With the class of material handled in dredging the minimum would appear to be somewhere round the figures 1 in 6, as the material is dead when compared to quartz tailing. With regard to de-watering and control, this factor requires consideration from designers when laying out the plant. If "boiling" of the pulp in the de-watering appliances (with its consequent sending over the overflow fine sand and possibly values, which should come on to the jig) is to be avoided, then an allowance of so many cubic feet of settling area per jig feed to the de-waterer must be allowed to obtain the required reduction in velocity and quiet overflow. Judging from systems working in Malaya the allowance would seem to be about 8 cu. ft. per jig feed.

In conclusion it can be said that the jig has proved itself. The evolution of the sluice box dredge is the result of years of practice and study, and although the jig has been known for very many years, and is one of the most efficient primary concentrators, its application to dredging conditions is but recent, and the technique of its operation thereunder as yet but imperfectly understood.

PLATINUM CONCENTRATION IN SOUTH AFRICA

In the MAGAZINE for July a digest was given of a paper by R. A. Cooper and F. W. Watson, which described the results of research on platinum extraction by the chlorine process. This work was undertaken by the Rand Mines metallurgical department and further work in this department is embodied in a paper read by T. K. Prentice at the annual general meeting of the Chemical, Metallurgical, and Mining Society of South Africa. This paper dealt with the production of concentrates from Transvaal ores, including quartzite ore from the Waterberg district, dunite ore from the Lydenburg district, and norite ore, both oxidized and sulphide, from the Lydenburg and Rustenburg districts.

It was soon evident that average platinoid values were to be low, and it was seen that a preliminary concentration of the platinum values by some means or another was essential. The most successful methods tried for obtaining the preliminary concentrate, with which the paper deals, were, according to the nature of the ore, water gravity concentration by means of reciprocating tables, in conjunction with corduroy, or flotation, or a combination of both. Tests showed that a combination of flotation and gravity concentration would give a maximum extraction of about 93% of the platinum group metals in the Welgevonden ore. Gravity concentration alone gave results in the neighbourhood of 70%, and on these figures it was decided to lay down a plant taking in, at first, gravity concentration only, and to add flotation when the gravity section had settled down and the proposed methods of final extraction, by electro-amalgamation and chlorination, were established. A plant was accordingly erected and started operations in March, 1925. It ran smoothly from the start and gave results in accordance with expectations, having regard to the low value of the ore treated, which averaged from 3 to 5 dwt. per ton. On this basis the metallurgical outlook for the Welgevonden section seemed satisfactory, but extended development throughout the mine, from January, 1926, failed to disclose any appreciable quantity of payable ore, and the result was the closing down of the plant, in September, 1926.

Oxidized norite ores from a number of farms in the Lydenburg district and from Boschkoppies and Eerstegeluk, in the Rustenburg district, were tested over a considerable period. In the early stages of this work, the Rand Mines equipment did not include flotation apparatus and flotation tests were carried out by Minerals Separation, Ltd. Gravity tests showed that an extraction of about 37% of the values, in a concentrate weighing about 2% of the original ore, could be expected from Lydenburg oxidized norite ores. Flotation tests were unfavourable. A survey of the results obtained on these ores showed that neither method would give a percentage of extraction sufficiently high to make a 4 dwt. ore commercially profitable, and attention was therefore devoted chiefly to the more important problem of recovery from sulphide norite ores. In view of the promise of the flotation process becoming a large factor in the economic treatment of sulphide ores, it was considered necessary to conduct flotation tests on a semi-working scale to check all laboratory extraction tests previously made. Larger scale runs, by eliminating the incidence of the middling product, so prominent in the laboratory tests, would indicate more definitely what percentage concentration and extraction could be expected from these ores. Moreover, a greater quantity of concentrate was necessary for the continuation of research in order to determine the best method of recovering the platinum group metals contained in the concentrate. At this time, the research indicated that the sulphide concentrates would be treated either by smelting or chlorination, either of which methods definitely favoured a flotation concentrate, since certain deleterious minerals, such as chromite, which were present in gravity concentrates, did not appear in the flotation concentrates.

An attempt to use, at the Robinson gold mine, a flotation plant, capable of treating 150 tons per 24 hours, for the semi-working scale tests, proved abortive, due to the fact that the machine was too large, and that facilities for controlling dilution, re-cleaning, etc., were not satisfactory. It was therefore decided to build, at the Ferreira Deep experimental plant, a complete unit capable of treating up to 200 lb. per hour. This plant was erected and running in March, 1927. The crushing and grinding section of the plant consisted of a 4 in. Stockman crusher, capable of reducing the ore to minus ¼ in., followed by a Krupp ball-mill fitted with 40 linear mesh screening. A minimum of water was used in the Krupp mill. From there, the ore pulp gravitated to a ball-tube mill, 12 in. in diameter by 24 in. long, which was nearly half-full when charged with 300 lb. of steel balls, ranging from 1¼ in. downwards. The outflow from the ball-tube mill was elevated by a 2 in. centrifugal pump to a small classifying cone, the underflow of which gravitated back to the ball-tube mill inlet, and the overflow to the flotation unit.

The flotation unit was of the sub-aeration type and consisted of a mixing cell and five frothing cells, each of which was 12 in. square by 20 in. deep and fitted with diagonal baffles and a horizontal perforated grid plate. Shrouded impellers, 7 in. in diameter, revolving at 750 r.p.m., provided the agitation. Air, drawn from the mains of the Victoria Falls Power Co., through a reducing valve, was delivered under the impellers at a pressure of 4 to 5 lb. per square inch. Froth was taken from one side of the cells only, and was conducted over the lips by "crowding boards." The feed intake pipes and the tailing discharge pipes were fitted with water-jet attachments, so that, in case of choking, clearance could be effected without loss of pulp. Reagents were fed by special vacuum type feeders, and all water used was from the Rand Water Board domestic supply. Provision was made so that the combination of cells could be used in a variety of ways, the more important of which were :—

Arrangement "A."—The five cells in series giving a composite concentrate from the five cells and one flotation tailing.

Arrangement "B."—The five cells in series giving a finished concentrate from the first cell, a combined concentrate from the remaining four cells and one flotation tailing.

Arrangement "C."—The first three cells in series, giving a flotation tailing for discard, and a combined concentrate, which passed by gravity for re-cleaning into the remaining two cells in series. The tailing from these two cells was delivered by pump to join the feed to the first three cells. A finished concentrate was taken from the first only of the two re-cleaning cells, and the froth from the second gravitated back to join the feed to these two cells.

In all tests the flotation oil, or mixture of oils, was added to the feed end of the ball-tube mill and the potassium xanthate to the mixing cell. The amount of crude ore taken for every test was in the neighbourhood of 1,000 lb., the rate of feed being 150 lb. per hour. At each essential point, where the product was not collected *in toto*, dried, weighed and assayed, running time samples were taken at regular intervals for assay and determination of the weight of the product. At the end of each test the whole circuit was drained and the plant washings dried, weighed and assayed. The assumption was made, after a laboratory test, that if the plant washings had been completely treated by flotation, the concentrate and the tailing therefrom would have been equivalent to the concentrate and tailing obtained in the last stage in the flotation plant. Mathematical adjustments were made in all tests accordingly.

Seven half-ton tests were carried out on Der Brochen Lydenburg sulphide norite ore, using the different arrangements of cells and different flotation agents. The most successful result was obtained by subjecting the ore, after grinding to 89% minus 90, and oiling with a mixture of 1 lb. eucalyptus amygdalina and 1 lb. kerosene oil per ton of ore, to Arrangement "A." To the mixing cell was added potassium xanthate equivalent to 0·4 lb. per ton. The rough concentrate produced after partial dewatering by decantation, was then subjected to Arrangement "C." In this stage no oil was used, but xanthate equivalent to 0·2 lb. per ton of original ore was added. The dilution in the first roughing stage was 3½ : 1 ; in the second cleaning stage 11 : 1 ; and in the final re-cleaning stage about 20 : 1. Most of the clean water was added to the froth entering the two-cell re-cleaning section, and the dilution in the three-cell cleaning section was derived from the returned middlings from the re-cleaning section. A little fresh water was added to the feed of the three-cell section occasionally to keep the circuit balanced. The time of treatment was 30 minutes for roughing, 18 minutes for cleaning, and 10 minutes for re-cleaning. In the roughing stage, the machine was run until the froth became too thin to take off. The machine was then stopped for alteration to Arrangement "C," any residual pulp remaining in the machine being carried over to Stage 2. In Stage 2, the machine was run until no more froth came over, and then the whole of the pulp was run out and added to the cleanings from the grinding circuit to make the product called "plant washings."

The finished concentrate, assaying 77·55 dwt. per ton, constituted 5·09% of the original weight, representing an extraction of 88·76% of the platinum group metals. This result confirmed the promising possibilities of flotation indicated by the laboratory tests.

The advantages of the flotation method adopted for treating this ore are that outlets are provided for the talcy gangue in such a manner that the possibility of it accumulating in the circuit is reduced to a minimum, and that the use of an unlimited amount of water is permissible in the cleaning stages without affecting the dilution in the roughing stage, where an excessively dilute pulp would interfere with the extraction. The presence of an adequate amount of clean water during cleaning operations is one of the most important factors governing the production of high-grade concentrates.

Other tests indicated that the mixture of eucalyptus and paraffin oils gave better results than eucalyptus oil alone, which, in turn, was better than M.S.F.O. (blast-furnace creosote). Potassium xanthate increased the floatability of the sulphides and prevented the formation of a tough voluminous froth difficult to handle in practice. Starch was tried as a modifier, and it was found that richer concentrates could be obtained in the roughing stage, but the action of starch is intricate, and it was found that with its use, difficulties arose in the subsequent cleaning operations. Cresylic acid and sodium silicate were tried without improved results.

In two of the tests on Lydenburg sulphide norite ore gravity concentration of the flotation tailing and the flotation middling was tried. In the former case, the gravity concentrate consisted chiefly of chromite, which does not readily float, with some coarse iron pyrites. It assayed only 10·2 dwt. per ton, indicating that the platinum in this ore is not associated to any appreciable extent with the chromite. The gravity concentrate weighed 1·2% of the original ore, and carried 2·41% of the original platinum content. This concentrate could not be considered a finished product, and in practice the best procedure would be to return it to the grinding circuit. The gravity concentration of the middling product gave a concentrate low in chromite and assaying 62 dwt. per ton, but the percentage extraction was no better than on the Stage 1 tailing, so that re-flotation appeared preferable to gravity concentration on this product. It was agreed that gravity concentration would be a useful adjunct to flotation, if applied as a scavenging treatment to flotation residues, insomuch as it would be a valuable indication of the quality of the work being done in the flotation section, and a further amount of platinum would be extracted from the residues and returned to the flotation section for further treatment, resulting in probable eventual recovery. The application of gravity concentration prior to flotation was not considered advisable, as the weight of concentrates to be treated by subsequent processes would be increased practically by the weight of the gravity concentrate produced, since the greater part of the weight of the flotation concentrate is made up of the talcy gangue, which would remain unchanged by the preliminary gravity concentration. In other words, the use of tables ahead of flotation would enhance and not alleviate the chief difficulty in the concentration of norite ores, namely, the obtaining of a satisfactory ratio of concentration.

In Germany, semi-working scale flotation tests were carried out by Fried. Krupp on this ore. An extraction of 86·73% was obtained into a concentrate weighing 11·83% of the original ore, and assaying 28·6 dwt. per short ton. This, however, is based on an assumption that a middling product, assaying 11·2 dwt. per ton, being returned to the grinding circuit, would not build up in the circuit and adversely affect the extraction. The German conclusion was that, in practice, a concentrate would be obtained, 5 to 6% by weight, assaying about 64 dwt. per ton and carrying 80 to 85% of the values.

Tests were carried out on oxidized ore from Boschkoppies and Brakspruit and quite favourable results were secured from ore taken between 50 and 100 ft. of the outcrops, an example being over 71% of the values in a concentrate of 4·91% by weight. Flotation tests on Eerstegeluk ore, taken from a zone intermediate between oxidized and true sulphide, gave an extraction of 85·2% with a concentration ratio of 18·2 : 1.

Another consignment of sulphide norite ore was received in September, 1927, taken from the 1,000 ft. level of the incline shaft of the Eerstegeluk mine. Unlike the previous consignment, this ore showed little evidence of natural weathering processes. It contained a large proportion of chromite, and sulphide minerals were more plentiful. The ore value was between 9 and 10 dwt. per ton. A large scale flotation test carried out in the same way as on the first consignment, gave a flotation concentrate weighing 4·8% of the original and assaying 169 dwt. per ton. The extraction was 84·3%, and the ratio of concentration 20·8 to 1. This result was very similar to that carried out on the first consignment of half the value. Gravity concentration of the final tailings gave a gravity concentrate amounting to 4·4% of the original ore and carrying a further 2·17% of the values. This concentrate assayed 4·72 dwt. per ton. On this consignment, another large scale test was carried out in which gravity concentration preceded flotation. This test was directly comparable with the one just described in which flotation preceded gravity concentration. In the two tests, the extraction and the concentration ratio were practically the same, but the former gave a high valued flotation concentrate and low valued gravity concentrate, whereas the reverse was the case in the latter test. The latter test required dewatering arrangements between the gravity and the flotation sections. It would appear that whichever method produced concentrates most suitable for subsequent treatment would be the preferable scheme.

On the completion of these tests at the Ferreira Deep experimental plant, a larger plant was erected jointly by the Johannesburg Consolidated Investment and the Central Mining and Investment Corporation at the Rand Mines laboratory. This plant consisted of a Stockman crusher and a ball-tube mill, and a flotation unit comprising Arrangement "A," followed by Arrangement "B" and subsequently Arrangement "C." A dewatering cone was provided between "B" and "C," overflow water being the supply for the grinding circuit. This plant, capable of treating up to 700 lb. of ore per hour, permitted continuous flotation operations, and therefore eliminated the break in the continuity of operations, which was objectionable in the Ferreira Deep plant. It was possible with the larger plant to run a test until all sections were in balance before taking samples. The products were then sampled for a given period during the stabilized conditions, after which the plant was stopped. The factor of "plant washings" therefore did not enter the data. Particular emphasis should be laid on the fact that the results from this larger plant were strictly working scale results, obtained in exactly the same manner as in a large mill, that is, the feed to the plant was accurately weighed and sampled, and the extraction given was based on the actual total platinum metals contained in the final concentrate obtained from a given weight of ore. There were no intermediate products, the only products being finished concentrate and final tailing, which was carefully sampled before discarding. In all tests the sum of the content of the concentrate and tailing checked well with the content of the ore.

In this plant in August, 1928, a consignment of sulphide norite from the farm Boschkoppies was treated at the rate of 700 lb. per hour. The ore value was 5·5 dwt. per ton. The final flotation concentrate weighed 6·443%, assayed 78·8 dwt. per ton, and carried 91·1% of the values in the original crude ore. In September and October, 1928, a consignment of sulphide norite from the farm Brakspruit was treated. In this case the ore value was 7·5 dwt. per ton. The final flotation concentrate weighed 5·63%, assayed 118 dwt. per ton, and carried 88·0% of the values. Many more tests were carried out in this plant on further consignments of sulphide norite ore from

Eerstegeluk. Generally, the results obtained confirmed the smaller scale tests carried out in the intermittent Ferreira Deep experimental plant.

Laboratory tests on the pre-conditioning of sulphide norite ore pulp for a period of five or six hours, in the presence of the regular reagents, did not show any benefit, either in extraction or ratio of concentration. Pre-conditioning for longer periods of 16 to 18 hours showed a distinct advantage in the ratio of concentration and in rapidity of flotation, without appreciable decrease in extraction. Zinc chloride, with and without pre-conditioning, showed no activating action on the platinum-bearing minerals. Dark lactic acid used in conjunction with pine oil gave poor results. Pale lactic acid in conjunction with eucalyptus and kerosene oils and potassium xanthate gave results similar to those obtained with the same reagents without lactic acid. Re-treatment of the flotation tailings after addition of extra fresh reagents showed little promise of increased extraction either before or after pre-conditioning.

In summarizing the results on norite ores, it may be stated that neither gravity nor flotation methods of concentration hold out much hope for the successful exploitation of the low valued oxidized ores. The economic value of the norite fields would therefore appear to lie in the sulphide zones, from which an extraction of about 88% can be obtained by flotation with a concentration ratio of 20 to 1. It is interesting to record that the best results obtained in America on samples of Rustenburg sulphide norite ore gave an extraction of 83% to 84% into concentrates weighing 4·3 to 5·5%.

THE PROBLEM OF SECONDARY TIN IN BOLIVIA

(*Concluded from August issue, p.* 115.)

A somewhat analogous case for silver has been described by Earl V. Shannon[1] in the Coeur d'Alene District, Idaho. The Caledonia mine shows a markedly greater silver enrichment than adjoining mines. Its vein filling differs in a greater abundance of the favourable mineral chalcopyrite which affords the solvent iron sulphate and less of the unfavourable mineral siderite which occurs so abundantly in the Coeur d'Alene veins. Although cassiterite is not taken into solution in most tin deposits, may there not be some peculiarly favourable conditions in the Bolivian tin veins which make possible secondary enrichment ? The many departures of the Bolivian deposits from the normal or typical tin vein type, as established by the earlier studies of the European tin districts, lend a certain probability to such a possibility.

W. H. Emmons,[2] Gruner and Lin, J. B. Scrivenor, E. Kittl,[3] and Careaga[4] do not place much credence in the solubility of cassiterite under supergene conditions. Emmons says Frank L. Hess informs him that cassiterite from tin deposits in widely separated parts of the world is rarely much corroded and adds the statement that neither stannous nor stannic chloride or sulphate are stable in the ordinary oxygenated waters of the upper zone of ore deposits. Gruner and Lin describe two-month solution tests on both cassiterite and stannite. Cassiterite showed practically no solubility in cold dilute acid solutions. A limited solubility of stannite suggested the possibility of the transportation of colloidal tin, the dehydration of which would give rise to wood tin. Scrivenor says there is no evidence in British Malaya of the solution and redeposition of cassiterite. An experiment which he conducted for over a year on finely powdered cassiterite gave no evidence of solubility. Kittl, combating the rôle of phosphoric acid as a solvent, which was advocated by Greene, says the influence of phosphoric acid is not great and could be only local, so that sulphuric acid must play the main rôle. If this reagent were capable of dissolving and transporting cassiterite, corroded cassiterite ought to be encountered frequently. Despite the presence of limonite, sulphates, etc., evidencing complete decomposition of sulphides, cassiterite, he says, is generally encountered with brilliant faces and without indication of corrosion. Careaga finds that in the Veta Colorada at Chocaya there is evidence of secondary alterations, but that the cassiterite has not been affected.

Evidence of varying weight in support of supergene cassiterite is advanced by J. H. Collins, M. W. Davy,[1] F. R. Koeberlin,[2] G. U. Greene, P. A. Wagner, and H. Winkelmann.[3] The possible presence of stanniferous solutions is indicated by Collins' statement that wood tin is sometimes soluble to a remarkable degree in hydrochloric acid. However, the solubility of wood tin does not explain secondary cassiterite. Davy found that the solutions which deposited wood tin dissolved quartz and cassiterite, two minerals notably insoluble in acid solutions. He concludes : "therefore, any explanation must account for a pronounced change from acidity to alkalinity in the tin-bearing solutions." This leaves the source and character of the solutions which dissolved the cassiterite in doubt, and its solution is established only in connection with the deposition of wood tin. Koeberlin cites a personal communication from E. H. Davison that bones dug up at the bottom of some alluvial gravels had the bony tissue partly replaced by cassiterite. Against Gruner and Lin's objection that only a very powerful reducing agent like hydrogen could make possible the solution of tin oxide in an acid solution, he says cassiterite in close association with pyrite undergoing oxidation is not itself under oxidizing conditions. Wagner,

[1] Shannon, Earl V., "Secondary Enrichment in the Caledonia Mine, Coeur d'Alene District, Idaho," *Econ. Geol.*, vol. 8, pp. 565–570, 1913.

[2] Emmons, W. H., "The Enrichment of Ore Deposits," *U.S. Geol. Surv. Bull.* 625, pp. 398–402, 1917.

[3] Kittl, E, "Los yacimientos estañiferos de Bolivia," *Revista Minera de Bolivia*, 1928, pp. 65–88, 97–118, 225–244, 257–280.

[4] Careaga, *op. cit. supra.*

[1] Davy, *op. cit. supra.*

[2] Koeberlin, *op. cit. supra.*

[3] Winkelmann, *op. cit. supra.*

discussing Koeberlin's theory, cites the replacement of earlier quartz by cassiterite and its replacement in turn by silica gel in the Potgietersrust pipes. Corrosion of cassiterite by chalcedony and quartz is shown at this locality. But he ascribes the action to a late hydrothermal or low temperature stage not much above and possibly lower than 100° C. It is consequently a hypogene and not a supergene process. Winkelmann describes the corrosion replacement of cassiterite by quartz at Monte Blanco, but likewise ascribes it to a late thermal phase. The strongest evidence is that presented by Greene. He concedes the difficult solubility of pure cassiterite in acid solutions, but suggests that the iron oxide in an impure cassiterite like that at Llallagua, which contains only 94·06% SnO_2 and 4·30% iron, would set up a difference in potential which might be a controlling influence in facilitating solution. On the other hand, Boydell, who attacks the problem from the standpoint of physical chemical theory, doubts if impurities increase solubility. Greene found, however, that three samples of Llallagua mine water contained 19·4 to 180·9 mg. tin per litre, proving some solution of tin by meteoric waters in that mine. Greene did not prove, however, that the tin represented dissolved cassiterite. It is not improbable that its source was oxidizing stannite. Solubility experiments which he conducted indicated phosphoric acid to be the best acid solvent, and he says the Llallagua ores contain the phosphates vivianite, wavellite, vauxite, and paravauxite.

Koeberlin,[1] Spurr, and Boydell argue for the probability of cassiterite solution by descending waters from the standpoint of physical chemical theory. The basis of these arguments is the impure nature of the Bolivian cassiterite and its association with minerals not characteristic of tin deposits in those districts which do not furnish evidence of solution and redeposition of cassiterite. Koeberlin makes little attempt to explain the chemistry of the process. He rightly says geologic facts must be accepted even though their chemical explanation is not yet forthcoming. As purely speculative he suggests the presence of pyrite may exercise a reducing action facilitating solution as lower valence compounds or the presence of copper minerals may bring about a transitional stannite alignment. He also points to the impurity of Bolivian cassiterite as compared with that from Saxony and the Straits Settlements as a possible factor favouring secondary enrichment. Greene, he says, shows enough solubility of tin, with the time available, to dissolve and reprecipitate the largest Bolivian ore-bodies several times over. Spurr sees considerable plausibility in Koeberlin's theory. He says the stability of minerals in ground waters depends to a degree not yet evaluated upon the associated minerals and that solubility may be due to chemical or electrochemical reactions caused by the complexity of the Bolivian ores. On the other hand, Boydell states that the available electrochemical data indicate decreased solubility for both heterogeneous impure cassiterite and impure homogeneous cassiterite. But on general principles he believes cassiterite must have some solubility in water at ordinary temperatures. Because of chemical similarities in tin oxide and silica he believes the solutions to be true and colloidal, and that stable tin oxide sols may have migrated considerable distances. The occurrence of wood tin suggests to him a colloidal stage in the history of cassiterite. Boydell concludes that, meagre though the evidence is, it is sufficient to suggest variation in the solubility of cassiterite, conditions for its solution not being fulfilled in the case of some veins.

The foregoing data and discussions of the chemical evidence of secondary cassiterite demonstrate the need of caution in utilizing the preponderant evidence against solution and reprecipitation of cassiterite as the basis for a denial of its possibility. There is positive evidence of the solution of cassiterite and of the presence of an appreciable quantity of tin in mine waters. But much of the solution has been affected by hypogene waters; and the evidence of tin in descending waters rests on the single case of Llallagua. Various physical chemical phenomena suggest the possibility of solution when conditions are peculiarly favourable. The advocates of secondary cassiterite *believe* the Bolivian veins present such conditions. But one is forced to the conclusion that the chemical evidence permits neither the categorical denial of the possibility of secondary cassiterite nor the assertion that there is clear chemical evidence of the operation of such a process. In other words, available chemical evidence does not make out a conclusive case either for or against the deposition of secondary cassiterite.

Textural Evidence (*Paragenesis*).—The strongest evidence that could be marshalled in support of secondary cassiterite would come out of the paragenetic relations of the ore minerals in the vein filling. The advocates of enrichment have completely overlooked this line of evidence. Since the summary of existing knowledge concerning the Bolivian tin veins was written by Miller and Singewald in 1919, important additions have been largely in the form of paragenetic studies of the ores. If there has been much enrichment in cassiterite by supergene processes, the paragenesis of the ores should clearly show two generations of cassiterite, the younger of which should be later than the youngest of the hypogene minerals. The paragenetic studies have been made by workers not influenced by a desire to prove or disprove secondary cassiterite. Their observations and deductions should be entirely objective and hence worthy of acceptance as correct.

The importance of microscopic studies of the ores in the consideration of this problem was recognized by a number of those who have discussed Koeberlin's papers. As early as 1923, Sznapka wrote that microscopic studies were desirable in order to determine the paragenesis of the ore minerals and to answer the questions whether and to what depths secondary enrichment occurred. Strauss criticized Koeberlin for failing to back up his redeposition suggestion with petrographic evidence. Though inclined to accept Koeberlin's views in part, Ahlfeld[1] lamented the lack of a microscope, which he recognized as necessary for a satisfactory attack of the problem. After arguing rather favourably to Koeberlin from the standpoint of physical chemical theory, Boydell concludes that "the really essential point is to establish the definite deposition, in the absence of stannite from the ore, of cassiterite (or wood tin) on later minerals of the paragenetic sequence,

[1] Koeberlin, *op. cit. supra.*

[1] Ahlfeld, *op. cit. supra.*

such as the sulphides and silver minerals." The criterion should read "the really essential point is to establish the deposition of casserite (in considerable quantity) on later minerals of the paragenetic sequence (those minerals being the sulphides and silver minerals)." Let us examine the evidence on that point.

Greene presents evidence of cassiterite definitely younger than a sulphide. He found a vug with loose crystals of bismuthinite completely coated with crystalline cassiterite which he regarded as evidence of deposition from solution and that the cassiterite is undoubtedly secondary. The cassiterite is obviously younger than the bismuthinite in that vug. But bismuthinite and cassiterite overlap in the hypogene paragenetic sequence so that some cassiterite is later than some bismuthinite. The sequence alone cannot be interpreted as proving the cassiterite secondary.

Kozlowski and Buerger and Maury describe repeated successions of cassiterite and sulphides. Kozlowski mentions among the principal characteristics of the Oruro deposits the contemporaneous formation of the tin ore and silver, the abundance of metallic sulphides and the frequent occurrence of tin sulphide. In the Potosi ores he says bands of compact cassiterite alternate with bands of stannite, tetrahedrite, and pyrite. Buerger and Maury give as the sequence of the Chocaya ores pyrite, quartz, and cassiterite succeeded by stannite replaced by sphalerite and galena, then tetrahedrite, and finally jamesonite. Oft-repeated cycles of this sequence gave rise to cockade and banded ores. These phenomena are explained as due to repeated refreshing of the mineralizing solutions. They establish the hypogene origin of all of the minerals involved.

More adverse to secondary cassiterite are the other paragenetic studies. Davy, studying an extensive suite of Bolivian ores, arrived at the general sequence: quartz and cassiterite; sulphostannates; stannite, sphalerite, and chalcopyrite; tetrahedrite; and jamesonite. All of these minerals were considered hypogene. Hall examined my own collections from most of the important Bolivian tin districts and likewise placed the cassiterite earlier than the argentiferous sulphantimonides. Lindgren [1] put the cassiterite of the Chacaltaya ores in the early hypogene mineralization and older than stannite, fluorite, and pyrite. In the Caracoles [2] ores he places cassiterite earlier in the paragenetic sequence than pyrite, sphalerite, and bismuthinite. At Potosi, Lindgren and Creveling give as the sequence from early to late primary minerals pyrite, cassiterite, stannite, sulphantimonides. They recognize as supergene minerals chalcopyrite, ruby silver, chalcocite, and covellite, without mention of cassiterite. Winkelmann says the sulphides fall into two groups—one immediately following cassiterite including arsenopyrite, pyrite, and marcasite, and a younger group of sphalerite, galena, and chalcopyrite. In other words, he recognizes cassiterite only as older than undoubted primary sulphides. Kittl [1] states that no cassiterite younger than stannite has yet been observed. Careaga [2] recognizes cassiterite only as an early hydrothermal mineral preceding the hydrothermal silver minerals.

It would seem certain that if secondary cassiterite were an important feature of the Bolivian tin veins, it would not have escaped detection in all of these microscopic investigations of the paragenetic sequences of the minerals. The unanimity of interpretation in ascribing the cassiterite to the early stage of the hypogene mineralization is imposing evidence against any theory postulating important secondary cassiterite enrichment in the Bolivian veins which involves the solution and redeposition of cassiterite. It becomes incumbent upon the advocates of such a process to present equally conclusive evidence of cassiterite younger than the late hypogene sulphides before they can consider their theory established.

Conclusion.—The writer shows that geological evidence in support of secondary cassiterite enrichment in the Bolivian tin veins is meagre and by no means conclusive. Definite mineralogical evidence is wholly lacking. There is no convincing chemical evidence establishing a high degree of probability for such a process. Satisfying evidence would have to include proof of the occurrence of cassiterite younger in the paragenetic sequence of the vein-forming minerals than the late hypogene sulphides. The supporters of the theory have entirely neglected this most important line of evidence. Numerous paragenetic studies of the Bolivian tin ores are unanimous in placing cassiterite early in the sequence and older than the late sulphides of the hypogene mineralization. The available evidence does not warrant the conclusion that the Bolivian tin veins present the unusual phenomenon of important secondary cassiterite enrichment.

[1] Lindgren, W., "The Tin Deposits of Chacaltaya, Bolivia," *Econ. Geol.*, vol. 19, pp. 223–228, 1924.

[2] Lindgren, W., "Replacement in the Tin-Bearing Veins of Caracoles, Bolivia," *Econ. Geol.*, vol. 21, pp. 135–144, 1926.

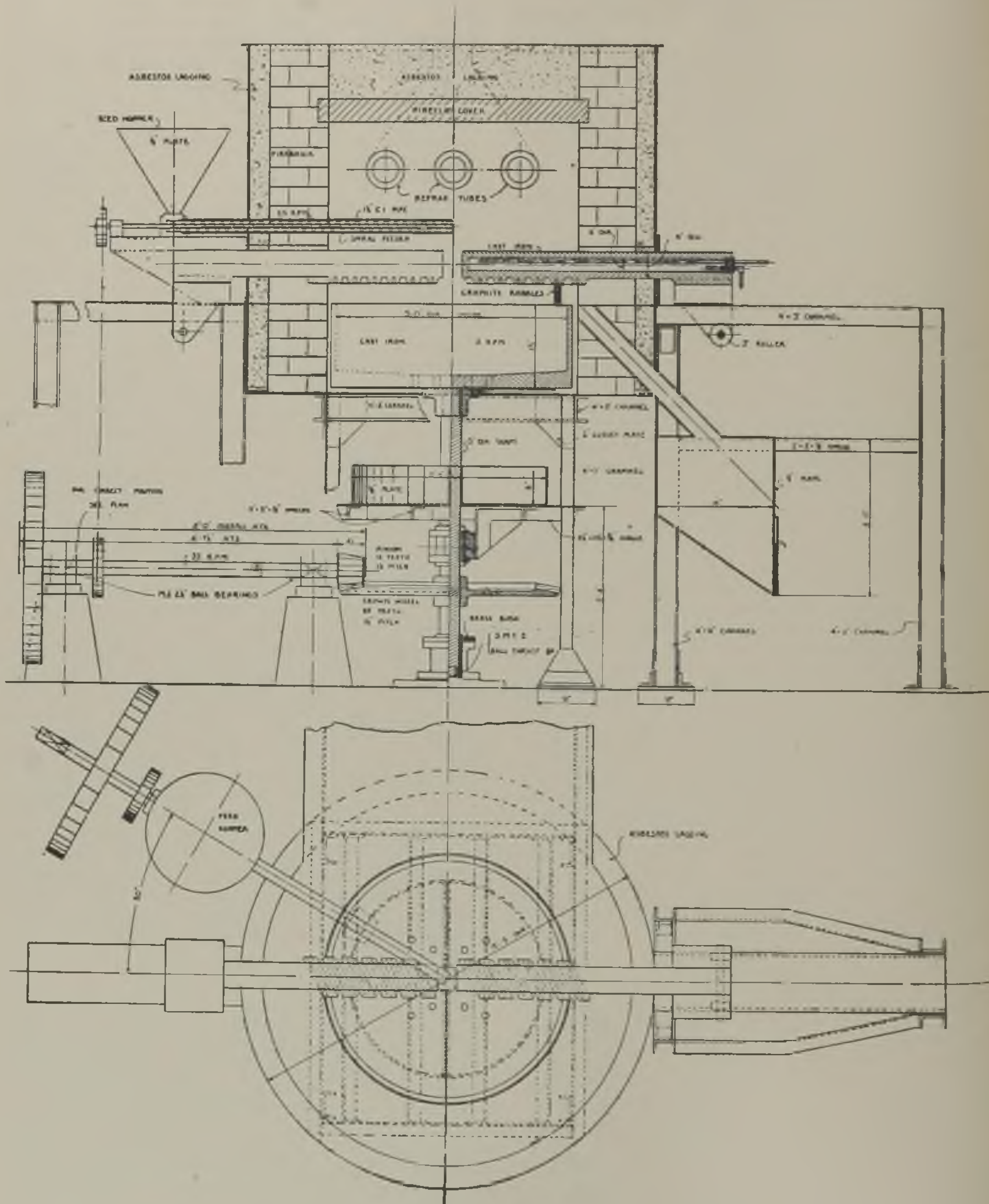
[1] Kittl, E., *op. cit. supra.*

[2] Careaga, *op. cit. supra.*

The Cayzer Tin Smelting Furnace.—In April, 1928, reference was made in the MAGAZINE to an article in the *South African Mining and Engineering Journal* describing a tin-smelting furnace designed by W. J. Cayzer. A further article appears in the same journal for July 6, dealing with the position of the Cayzer process, and of this we give extracts herewith.

The method developed by Cayzer exposed a mixture of concentrates and coke to radiant heat in a reducing atmosphere, keeping the charge at a temperature within the limits of 900—950° C. Under these conditions, the oxides of tin, iron. and other metallics present were reduced to metallic form, but without slagging or sintering of the charge. It was proposed to provide a rotating hearth filled with coke, with discharge openings on the underside, and a system of rabbles to move the charge radially outwards across the hearth. The tin, being at these temperatures molten and highly mobile, like mercury, would flow through the porous bed and fall through the bottom openings, the remaining metallics, with any silica and excess carbon being taken over the top of the hearth to a separate discharge point. The general arrangement of a proposed pilot furnace, with a nominal capacity of one ton of metallic tin per day, is reproduced herewith.

The furnace which is figured here was made and set up at the Ferreira Deep yard of Fraser and Chalmers (S.A.), Ltd., under the personal supervision of the inventor. Oil fuel was used for heating internally the two Refrax tubes provided for radiating heat to the hearth, and various types of burners were tried. Considerable difficulty was found, from the outset, not only in securing the necessary temperature on the hearth, but also in maintaining this temperature when feeding concentrates, the reaction requiring considerable supplies of heat for its maintenance. The burner tips were set actually within the refractory tubes and effective combustion and heating was only



THE CAYZER TIN-SMELTING FURNACE.

possible at an appreciable distance away from them, that is, at the end of the tubes and in the uptake. Several iron stacks were raised to such a temperature that they collapsed under their own weight before the necessary temperature conditions could be stabilized inside the furnace. One or two runs with cassiterite were achieved and $1\frac{1}{4}$ tons of metallic tin, assaying 99·6% pure, were produced.

Owing to financial difficulties work was suspended at this point for some time. Fresh interest, however, is now being taken in the process, and experimental development work on the pilot plant will be re-started.

It is interesting to note that the average yearly output of tin in concentrates in South Africa is approximately equal to the annual import of smelted tin, so that a plant capable of handling the local cassiterite output would make the country practically self-supporting as regards this metal. Realization and smelting charges will be greatly reduced, especially when an efficient method of heating is devised.

Open-cut Mining.—The United States Bureau of Mines has issued Bulletin 298 dealing with methods adopted in stripping and mining coal, copper ore, iron ore, bauxite, and pebble phosphate, by F. E. Cash and M. W. von Bernewitz.

Open-pit methods of mining, by which coal or ore is mined from the surface by the use of gigantic steam or electric shovels, has been developed to a point where during an average year approximately 19,000,000 tons of coal, 24,000,000 tons of copper ore, 32,000,000 tons of iron ore, 150,000 tons of bauxite, and 2,700,000 tons of pebble phosphate are mined in the United States. These quantities total 78,000,000 tons, and at least four times that amount of overburden is stripped to expose these minerals for mining. The great power shovels used in the stripping operations range in dipper capacity from 3 to 12 cu. yd., weigh 125 to 850 tons, and may cost $100,000 or more. A 15 yd. shovel, weighing 1,300 tons, has recently been designed. Stripping as a method of mining dates back to the early mining of coal, when overburden was removed by pick and shovel, loaded into wheelbarrows or carts, and dumped. Some of the early wheelbarrow runs and dumps can still be seen in the anthracite districts of Pennsylvania. When the overburden became too heavy to move by hand, horses with ploughs and slip scrapers were used; and later came wheeled scrapers for heavier work or thicker overburden. Much of the development of the coal stripping industry has taken place in the Danville district, Illinois, where small pits were opened in 1866. Pittsburg, Kansas, also was the scene of early coal-stripping operations. In 1897 the first steam shovel was introduced into the iron range of Minnesota, and in 1906 stripping of copper ore with steam shovels was started at Bingham, Utah.

Bituminous coal is stripped of its cover and mined in 20 States of the Union. The total production by stripping operations is growing, particularly in Indiana, Illinois, Missouri, Oklahoma, Montana, and North Dakota. This output is equal to about 3% of the total coal produced in all States. The strip mines range in capacity from a few hundred to several thousand tons a day. The capital required to purchase and equip a strip mine is large. The land may cost $100 to $500 an acre; a 6 or 8 yd. stripping shovel costs $99,000 to $158,000 and a loading shovel $15,000 to $26,000; locomotives cost $6,000 and up; track costs $27 to $43 a ton (about $2,000 a mile); dump cars cost $400 and up; and a tipple may cost $3,000 to $130,000, depending on the amount of machinery installed. This equipment has to be placed and considerable overburden removed before the mining of coal can be commenced. It is essential also that the coal be picked and screened before it is shipped to consumers. Anthracite has been stripped somewhat irregularly, but the yearly total exceeds 2,000,000 tons. In all, an enormous amount of cover and coal has been removed. Stripping is being done in the Northern, Eastern-Middle, and Western-Middle fields of Pennsylvania. The cost of stripping and mining ranges from $1·85 to $4·91 per ton of coal produced.

Bituminous coal mining in strip pits has made increasing strides, partly because of economic factors, partly because of the comparative simplicity of operations, and partly because of the great improvement in equipment which has helped to reduce costs. Electric stripping shovels of capacity as high as 12 and 15 yd., 3 yd. electric loading shovels, trains with 15 to 40 yd. dump cars, liquid oxygen explosive, modern tipples, and a daily production of up to 5,000 tons of coal are some of the features of bituminous strip mines. The cover is 15 to 60 ft. in thickness. At one mine in Wyoming the cover is removed successfully by hydraulicking. In Illinois and Indiana part of the cover at two mines is removed by drag lines and shovels in tandem. The coal beds are 18 to 84 in. in thickness, although 22 ft. is being mined in Montana and 79 ft. in Wyoming.

The stripping and mining of copper ore represent a highly developed and extensive phase of the mining industry. In a recent year 60 shovels stripped at least 16,000,000 yd. of capping, and 24,000,000 tons of ore in 30 to 70 ft. benches in mountainous country. Iron ore has been stripped and mined for years on an enormous scale. Generally, operation is on a greater scale than that at open-pit copper mines, but the average production of the many iron mines is much less. No iron mine handles by a large tonnage as much material as the benches at Bingham, Utah, and few of the iron mines handle as much as the other copper mines. However, the removal of up to 21,000,000 yd. of capping and 35,000,000 tons of iron ore in a season of eight months with 300 to 400 power shovels in operation and standard transportation systems is a great feat.

Well or churn drills are used in prospecting and in blasting at stripping operations. The type to be used depends upon the character of the overburden or ore, the method of mining, and the equipment available. Piston drills or hammer drills are used at the metal mines, particularly for hard rock and bench work, and also at anthracite pits. Blasting is necessary at all but pebble phosphate mines. Where well-drill holes have been put down it is necessary to chamber or spring the holes one, two, or three times, occasionally more than that. Holes are sprung by shooting a relatively small charge of, say, 40% low-freezing dynamite at the bottom, where a chamber large enough for the charge required to loosen the ground is formed. At each succeeding springing the quantity of explosive is increased. For actual blasting black powder is generally used at coal mines, and at copper and iron mines both black powder and dynamite of various strengths are used. Fuse and detonators and electric detonators with blasting machines are used to set off the charge. In general, air-drill holes are loaded with stick explosives, tamped, and stemmed with various materials. Bulk explosives are sometimes used but require rather more attention in loading.

The use of liquid oxygen explosive for shooting overburden is increasing, particularly at coal mines. The Bureau of Mines has information of its use at five large strip coal mines. At one property in Indiana the physical and financial results were so satisfactory that the oxygen plant was doubled. Black powder was formerly used. At another mine liquid oxygen replaced dynamite. At a large open-pit copper mine in Chile owned by American capital liquid oxygen is now breaking more than 1,000,000 tons a year. The size of the oxygen plant was recently tripled. It appears to be adapted to open-pit work and its use in such projects will expand.

Great advances have been made in the design and construction of shovels. Stripping shovels are made in sizes ranging from 3 to 15 yd. capacity. Loading shovels range from ¾ to 3½ yd. capacity. There are 800 to 900 shovels of all types working at strip mines. Naturally most of these are steam-driven, but the trend to the use of electric shovels and to electrification of steam shovels is decidedly upward. Open-pit mining is largely a problem of transport of stripped overburden and mined minerals, and this is more complex at copper and iron mines because of the bench system of mining. In nearly every instance steam locomotives are employed, and certain types have become more or less popular, particularly at coal mines, but, as with the shovels, electric locomotives are finding a place, especially at copper and iron mines.

Strip or open-pit mining is adapted to minerals of low market value. For instance, anthracite averages $5·60 in value a short ton and bituminous coal $2·20; copper, $2·80 to $4·40 a long ton; iron, $4·55 a long ton; bauxite, $6·15 a short ton; and pebble phosphate, $3 a long ton. These same minerals, except pebble phosphate, are also mined by underground methods, sometimes in the same districts, and sell on the same market, yet naturally production costs are higher. Most of the coal and ores now being mined by open-pit methods could not, however, be recovered by underground methods because of the shallow overburden and contingent expense and hazard.

Smelting at Rio Tinto.—The August *Bulletin* of the Institution of Mining and Metallurgy contains a paper by H. R. Potts on present day copper-smelting practice at Rio Tinto. The smelting plant consists of six furnaces each 216 in. by 48 in. It has been running for over 20 years. The amount of coke used at present and for several years past is 3·3% of the total burden smelted. In earlier years much less coke was employed and in fact the operations were in the nature of pyritic smelting. This method was abandoned because it was necessary that the pick of the export sulphur ore should constitute 60% of the total charge and moreover too much copper was lost in the slag. The function of the smelter at present is that of a scavenger and, as far as possible, only those ores are sent in which are too dirty or have too low a sulphur content to be exported direct for acid-making. A certain amount of customs business is done, and every effort is made to keep the average grade of all ore sent to the smelter as high as possible. A difficulty is to find a good siliceous ore as flux for the iron in the pyrites, as most of the so-called quartz contains a great deal of combined silicates and runs very low in free silica. The result of the combination of high sulphur, which runs about 26% on the charge, and low free silica, means very low mattes, which sometimes under the worst conditions drop down to 12% to 15% Cu, but which normally can be kept around 20% Cu. The furnace charge for 1928 averaged :—First-class pyrites, 14·4%; other than first-class, 33·8%; cupriferous quartz, 24·3%; barren quartz, 2·5%; secondaries, 20·2%; limestone, 4·9%; Total, 100·0%. The order in which the materials are charged is: coke, pyrites, siliceous ore, limestone, and slag, and each furnace smelts an average of 425 tons, exclusive of coke, in 24 hours. This is an average figure, but individual furnaces very often exceed 500 tons in the 24 hours and sometimes even 600 tons. The average length of furnace campaign is seven months, but campaigns of over a year have been made. The paper describes the constitution of the furnaces and the charges in some detail and gives similar information relating to the converters.

Waterval Platinum.—*The South African Mining and Engineering Journal* for July 27 contains a description of the mine and dressing plant of the Waterval (Rustenburg) Platinum Mining Co., the operations of which were officially started on July 23 by Dr. Hans Pirow, the Government Mining Engineer. The plant has a capacity of 10,000 tons of ore per month. The ore is oxidized and comes from the Merensky norite reef. The Consolidated Gold Fields has provided the working capital that was required to bring the company to the producing stage, Douglas Christopherson is chairman, and the management is in the hands of the technical staff of the company. The reef has been opened up by a series of 20 inclines placed 200 ft. apart and the rich chromite band which rests on the norite foot-wall is removed by a reversed resuing method. This is the first time that surface oxidized platinum ores have been worked and the concentration plant is different from the plant treating sulphide ore at the other South African mines.

The ore, collected by 2 ft. gauge locomotives, running on a 2 ft. track along the line of the outcrop, is brought to the main bin, which has a capacity of 500 tons. From this it is fed to a primary breaker (30 in. by 12 in. Blake type) which reduces it to minus 2 in. The crushed ore is raised by a conveyor to the secondary crushing station, where the minus ½ in. material is removed by two 5 ft. by 3ft. 6 in. Vibrax screens operating in parallel. The plus ½ in. material passes through a coarse and two fine 24 in. Symons disc crushers. The whole of the feed, now minus ½ in., is delivered by a second 24 in. belt conveyor to the 500 ton mill bin. From this it is fed to three ball-mills 5 ft. 6 in. diameter by 8 ft. long, operating in closed circuit with rake classifiers. The overflow from the latter is distributed to sixteen James sand tables. The tailings from the latter are dewatered by two 8 ft. by 10 ft. cones, whose underflow is fed to a fourth ball-mill again operating in closed circuit with a rake classifier. The overflow from this circuit is distributed to a group of eight sand tables. The tailings from the latter are again dewatered by cones, and all cone overflows pass over corduroy tables before being passed to the dump via a thickening tank which recovers the water for return to the circuit. Concentrates from the 24 tables go to the clean-up room for further treatment. As the primary tables, in operation, show a distinct streak of metallics, it would seem that final treatment is again by gravity concentration, a final cut being obtained which is very high in platinoids, and also contains gold. The bulk is now so reduced that the product may be cleaned up with acids to remove as much base metal as possible, giving a realizable product known as "metallics," which is largely precious metals, though still containing chromite. It is understood that about 50% of the original platinoid contents of the ore will be recovered in this form. Other cuts will also be produced, ranking as concentrates, to be stored for subsequent extraction by other methods. The simple process described, giving an extraction, as metallics, of about 50%, is expected to be highly profitable. If there be any discovery in connection with the present process, the writer surmises it to be that oxidation has set free the precious metal contents in the Waterval ore to such an extent that gravity concentration can be effective, when aided by fine grinding. It will be seen that at present froth flotation is not employed.

Anodes for Electrolytic Zinc.—In July last an account was given in these columns of the electrolytic zinc system and plant designed by U. C. Tainton. A supplement to that article now appears as Technical Publication No. 221 of the American Institute of Mining and Metallurgical Engineers by U. C. Tainton, A. G. Taylor, and H. P. Ehrlinger, entitled "Lead Alloys for Anodes in Electrolytic Production of Zinc of High Purity." In this paper the authors describe the advantages of a lead-silver alloy in place of pure lead.

Lead has hitherto been the standard material for anodes in electrolytic zinc production and it has been generally accepted that this lead should be as free as possible from impurities. Pure lead, however, is not entirely free from objection. The plain lead anode gradually disintegrates under electrolysis, so that the life of an anode, say ¼ in. thick, is frequently not more than two years. Part of the lead from the anode finds its way to the cathode, lowering the purity of the deposited zinc and decreasing the hydrogen overvoltage. The rest of the lead that comes from the disintegration of the anode goes into the manganese dioxide which is precipitated in the cells, rendering unsaleable what might otherwise be a valuable by-product. A still further disadvantage of plain lead anodes comes from their tendency to bend or buckle during electrolysis, as a result of intercrystalline oxidation. This makes it necessary to use a fairly wide spacing between anode and cathode to avoid short circuits, and thus leads to a higher power consumption than would otherwise be necessary. The power consumption is also affected by the high decomposition voltage at a lead peroxide surface. This paper describes a research directed towards overcoming some of these disabilities by the use of lead alloys instead of pure lead. The authors decided to concentrate attention on metals that could be made to alloy easily with lead and particularly those that formed more than one oxide. Investigations were made of lead alloyed with the following elements, either singly or in combination: arsenic, antimony, barium, bismuth, calcium, cerium, copper, mercury, silver, thallium, tin. While a number of the alloys showed advantages over plain lead, there was one so outstandingly superior that, as soon as it was found, special attention was concentrated on it, leading eventually to its adoption in the large plant. This was Pb-Ag series containing no free silver, that is, at or below the eutectic of 2·6% Ag. The authors give details of experiments comparing pure lead anodes and lead-silver anodes containing 1% of silver. The silver alloy anode proved inferior in point of current efficiency to the plain lead anode, but superior in point of terminal voltage and resistance to attack. Examination under the microscope of the two anodes showed that the oxidation of the plain lead anode had proceeded to an appreciable depth while the silver-lead anode was practically untouched. This at once suggested that with this alloy buckling under electrolysis would be done away with and it would therefore become possible to use a closer spacing. The authors also describe experiments on the effect of employing other addition agents than glue, and found that silicic acid in the proportion of 2 lb. per ton of zinc gave a higher current efficiency and lower amounts of lead in the zinc.

Strontium Supplies.—In a report published by the United States Bureau of Mines, R. M. Santmyers has reviewed the world's supplies of strontium minerals.

Strontium salts are used mainly in the refining of beet-sugar, in the manufacture of fireworks, in medicine, and in glass making. Deposits of strontium minerals in the United States have been discovered in California, Arizona, Texas, Utah, and Washington, but these have been worked only to a limited extent, as it has been found more economical to import from England and Germany. These last two countries are together capable of furnishing the world's comparatively small requirements. The close proximity of their deposits to consuming markets, the ease and cheapness of production, and the availability of water transport practically prohibit successful competition in the United States. A limit is placed upon the English dominance, however, by the existence of the Sicilian deposits, and this in turn tends further to inhibit the development of the American deposits. Although they ordinarily cannot be worked profitably, the Sicilian deposits nevertheless do operate to prevent advances in the price of British or German celestite beyond a point that covers the cost of mining and transporting the Sicilian mineral on muleback to the sea-coast. Germany also is able to exert a strong influence on the price of the raw material by reason of its dominance in manufacturing strontium salts and chemicals.

Although strontium occurs in nature in many rocks and minerals, celestite (strontium sulphate) and strontianite (strontium carbonate) are the only sources of commercial or industrial strontium compounds. Celestite is the more plentiful and widely distributed mineral and therefore is more commonly used for the manufacture of strontium salts and chemicals.

The strontium compounds which are commercially important are strontium hydroxide, used to some extent in the beet-sugar refining industry, and strontium nitrate, used in fireworks for producing a red light. A small quantity of strontium compounds is used in chemical laboratories and in medicines, and the carbonate is used in the manufacture of iridescent glass. Strontianite is said to have been used to a limited extent in the manufacture of basic brick. In some countries small amounts of celestite have been employed to replace barytes for certain purposes, price alone being the deciding factor.

Deposits in the United States east of the Mississippi River have furnished excellent specimens of both strontianite and celestite but have been of little commercial importance. It would appear that small quantities might be economically recovered by hand picking at various limestone quarries in south-western Michigan and near Toledo in north-western Ohio. Both celestite and strontianite are found in England, Ireland, Germany, and Canada, and celestite in India, France, and Sicily. The British deposits of celestite are the most important and furnish substantially the entire requirements of all countries, including the United States. Celestite deposits of economic interest occur at Giershegen in Westphalia, Germany, and at Obergembeck, and Helmscheid in Waldeck. Westphalia strontianite is much more difficult to mine than is celestite in Gloucestershire, England, and the output is comparatively small. This, together with the fact that the deposits are largely exhausted, practically prohibits competition by German strontium minerals in the world's markets with the cheaply produced and more abundant English celestite. As already mentioned, celestite has been obtained in Sicily, where it occurs associated with crystallized sulphur, aragonite, calcite, and gypsum at Girgenti, Caltanessetta, and other sulphur localities. The production is not accurately known but at times is fairly large, as considerable quantities have been shipped to Germany.

The sugar in beet-sugar molasses will not crystallize out readily. The molasses is now largely used in "molasses cattle food," but part of the sugar is recovered from the remainder by the lime process or the osmosis process. The Scheibler or strontium process is said to be more effective than either of these. The method is founded upon the readiness of strontium hydroxide to combine with the sugar to form saccharates, which can be separated and afterwards decomposed by carbon dioxide.

The salt of strontium most in demand for pyrotechnics is the nitrate, but the carbonate and chloride also are used in small quantities.

When alloyed with copper strontium is said to act as a hardening agent in castings and to free them from blow-holes. The alloy is made by adding metallic strontium to the melt or by the electrolysis of fused strontium chloride or other strontium salt, using a molten copper cathode. It is stated that the electrical conductivity of copper is not materially changed by the small percentage of strontium required.

Ground celestite has been used to some extent as a substitute for barytes as a filler, and for other uses, since it has nearly the same physical properties. It is also reported that celestite has been successfully used in place of barytes in the manufacture of a product analogous to lithopone.

SHORT NOTICES

Moisture in Coal. *Industrial and Engineering Chemistry* of July 15 contains a paper on the determination of the moisture content of coal and similar substances, written by Manfred Mannheimer.

Flotation Pulp. *Technical Publication* No. 224 of the American Institute of Mining and Metallurgical Engineers, gives an account of a study of reducing and oxidizing agents and lime consumption in flotation pulp, carried out by the research staff of the United Verde Copper Company.

Pulverized Fuel at Sea. In the *Engineer* for August 2 there is an account of the installation of powdered fuel plant on the "P.F.S. Swiftpool."

New Coke Works. The *Iron and Coal Trades Review* for June 28 gives a description of the works of the Consett Iron Company, which embodies coke ovens of the new Otto twin-flue regenerative type.

Iron-ore Sinter. G. M. Schwartz in *Technical Publication* No. 227, of the American Institute of Mining and Metallurgical Engineers, describes favourable results in the use of sintered iron-ore charges for blast furnaces.

Commercial Thorium. The metallography of commercial thorium made by the Ca-$CaCl_2$ process has been investigated by Edmund S. Davenport, and the results are published in *Technical Publication* No. 226 of the American Institute of Mining and Metallurgical Engineers.

Mercury-Cadmium Alloys. Robert F. Mehl and Charles S. Barrett describe their investigation of the crystal structure of mercury at low temperatures, and the properties of mercury-cadmium alloys, in *Technical Publication* No. 232 of the American Institute of Mining and Metallurgical Engineers.

Metallography. *Mining and Metallurgy* for August contains an article on the preparation of thin metallic specimens for microscopic examination written by R. A. Ragatz.

Electrical Gear in Mines. The inspection and testing of mine-type electrical equipment for the purpose of permissibility are described by L. C. Ilsley, E. J. Gleim and H. B. Brunot in Bulletin No. 305 of the Bureau of Mines, Washington.

Iron in Northeastern Minnesota. *Economic Geology* for August contains an account of the geology and genesis of the Agawa iron formation in Northeastern Minnesota, by J. T. Stark.

Zinc Alloy for Roofing. In *Technical Publication* No. 232 of the American Institute of Mining and Metallurgical Engineers E. A. Anderson gives the results of a study of an alloy of zinc containing 1% copper and 0.01% magnesium, with a view to its use as corrugated roofing.

Crystal Structure of Copper-tin Alloys. A note on the crystal structure of the α Copper-tin alloys by Robert F. Mehl and Charles S. Barrett is published in *Technical Publication* No. 231 of the American Institute of Mining and Metallurgical Engineers.

Steel. In *Technical Publication* No. 230 of the American Institute of Mining and Metallurgical Engineers, A. B. Kingel and J. J. Egan give experimental data on the equilibrium of the iron-oxide-carbon system in molten iron. In *Technical Publication* No. 229 of the same Institute, C. H. Herty, Jr., gives some data on the diffusion of iron oxide from slag to metal in the open-hearth process.

Wrought Iron. *Technical Publication* No. 228 of the American Institute of Mining and Metallurgical Engineers, gives details of the Byers New Process in the manufacture of Wrought Iron.

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.*

719 of 1928 (283,470). Dr. Ing. Bohuslav Stoces, Czechoslovakia. A method of cooling air by first drying the air, and then moistening.

4,117 of 1928 (285,040). Paul Gredt, Luxembourg. A process for forming briquettes from iron-ore concentrates, characterized by the feature that a portion of the ore is separately reduced and afterwards mixed with the original material and then oxidized to form a cement.

4,668 of 1928 (315,444). Leo Frederick Reinartz and John Hunter Nead, Middletown, Ohio. A process for producing commercially pure iron or iron-alloys.

6,669 of 1928 (314,822). Reginald John Lemmon, London. Improvements in the recovery of mineral or metal values by froth flotation by the use of certain isomeric chemicals for the sulphidizing of oxidized ores.

9,700 of 1928 (314,579). Stanley Cochran Smith, London. Improvements in the electrodeposition of metals from acid solution, using insoluble electrodes, and arranging for the neutralization of acid generated in the process.

9,786 of 1928 (314,585). Albin Carlson, Schwartau bei Lübeck, Germany. A new and improved method of increasing the output from mechanical roasting furnaces, involving pre-heating of the material by escaping gases of combustion.

10,004 of 1928 (288,208). Compagnie des Mines d'Ostricourt, Oignies, France. The use of high tension discharge between high tension wires and sheet metal plates for the precipitation of dust particles, is modified by the introduction of a grating between the electrodes, which creates differences of field strength.

10,036 of 1928 (288,973). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Refining of chromium ores.

10,374 of 1928 (288,333). The British Thomson-Houston Co., Ltd., London. Improved processes for refining alkali and alkaline-earth metals, and the production of alloys of these metals.

10,548 of 1928 (315,245). Burrows Moore, London. A process and apparatus for grading solid materials by means which cause the material to be carried in a fluid stream the cross section of which is suddenly contracted and then expanded.

10,948 of 1928 (315,459). Societa Italiana per le Industrie Minerarie e Chemiche, Italy. Metallic oxides are treated and purified by means of hydrocarbons.

11,214 of 1928 (300,248). The Barber Asphalt Co., Philadelphia. The preparation and composition of an alloy which is especially resistant to the action of nitric acid.

11,396 of 1928 (315,481). Frank Collingridge, Llanelly. Improvements in processes which recover metals from scrap by electrolysis.

16,621 of 1928 (311,955). David Ferguson, Edinburgh. Surveying apparatus, which, by means of a travelling wheel and attached barometric apparatus, produces graphical profile records.

17,786 of 1928 (314,667). The International Nickel Co., W. J. Harshaw and F. K. Bezzenburger, United States. Nickel anodes especially characterized by electrical non-passivity.

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.

Die Kaolinlager in Schlesien. By Dr. Ing. Egon Pralle. Paper backs, octavo, 52 pages, illustrated. Price Reichmarks 3.60. Halle (Saale): Wilhelm Knapp.

The Evolution of the Igneous Rocks. By N. L. Bowen. Cloth, octavo, x + 334 pages, illustrated. Price 23s. Princeton: Princeton University Press, and London: Oxford University Press.

Recent Geological Investigations in the Potaro River District. By H. J. C. Conolly and Smith Bracewell. Paper folio, with 2 maps. Georgetown, Demerara: The Government printers.

Special Reports on the Mineral Resources of Great Britain. Vol. xxxi.—Ball Clays. By Dr. Alex. Scott. Cloth, octavo, x + 73 pages, illustrated. Price 2s. 6d. London: H.M. Stationery Office.

Memoirs of the Geological Survey of England and Wales: The Country around Oswestry. By C. B. Wedd, B. Smith, W. B. R. King, and D. A. Wray. With contributions by T. C. Cantrill, and H. H. Thomas. Cloth, octavo, xix + 234 pages, illustrated. Price 5s. 6d. London: H.M. Stationery Office.

Summary of Mining Operations in British Columbia, for six months ended June 30th, 1929. Compiled by John D. Galloway. Paper backs, 68 pages, illustrated. Victoria: British Columbia Department of Mines.

The Support of Underground Workings in the Coalfields of Lancashire, Cheshire and North Wales. Paper backs, 92 pages, illustrated. Safety in Mines' Research Board. Paper No. 55. Price 2d. London: H.M. Stationery Office.

Nigeria. Annual Report of the Mines' Department for 1928. Paper folio, 6 pages and 3 appendices. London: The Crown Agents.

Output and Employment at Metalliferous Mines, Quarries, etc., during the quarter ended March 31, 1929. Paper, 5 pages. Price 4d. London: H.M. Stationery Office.

Abstracts of Scientific and Technical Publications from the Massachusetts Institute of Technology, January-June, 1929. Paper backs, 75 pages. Cambridge, Massachusetts: The Technology Press.

Geology of Hyder and Vicinity, Southeastern Alaska, with a reconnaissance of Chickamin River. By A. F. Buddington. Paper backs, 124 pages, illustrated, with maps. Price 35 cents. Bulletin No. 807 of the United States Geological Survey, Washington.

Aerial Photographic Surveys in Southeastern Alaska. By R. H. Sargent and Fred H. Moffit. Paper backs, 20 pages, with 2 maps. Price 15 cents. Pages 141-160, Bulletin No. 797-E, of the United States Geological Survey, Washington.

The Mother Lode System of California. By Adolph Knopf. Paper backs, 88 pages, illustrated, with geological maps. Price 55 cents. Professional Paper No. 157 of the United States Geological Survey, Washington.

Uganda Protectorate. Annual Report of the Geological Survey Department for the year ended December 31, 1928. Paper backs, folio, 43 pages, with key-map. Price 3s. Entebbe: The Government Printers.

The Copper Deposits of Michigan. By B. S. Butler, W. S. Burbank, and others. Paper backs, 238 pages, illustrated, with geological maps. Price $2.50. Professional Paper No. 144 of the United States Geological Survey, Washington.

COMPANY REPORTS

Tetiuhe Mining Corporation.—This company, which, in 1925, took over certain Russian lead-zinc-silver deposits from Selection Trust, Ltd., and others, has issued its report for the year ended September 30, 1928. The report shows that during the year, 47,302 metric tons of ore, assaying 11·1 lead and 14·8% zinc were treated for the production of 12,886 tons of zinc concentrates assaying 45·3% zinc, and 6,797 tons of lead concentrates assaying 71·9% lead and carrying 58 oz. of silver per ton. The ore reserves at the end of the year were estimated at 1,015,816 tons averaging 8·1 oz. silver, 10·3% lead and 12·9% zinc, as compared with 966,122 tons averaging 8·1 oz. silver, 10·6% lead and 13·7% zinc at the end of the previous year, an increase of 49,694 tons. In addition to these reserves there are 99,000 tons of ore and tailings in dumps at the surface. The year's working resulted in a loss of £28,628, making a total debit balance of £53,291. Additional plant has been built to enable the mill to treat 100,000 tons of ore per annum, by means of which it is expected that the costs will be lessened and profits thus made.

Fabulosa Mines Consolidated.—This company, which was registered under Bolivian law in 1921 to work groups of tin mines in Bolivia, has issued its report for the year ended December 31, 1928. During the year Messrs. Beresford and Glidden resigned the management of the properties, and later Mr. Beresford resigned from the board. The production of tin concentrates during the year was 33,158 quintals of 100 lb., an increase of 5,789 quintals on the preceding year. During the latter part of the year the plant at the mines and mills was thoroughly reorganized, and improved working is expected in the current year. The net loss on the year's working amounted to £15,440.

Rhodesian and General Asbestos Corporation.—The report for the year ended March 31, 1929, gives the output of fibre at 29,991 tons, of which 18,306 tons were from Shabanie, 7,481 from Gath's and 4,204 from King. The ore reserves at March 31 were estimated at 231,740 tons, as against 164,673 tons at the end of the previous year. The working profit for the year was £323,704, of which £319,181 was distributed as dividends, equal to 30%. A serious flood at the Shabanie mine occurred early in the year, but the mines are now working normally.

Rhodesia Broken Hill Development.—This company, which works lead, zinc, and vanadium properties in North-Western Rhodesia, shows in the report for the year ended December 31, 1928, that the production of lead and zinc for the year was 4,676 and 9,579 tons respectively. Sales of these metals realized £327,416, but there was a loss on the year's working of £26,078 which was covered by transferring a like amount from the reserve account. The year's operations have shown that the acid plant will have to be enlarged to enable zinc production to be brought up to the desired stage. The report also gives the zinc and lead output for the first 7 months of 1929, as 6,481 and 1,635 tons respectively.

Waihi Grand Junction.—During the year ended December 31 last 25,493 tons of ore were treated by the Waihi Company, in accordance with the existing agreement, the amount received being £5,205. The net profit for the year was £1,928, of which £1,725 was absorbed as dividend, equal to 1d. per share, free of tax. A considerable amount of development work has been done on the Eastern property and some blocks of payable ore are stated to have been opened up.

DIVIDENDS DECLARED

Amalgamated Zinc.—4%, less tax, payable October 10.

Andes Copper.—75 cents., less tax, payable August 12.

Anglo-Oriental Mining.—3¾%, less tax, payable August 31.

Balaghat Gold.—1s., less tax, payable Sept. 28.

Central Provinces Manganese Ore.—7½%, payable October 1.

Kuala Kampar.—4d., less tax, payable August 31.

North Broken Hill.—3s., less tax, payable September 30.

Nundydroog.—9d., less tax, payable October 4.

Patino Mines and Enterprises Consolidated.—4s., less tax, payable September 28.

Rhodesian and General Asbestos.—2s. 6d., less tax, payable October 16.

Selection Trust.—1s., less tax, payable August 26.

Witbank Colliery.—6d., less tax, payable October 4.

NEW COMPANIES REGISTERED

Great Tanami Gold Mines Syndicate.—Registered August 14. Capital: £20,000 in £50 shares. Objects: To carry on the business of promoters, miners, prospectors, etc.

New Guinea Goldfields.—Registered in Sydney. Capital: £5,250,000. Contracts for the acquisition by that company of the properties, etc., of the Edie Development Company are now in course of preparation.

Tin Producers' Association (Incorporated).—Registered as a company limited by guarantee, with an unlimited number of members, each liable for £5 in the event of winding up. Objects: To promote the consideration among members of all questions affecting the production of tin, and to watch over and protect their interests. The management is vested in a Council, the first members of which are: Sir Cyril K. Butler (chairman of Consolidated Tin Mines of Burma); L. G. Attenborough, mining engineer; O. T. Lempriere, Melbourne, Australia, metal merchant; J. Howeson, Halcot, Bexley (chairman of the Anglo-Oriental Mining Corporation); St. John Winne (director of Geevor Tin Mines); H. Waugh, Eastern merchant; and R. Pawle, Rookwood, Reigate (chairman of Ipoh Tin).

West African Mines and Estates.—Registered August 6. Capital: £120,000 in 100,000 Seven per Cent. Preference and 500,000 Ordinary shares of 4s. each. Objects: To adopt agreement with West African Mines and Estates, etc. Directors: J. A. Cooper, S. S. Briggs, and G. Parkins. Office: Broad Street House, London, E.C. 2.

Zletovo Mines.—Registered as a public company. Capital: £137,500 in 5s. shares. Objects: To acquire mines, mineral and other properties in any part of the world and to adopt an agreement with Georgine N. Patchitch and the Selection Trust.