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. 2. LONDON, AUGUST, 1929. PRICE ONE SHILLING

CONTENTS

EDITORIAL

AT a meeting of representatives of zinc producers in England, the continent of Europe, Canada, and Mexico, held last month, it was decided to curtail production still further during the remainder of the year to 10%, as against 5% during the first six months. The rate of production for 1930 will be decided later.

FOR some time the Governors of the Imperial College of Science and Technology have had it in mind to extend the Union and Hostel, owing to the popularity of these aids to social life. A start was recently made with the erection of the new building, but at present the funds in hand are only sufficient for the completion of two of the intended five storeys, and an appeal is being made for a further £18,000 in order that the whole of the five storeys shall be completed at one time. The new building will complete the quadrangle, of which the three other sides consist of the Union, Hostel, and Botany and Biochemistry buildings. The ground floor will contain two large lounges, a committee or silence room, the College bookstall, and a residential flat for the warden, and the first floor will contain 33 study-bedrooms, thus increasing the Hostel accommodation to 82. A scientific feature of the new building will be a central heating installation on the Sulzer electrical system, whereby the water will be heated during periods of the day when there is a minimum demand for current.

IN our January issue we wrote at some length on the forthcoming meetings of scientific societies in South Africa. The first of these is that of the British Association, which commenced last month. Sir Thomas Holland, in his presidential address, developed still further his thesis on the political importance of mineral resources and suggested that the Kellogg anti-war pact could be greatly strengthened if the two chief producers—the British Empire and the United States—combined to veto the supply of ores and metals to non-complying nations. Among other important communications was one by Dr. John S. Haldane, who put forward the suggestion that mining at great depth should be done dry and the effects of sharp silica counteracted by the addition of harmless rock dust. In the current month the fifteenth International Geological Congress is being held, and of the numerous papers probably that of Dr. J. A. Bancroft on the geology of the copper regions of Northern Rhodesia will be the most interesting to our readers. The MAGAZINE, however, will devote more special attention to the third Empire Mining and Metallurgical Congress, which is due to commence early next year. At the present time it is only necessary for us to draw attention to the pamphlet just issued outlining the journey, the details of travel, etc. Those contemplating the visit should communicate with the Congress Headquarters at 100, Fore Street, Johannesburg, or with the Institution of Mining and Metallurgy, at 225, City Road, London, E.C. 2.

PRESSURE of current matter of importance prevented our referring to the celebration of the centenary of the death of Sir Humphry Davy, which took place during June at Penzance, his birthplace. Addresses were given by Sir Humphry Davy Rolleston, the eminent doctor, and by Sir J. A. Fleming, the electrician, and a wreath was placed on his statue at the head of Market Jew Street. No doubt the mining engineer considers Sir Humphry's chief claim to fame was his discovery of the principle of the safety lamp, which still holds a place among coal-mine illuminants. On the other hand, the metallurgist will reply by quoting Davy's work on the fundamental laws of electro-chemistry as his great *tour de force*. Mining engineer and metallurgist, however, unite in blessing him when they pay a visit to the dentist, for was he not the discoverer of laughing gas? Other notable work done by him was the production of metallic sodium and potassium, the demonstration that chlorine is an element instead of being the "dephlogisticated marine acid" as supposed by Scheele, its discoverer, and that oxygen is not the principle of acidity, as supposed by Lavoisier. Davy won considerable success as a public lecturer at the Royal Institution, and in later years he became a power as President of the Royal Society. As an investigator he has been called excitable and rash, and as a personality somewhat theatrical, while his treatment of his subordinates, notably Faraday, was not all that could be desired, but his serious work for science far overweighs these little failings.

THE bicentenary of the death of Thomas Newcomen on August 5, 1729, has been celebrated by a joint meeting of the Newcomen Society and the Devonshire Association, held at Dartmouth, the birthplace of the inventor. Though Newcomen's engine was the first practicable machine for obtaining power from steam and was applied fairly extensively to the drainage of mines, it was not a permanent commercial success owing to the large amount of fuel required. The information available relating to his work is very scanty and little is known of him personally. The Newcomen Society has done much in collecting stray facts, but much more remains to be done in order to place him in his true historical niche. It has been established that he was an ironmonger who supplied west country mines with steel and other requisites and it was supposed he was impressed with the necessity of combating mine water in depth, but there is no record of his aptitude for the study of the problem or of his knowledge of other people's investigations. He must, however, have known of Savery's engine, in which water is drawn upwards by the condensation of steam in a device now associated with the pulsometer, and also of Papin's engine, in which the same effect is obtained with a piston and cylinder. He improved on the work of these two inventors by introducing valve-gear and the internal injection of condensing water into the cylinder, the former giving the automatic supply and cut-off of steam, which made the machine self-controlling. Eventually Savery, who had obtained a patent, and Newcomen joined forces and the engines were made on the latter's principle. Until recently the only extant record of their work was a print dated 1719 of a "Steam Engine near Dudley Castle, invented by Savery and Newcomen and erected by the latter in 1712." In 1925, however. an earlier print was discovered at Worcester College, Oxford, which clearly shows the self-acting valve-gear and the injection apparatus. Other evidence as to the nature of the engine is provided by the designs on certain Cornish penny tokens and by the illustrations of these in Borlase's book and other publications relating to the county. It is known that a number of his machines were at work in Cornwall for many years until they gave way to the Watt engines, one authority giving the number at 66. The first was at Wheal Vor in Breage district, which was erected some time between 1710 and 1714, and there are specific records of plants in the Wendron district and at Gwennap and St. Agnes, but the localities where the remainder were erected are not now known. There is no existing portrait of Newcomen and no description of his appearance. His only memorial is in Dartmouth Town Gardens, but as a result of the recent meeting it is hoped that his services to engineering practice will be publicly recognized in the centre of Empire. Why not call the new bridge to be erected at Charing Cross the "Newcomen"?

Pyritic Ore-Bodies

The origin of the Rio Tinto and similar massive pyritic ore-bodies has formed the subject of discussion among geologists and mining men for many years, and the theories of magmatic and hydrothermal origin have alternated in popularity. The magmatic theory has been upheld by Scandinavian geologists and it has been generally allowed that the application of this theory to the deposits in Norway has been justified. As regards Rio Tinto that brilliant young geologist, A. M. Finlayson, unfortunately killed in the Great War, brought once more the hydrothermal theory into prominence. Six years ago the whole matter was discussed at the Institution of Mining and Metallurgy, when the late H. F. Collins presented a review of current knowledge, and he, too, inclined to hydrothermal replacement. More recently Mr. A. M. Bateman, the distinguished American geologist, made an extensive examination of the region and published his views in *Economic Geology* in 1927, arguing in favour of hydrothermal replacement. The latest contributor to the discussion is Mr. G. Vibart Douglas, chief geologist to the Rio Tinto Company, who, after writing brief notes for *Nature* and *Economic Geology* and presenting a paper to the British Association last year, has presented his views in the *Geological Magazine* for July. Mr. Douglas endorses Mr. Bateman's views and gives additional evidence in favour of replacement. He draws attention to the structure of the stockworks where veins containing sulphides exist in the porphyry. He shows that the veins, whether a metre or a millimetre wide, are of the same composition, and argues that this uniformity demonstrates that all were deposited by the same carrier, and that it would be impossible

for a magma to traverse these veins for any distance and stay liquid. He also shows that horses of both slate and porphyry actually do exist in the ore, in spite of asseverations to the contrary which have frequently been made. Moreover he brings evidence that on the slate contact ore can be found which has inherited the cleavage of the slate, with the same orientation.

Perhaps, however, the most interesting feature of Mr. Douglas's paper is the war which he carries into the Scandinavian geological camp by expressing his opinion that conditions at Orkla and Sulitelma can be equally well if not better explained by the replacement than by the magmatic theory. He had had the advantage of Professor Vogt's personal exposition of the magmatic theory, but his own work in the field at Sulitelma did not, in his opinion, confirm Professor Vogt's views. For instance, he found remnants of schist within the ore having the same orientation as the hanging-wall and foot-wall and noted that the massive ore has no chilled margin such as would be expected if the ore had been intruded as a magma. Mr. Douglas's evidence in favour of replacement at Sulitelma is quite brief, and no doubt all geologists would be glad if he would expand his arguments in greater detail.

The mention of the stockwork of sulphide-bearing veins in porphyry draws attention to the fact that this type of deposit is now receiving the attention of the mining engineers at Rio Tinto. In his speech to shareholders three months ago the chairman, Sir Auckland Geddes, mentioned that these deposits are in course of development and that concentration plant has been erected for their treatment Thus in the future Rio Tinto will no longer be solely identified with the mining of massive pyrites.

Australian Geophysical Investigations

Two years ago announcement was made that the Australian Development and Migration Commission, of which Mr. H. W. Gepp is chairman, intended to conduct geophysical tests on a large scale, with a view to assisting the mining industry. At the time Mr. Gepp and associates presented a paper on the new prospecting methods to the Australasian Institute of Mining and Metallurgy, thus greatly increasing the public interest therein, and it was decided to establish an Imperial Geophysical Experimental Survey, the funds being provided by the British and Commonwealth Governments, to carry out Mr. Gepp's idea. Mr. A. Broughton Edge was appointed head of the organization and has already spent a term in the Commonwealth. When recently in London he briefly outlined for the benefit of the MAGAZINE the progress of the work in which he is engaged.

The work undertaken at first consisted chiefly of a comprehensive study of the various methods and the instruments and equipment employed, the investigations being made on a field scale. In this way an idea was obtained of the special applications and the limitations of the various instruments and processes. The preliminary investigations on these lines having been completed, specific applications of the methods were undertaken in the field. A gravimetric survey of the brown coalfield of Victoria has already been completed. Another gravimetric survey is now being made in the Lakes Entrance district in which borings for oil have been carried out during the last two years, and a magnetic survey is being made, if it is not already complete, of the same area. Subsequent to the testing of different electrical methods in various parts of New South Wales, notably the Lake George copper area, the several parties working this system visited Tasmania, where the silver-lead and copper-nickel lodes of Zeehan and the tin-bearing pyrrhotite sills of Renison Bell received attention. One of these electrical parties is being sent to West Australia, where the Northampton lead deposits will probably be examined. Another party, specializing in the seismic method, commenced work on the Gulgong auriferous deep leads, New South Wales, and may later be engaged in the Lakes Entrance area. It is intended wherever possible to follow up the investigations by drilling campaigns with the object of proving the results obtained. This course is not always easy to arrange on account of objections raised by land owners, but as the various Mines Departments are giving valuable assistance to the Survey any difficulties that arise may be smoothed down. A case where definite arrangements for drilling have been made is the Renison Bell.

Six or seven electrical types of prospecting are being studied. In this connection one of the problems to be tackled is to ascertain the effect of saline waters on the electrical survey and, as a corollary, to apply electrical

methods, if possible, to the location of underground waters. The presence of underground saline waters—which are widespread in Australia—would appear to have a restricting influence on the electrical prospecting of such regions as the Moonta and Wallaroo copper areas (South Australia) and the Northampton lead field (West Australia), while the location of underground fresh water is of particular agricultural importance in the Mallee (Victoria) and for the 3,500 farms scheme of the Development and Migration Commission in West Australia. Before the Survey ends early next year practically all known systems of geophysical prospecting will have been tested over a wide range of mineral occurrences. The keen interest of Australian metallurgists and mining men and the support of a strong Committee in Great Britain in the work of the Survey should ensure the production of a report well worthy of close attention and justifying the expenditure incurred.

The Tin Position

In our last issue we commented briefly on the calling of a meeting of leading tin producers, held just prior to our day of publication, having for its object the consideration of a proposal to form a tin producers' association, the function of which would be to stabilize the price and rationalize the output of the metal. This meeting was duly held, under the chairmanship of Sir Edmund Davis, and 167 companies were represented. The immediate result of the meeting was the passing of a unanimous resolution to establish such an association, followed by the nomination of a Provisional Council of 21, of whom 14 represented Malaya, two Nigeria, two Siam and Burma, two Cornwall, and one Australia. It is understood that this council's duty is to discuss the various arguments for and against the establishment of a control and to suggest the most feasible propositions, if a control is decided on. A statement by this council has been promised, but up to the time of writing has not been published. We have before us a list of the members of the Provisional Council, but no good reason exists for reproducing it here, as there is some doubt whether all those nominated will serve.

On general principles the idea of a control has recently won a certain amount of cautious support from influential people who at first were not favourable, but there are still waverers and out-and-out objectors. No doubt the ultimate decision of both supporters and waverers will depend on the nature of the actual proposals put forward and until this stage has been reached it is futile to make comments or criticisms here. It is obvious, however, that under present conditions of tin production it will be difficult to arrive at any scheme which is to the direct commercial advantage of everybody, and whether any group of business men can be induced to adopt an attitude that verges on the altruistic is open to doubt. If any proposals are forthcoming whereby the price could be stabilized at, say, £250 and the floating of new properties restricted to probable requirements they should receive support, and if the market should right itself automatically in the meantime—as it gives indications of doing at present—the deliberations of the council should not be suspended but preparations made for the future.

While writing on tin rationalization and a producers' association it is appropriate to mention another step taken with a view to benefiting the tin industry—the formation of a Tin Applications Committee, the function of which is to encourage metallurgical research in tin and its alloys. A number of companies representing the tin mining and smelting industries have subscribed funds for conducting this branch of research and have placed the work in the hands of the British Non-Ferrous Metals Research Association. The duty of the Tin Applications Committee will be "to collect and disseminate a greater knowledge of the properties of metallic tin, to investigate the rational and economic scope of the metal's chief industrial applications, to seek possible new uses for tin and tin alloys, to keep manufacturers and consumers informed as to the results of research, and to encourage and support study and research in the above field." The main objects of the committee are, of course, excellent, but there is one aspect of this question to which attention may be drawn. We refer to the seeking of possible new uses for tin and tin alloys. In view of the approaching famine in tin, which, according to the authorities, is due in a few years, it may not be altogether wise to extend its consumption. Rather it would be better to seek for dependable substitutes wherever possible, and to confine the use of the metal to applications where it is entirely unreplaceable.

REVIEW OF MINING

Introduction.—The summer holidays are here and the City will be a dull place for a month or two. There is some expectation of dear money, owing to the unusually large exports of gold. The Parliamentary recess withdraws direct public notice from the Government's intentions as to future legislation, but members of the Cabinet are not far from the centre of affairs and are doubtless preparing their plans in readiness for the re-assembling of Parliament.

Transvaal.—The output of gold on the Rand for July was 853,370 oz. and in the outside districts 36,110 oz., making a total of 889,480 oz. The natives employed on the gold mines at the end of the month totalled 190,031, as compared with 192,595 at the end of June.

Payable ore at the Onverwacht platinum mine in the Lydenburg area is approaching exhaustion and the company announces that stoping may cease before long. This company started milling early in 1926 and has paid dividends totalling 27½% on a capital of £450,000. The failure of the ore-body in depth is a disappointment to the Central Mining group.

Rhodesia.—The gold output of Southern Rhodesia for June was 48,406 oz., as compared with 48,189 oz. for May. Other outputs for June were: Silver, 7,203 oz.; coal, 88,741 tons; chrome ore, 38,562 tons; asbestos, 3,355 tons; mica, 17 tons.

The report of the Shamva Mines shows that developments have continued unfavourable lately and the future of the property depends on the results obtained during the work done on the recommendation of Dr. Malcolm Maclaren made earlier in the year. During 1928 the ore treated was 573,400 tons averaging 3·01 dwt. gold per ton, and during the same time the ore disclosed was 297,878 tons averaging 2·77 dwt. The reserve now stands at 725,000 tons, averaging 3·2 dwt.

Particulars of the Bwana M'Kubwa Copper Mining Co. are given elsewhere in this issue. The most important assets as regards the future are the N'Kana mine and interests with the Rhodesian Selection Trust in the N'Kana Concession. At N'Kana mine drilling has indicated the existence of 35,000,000 tons of ore averaging 4·2% copper, of which 31,000,000 tons is sulphide and the remainder mixed oxide and sulphide. As regards N'Kana Concession, similar deposits are being proved at Mufulira and other properties. At the Bwana M'Kubwa mine many improvements have been introduced into the ammonia process for treating the oxidized ore and it is estimated that the July output of 600 tons of copper by this process will yield a profit of £5,000. It is of interest to note that the company is engaging mining labour from the North of England coal mines.

The N'Changa Copper Mines, Ltd., reports that at the beginning of the current year the amount of mixed oxide-sulphide ore was estimated at 31,000,000 tons averaging 3·85% copper and that more recent borings have made it possible to increase this estimate considerably, both as to tonnage and copper content. It is also notable that the proportion of sulphide to oxide is increasing. Two recent bore-holes indicate an average of 5·1% and 6·2% copper, of which 2·7% and 3·4% respectively are in the form of sulphides. When these ore-bodies are developed it is intended to employ Minerals Separation's copper segregation process for their treatment.

Since further capital was subscribed for Loangwa Concessions in February last the company has received further prospecting rights which cover the whole of the remainder of North-Eastern Rhodesia not at present granted to any other party. This increases the total area held under concession from 84,000 square miles to 134,000 square miles. Prospecting is being undertaken energetically in various localities.

It was recently announced that Mr. Charles H. White had been sent by Mr. Leslie Urquhart to prospect for copper in the North Charterland Concession. Mr. White reports that several zones carrying copper and iron pyrites have been discovered and he advises that the option now held by the Mining Trust, Ltd., should be exercised. A company will be formed to continue exploration and development.

The Gaika Gold Mining Co. gives preliminary figures showing the result of operations for the year ended April 30 last. During this period gold worth £97,972 was produced from an unspecified amount of ore and the mining profit was £11,268. This does not include any allowance for expenditure on development, which is estimated at

£13,115. On the whole development results were disappointing.

Tanganyika and Nyasaland.—A year ago the Nyasaland Minerals, Ltd., was formed by the National Mining Corporation and others to examine mineral areas, Mr. W. H. Rundall being sent to Tanganyika and Mr. Baldwin Davies to Nyasaland. Col. Villiers is chairman and Messrs. R. Annan and E. W. Janson are on the board, while Mr. Stanley H. Ford is consulting engineer. Mr. Rundall has reported hopefully on the Ufipa and Rukwa coal areas and on the Kidete copper region, while Mr. Davies has concentrated on the Sumbu coal deposits. It is noteworthy that the Governments of the East African states are anxious to obtain local supplies of coal. The board is issuing an additional 550,000 shares of 1s. each to continue prospecting and development.

Belgian Congo.—In his speech to shareholders in Tanganyika Concessions Sir Robert Williams said that Union Minière is now within sight of a yearly output of 200,000 tons of copper, additional plant being under construction to provide for the increase over the present yearly rate, 120,000 tons. He also reported that developments are excellent at the Kansanshi mine over the border in Northern Rhodesia, which was the original property of Tanganyika Concessions before the interest was taken in the Katanga mines.

Gold Coast.—The Ashanti Goldfields Corporation reports excellent developments on the Obuasi shoot and on the "new make." On the 23rd level Obuasi shoot cross-cut No. 5 showed a width of 10 ft. averaging 30 dwt. gold per ton. On the new make a cross-cut on the 20th level gave 25 dwt. over 9 ft., one on the 21st level 23·8 dwt. over 20 ft., and one on the 23rd level 55·2 dwt. over 29 ft.

Taquah and Abosso Mines is still in a state of transition and the accounts for the year ended March 31 last show an adverse balance of £8,599. At the end of August, 1928, the ore at Taquah was exhausted and, owing to rearrangements in working, it was not possible to send much ore from the lower and richer levels at Abosso to the mill, so that the supply of ore came from the older lower grade sections of the Abosso and Adjah Bippo.

The Ariston Gold Mines, which started producing at the end of last year, reports a serious accident to the power plant, which has rendered a stoppage of milling operations necessary. The reconstruction of the company has thereby become necessary.

Nigeria.—The latest company to come under the influence of the Anglo-Oriental group is Ropp Tin. This property is to be acquired by the London Tin Syndicate, the purchase price being 140,000 shares of £1 each in the syndicate, each holder of six Ropp shares of 4s. each receiving one new share. The chairman of Ropp is Sir Edmund Davis and the Consolidated Gold Fields acts as consulting engineers.

Australia.—Shareholders in the Mount Morgan Co. have received £1,000,000 from the liquidators, being a return of 20s. in the pound. In addition the mine and remaining assets have been sold to a syndicate for £70,000. This syndicate will form a new company and raise £100,000 for the purpose of operating the mine, employing a leaching and precipitation method.

The directors of the Wiluna Gold Corporation state that recent operations have been centred on the preparation of the mine for an initial output of 40,000 tons of ore per month, chiefly from the East lode. As regards metallurgical extraction, experiments have indicated a further profit of 1s. 6d. per ton, due partly to increased recovery and partly to a reduction in costs.

Tasmania.—The Federation Tin Mines, which started milling in February, is now drawing up a scheme for doubling the plant and for redeeming the debentures.

New Guinea.—The Ellyou Goldfields Development Corporation has decided, in order that Australian shareholders shall not be liable for British income tax, to form the final operating company in Australia and not in England. A new company, to be called New Guinea Goldfields, is to be formed and three English directors, Messrs. Leslie Urquhart, Arthur Dickinson, and Deane P. Mitchell, are in Australia arranging for its registration.

Malaya.—Kampar Malaya Tin Dredging, Ltd., was formed in March, 1927, by the Anglo-Oriental group to treat alluvial tin ground on the Kampar River, Kinta district. It is now announced that the dredge started operations on June 2 and during that month extracted 50 tons of tin concentrate from 123,700 cu. yd. of ground. The monthly output will gradually increase, as the capacity of the dredge is 215,000 cu. yd. per month. The yield per yard was 0·9 lb., which for a

start shows up well against the estimated value of the ground, which was given at the time of flotation as 1 lb. per yard in 20,000,000 cu. yd. and 0·75 lb. in 3,000,000 cu. yd.

It will be remembered that the Kay Yew (Kinta Valley) Tin Mines, which operates an unusual type of tin property in Kinta Valley, found last year that the results were not up to the estimates in the prospectus, and commissioned Mr. L. G. Attenborough to make an independent examination. Mr. Attenborough's report was unfavourable to the property. The directors and vendors were not satisfied with the adverse report and they appointed as manager Mr. Frederick Wickett, who reported for the vendors, and elected Mr. Nance Williams to the board. Mr. Wickett and Mr. Williams have a long experience of Malayan mining and it now rests with them to prove the accuracy of their views.

Canada.—In our May issue it was recorded that the Consolidated Mining and Smelting Co. of Canada was proposing to manufacture sulphate of ammonia from nitrogen fixed from the air, in addition to making superphosphate fertilizer as at present. It is now announced that the company has decided to spend between seven and eight million dollars during the next two years on ammonia plant, which will make sulphate and phosphate of ammonia. This plant will have a daily capacity of 35 tons of fixed ammonia.

United States.—The liquidation of the Arizona Copper Co. has been concluded by the payment of a final dividend of 3s. 5d. per share, making a total distribution of 42s. 5d. per 5s. share. It will be remembered that the property of the company was acquired in 1921 by the Phelps Dodge Corporation in exchange for 50,000 shares of $100 each. These shares were recently disposed of for cash and resolutions passed to distribute the assets and wind up the company. The company was formed in 1884 and was a pioneer of southern Arizona development.

Venezuela.—Owing to the limited amount of development done during the year ended January 31 last the New Gold Fields of Venezuela reports that the reserve remains substantially the same as that for the previous year, namely 191,670 tons averaging 9·5 dwt. gold per ton. In addition probable ore is estimated at 82,070 tons averaging 9·8 dwt. During the year 16,069 tons was milled yielding 11,700 oz. In order to provide the funds required for development and equipment the capital of the company is to be increased from £1,000,000 to £1,500,000, and £250,000 is to be raised forthwith.

The Carabobo Venezuela Gold Mines, Ltd., is to be wound up, as the new board is not prepared to finance operations owing to the uncertainty of the position. The property was acquired in 1927 and the plan was to unwater the property before deciding on a development campaign. Progress has not been made with these plans and when representatives of Messrs. Lewis and Marks were appointed to the board in May an inquiry was instituted, with the result above indicated.

Yugoslavia.—Particulars of the Trepca Mines, Ltd., one of the Selection Trust group, are now available. This company was formed in 1927 to acquire the Trepca mining concession and other mining rights and has devoted special attention to the Stantrg lead-zinc-silver deposit, which is situated five miles east of the town of Kosovska Mitrovica, and about 200 miles north of Salonika. The ore-body is a replacement in limestone and it has been developed by means of adits. It is estimated that 1,750,000 tons of ore has been proved or indicated, averaging 11·5% lead, 10·5% zinc, and 3 oz. silver per ton. Last month 1,600,000 shares of 5s. each were subscribed at par, the funds being required for a concentrating plant with a capacity of 500 tons per day.

National Smelting Co.—The report of this company for 1928 shows a profit of £184,212, against £176,092 for the previous year, and dividends of 10% were paid on the preference and ordinary shares. The profits were made partly from dividends on share holdings, of which Burma Corporation is the most important, and partly from the production of zinc at Swansea Vale. Since the close of the financial year a portion of the distillation plant at Avonmouth has been brought into operation and it is hoped that before the end of the current year the whole of the first section will be running. Owing to conditions having changed since the company was formed during the War, the directors have decided to form a new company to be called the Imperial Smelting Corporation to take over the business. The contract to smelt Australian zinc concentrates is about to expire and the company has made arrangements for the treatment of lead and copper ores as well as zinc material. This change in the basis of operations renders it desirable to have an entirely new organization, which will be able to expand unrestrictedly.

THE HISTORY OF MAGNETIC AND ELECTRICAL PROSPECTING FOR ORE

By HANS LUNDBERG

The author, well known to readers of the Magazine as a pioneer of modern methods of prospecting, gives an outline of the development of geophysical methods, particularly with regard to their development in Sweden.

Introduction.—The art of geophysical prospecting was used very early in Sweden, possibly earlier than in any other country. A reason for this may be found in the geological mode of occurrence of ore deposits in Sweden and in the studies made during the earliest development of the Swedish mining industry. Mining was started on a large scale as early as the 13th century, when important iron and sulphide ore deposits were discovered in the central regions of Sweden in the provinces called Bergslagen. There, ore-bodies that outcropped at the surface were first explored. At that time the technique of mining was not highly developed and, on account of heavy water flow, it was impossible to mine to any great depth. New deposits constantly had to be sought and prospecting therefore was carried on rather intensively. At the beginning of the 17th century most of the ore deposits outcropping at the surface had been discovered in Bergslagen and the great demand for more ore made it necessary to search for deposits concealed from view. The situation gradually became acute, especially in the iron industry, which was in the hands of a great number of small operators without sufficient resources to consolidate the industry and systematically mine a few deposits on a large scale as, for example, was the case at the large copper and silver mines, which even at that early date had the support of the Swedish Government.

Magnetic Prospecting.—The technique of geological prospecting existing at that time in several other mining countries (see Agricola's "De Re Metallica") could not be applied in Sweden for several reasons. Geological prospecting was then based on the study of outcrops, the weathering of which was especially studied, and consequently the methods were applicable only in countries which had little or no glaciation. Furthermore, geological experience was at that time mostly confined to more or less regular veins or vein systems with regular strike and dip. The Swedish ore deposits, on the other hand, are lenses conformably bedded and more or less following the folds of the region and thus belonging to a type which geological science at that time could not master. On the other hand, the ore deposits in Bergslagen, particularly the iron ore deposits, are in general magnetic, a physical characteristic which at that time was known and thus could be utilized for prospecting purposes.

At the beginning of the 17th century, Sweden was the largest producer of iron and copper, then dominating the world market in about the same way as does the United States at the present time. During this time of material development, there was a great advance in science and technique. The intensive development of the mining industry constantly demanded discovery of new ore deposits and skilled scientists and engineers in close touch with the industry developed the use of geophysical methods. The magnetic properties of magnetite were known in early antiquity, but for prospecting it was not used until the beginning of the 17th century. The first document referring to this method of prospecting is found in correspondence from the State Chancellor in Sweden, Axel Oxenstjerna, and is dated around 1630. By the end of the 17th century a great number of iron ore deposits had been discovered by the magnetic method. The instrument used was the sun dial compass and the ore-bodies were located by reading anomalies of the declination as compared to the normal value. Even if the instruments were rather simple, a field technique of magnetic prospecting was developed to great perfection, which may be seen from several papers written during the 18th century. Prospecting was carried on by men especially trained for this purpose who may be considered the predecessors of the economic geologist and geophysicist of our time. These experts prospected large tracts both in the known ore regions and far outside. Magnetic maps resulting from their work have been preserved.

Development of Field Technique and Instruments.—The technique of field work developed at this early stage has been a very great help to the prospecting work in our

time, as it was early learned to plan and apply the prospecting so as to suit the conditions, the occurrence and size of the ore-bodies, and that due regard had to be given to geology and thus render the prospecting as effective as possible. In this tradition, in fact, is found the explanation of why geophysical prospecting later reached the highest development of the art in Sweden.

Prospecting with the sundial compass was, however, a rather difficult and lengthy procedure, the strength of the reading depending upon the position of the ore-body in the earth's magnetic field. Further, observations could only be taken on sunny days. Therefore, the invention of the miner's compass was a very great step forward. This invention was introduced sometime around the end of the 18th century, but the name of the inventor is not known with certainty. By using the miner's compass the anomalies in inclination of the magnetic field are observed. This was a rather important step, as it was possible to work independently of the horizontal orientation. Further, above an ore-body the vertical component of the magnetic field is much more pronounced than the horizontal, especially in Sweden, being so far north and closer to the earth's magnetic pole. The miner's compass became a very much used instrument and, as a result, a great number of new deposits were discovered. The magnetic indications thus discovered were of various strengths. To begin with (especially when the instruments were still of crude design), only the strongest indications were investigated and those of weaker character were disregarded. Later on, as the stronger indications had been followed up, the weaker ones were investigated more closely, and it was found that several of the weaker indications corresponded to valuable ore-bodies, the weak reaction depending upon great depth of overburden or only slight content of magnetite. The latter case was found on sulphide deposits where, instead of magnetite, pyrrhotite caused the reaction.

Discovery of Sulphide Ore by Magnetic Surveys.—By using a more highly developed and sensitive miner's compass and taking due regard of weaker indications and their relation to the general geology of the region, it was possible to find even sulphide deposits and thus compensate for the gradually decreasing ore reserves. Among deposits discovered in this way were the Kaveltorp mines in 1849 and Saxberget mines in 1880, each containing more than one million tons of zinc-lead-copper ore.

Improvement of Magnetic Instruments and Methods.—In the middle of the 19th century, the theory for the magnetic field around magnetic bodies was worked out mathematically and it was found that complete information as to the magnetic field could not be derived by determining the direction only, as had been the case when using the sun dial compass as well as the miner's compass. The intensity of the magnetic field had also to be determined. Instruments suitable for determining intensity in the field for prospecting purposes were made in the early eighties by Prof. R. Thalen and E. Tiberg, a young mining engineer. At first these instruments, the "magnetometer" and the "inclinator" as Tiberg called his instrument, were used only for detail investigation of the magnetic indications, while the reconnaissance work was still carried on by using the miner's compass. Later when the new instruments—especially the inclinator—were developed to a high degree of perfection and usefulness in the field, the use of the miner's compass gradually ceased. The advantage of the new instruments was that the readings could be obtained and expressed in figures and were easily plotted on a map. Thus the magnetic anomalies became easier to interpret and often from readings carefully plotted a general idea of the form and characteristics of the ore-bodies could be gained. A very great number of magnetic maps were made in this new way, which added considerable experience to the general knowledge of the art of magnetic prospecting. In order to obtain and use the magnetic methods fully, it is necessary to work the geophysical picture, derived magnetically, into the geological structure and thus avoid mistakes and, on the other hand, make the interpretation and conclusions more accurate. As long as the magnetic prospecting was carried out in the Bergslagen area of Central Sweden and only the strongest indications were followed up, the risk of working on indications that were not caused by bodies of ore was rather slight. It is true, however, that sometimes the ore found was not very good and sometimes too low grade or of insufficient quantity to be of commercial importance, but as a whole it was the experience that nothing but ore could cause strong magnetic reactions. Results were less satisfactory, however, in prospecting the large areas in Northern

Sweden during the latter part of the 19th century. A few of the largest ore deposits forming mountains of ore were known as early as the 17th or 18th century, but as a whole the geology of the formation and ore-bodies covered by glacial moraine, muskegs, and swamps was hardly known at all. The construction of the railroad through this district in the nineties, however, caused a rush the like of which had not been witnessed in Sweden since the medieval rush to the ore district in Central Sweden. The prospectors, who often were Lapps, searched the district, using a miner's compass and inclinator, and made magnetic maps of their observations. Trenching and diamond drilling were performed on the basis of these maps.

A number of large ore-bodies containing several million tons of rich iron ore were discovered in this rush, but it was found that several indications did not correspond to any ore, but were caused by weak disseminations of magnetite or breccias in the ore-bearing porphyries, and sometimes also basic intrusive rocks caused strong magnetic attractions, due to slight dissemination of titaniferous magnetite. These failures were caused, to some extent, by the fact that the intensity of the magnetic field is greatly increased with decreasing distance to the North Pole ; so that even low-grade deposits of magnetite or magnetic minerals there will give much stronger reactions than in the central part of Sweden. In the Lapland areas the outcrops are still scarcer than in Central Sweden, and thus the geological structure is not so well known. Therefore, non-commercial indications could not be eliminated without relatively extensive campaigns of trenching or drilling. After a great deal of money had been spent during the early stages of the rush in examining such valueless magnetic indications, one became more cautious before performing expensive development work, and therefore studied the magnetic conditions in more detail and tried to ascertain whether the indications were situated within the ore-bearing formation or if it could possibly be caused by valueless rocks. Later, during the prospecting rush in Northern Lapland, the magnetic surveys as a rule were conducted and interpreted by skilled geologists, thus reducing the number of failures to a minimum, in spite of the fact that the valueless indications were more frequent within the sections prospected later, as compared to those areas covered in the early part of the rush. During the latter period of the rush, the experience was widened and two new causes of magnetic indications were found, namely, extensive horizons of sediments containing some magnetite (similar to banded ironstone) and, further, graphitic slates with pyrrhotite (black schists.)

Recent Discoveries of Large Bodies of Iron Ore.—Still another important improvement was made during the Lapland campaign ; the systematic planning of the reconnaissance work so that no blank spaces were left uncovered and also so that no duplication of work was done. Two ore discoveries in 1918 clearly showed the necessity for systematic work. On one occasion, the wife of one of the leaders in charge of the prospecting campaign went out berry-picking close to the large iron ore area Kiruna and she happened to notice that her miner's compass, which she always carried with her, was pointing vertically, which information resulted in the discovery of the great Vieto ore-body. The other occasion was the finding of the huge Kaunisvaara ore-body in the Pajala area, where mining had been carried on since the 17th century. Both of these areas were supposed to have been sufficiently prospected during the first period of the rush. Kaunisvaara, with its 100,000 to 150,000 tons of iron ore per metre depth, is mostly high-grade and is probably the largest find so far made exclusively with geophysical methods. This find also shows how far the efficiency of a prospecting campaign can be carried, if it is planned, conducted, and carried out by geologically skilled and qualified persons. The survey, which comprised an area of about 1,000 square kilometres, was planned and supervised by A. Gavelin, Director of the Geological Survey of Sweden. The survey, including the inclinator work, was carried out, without any assistance, by one of the foremost geologists in Finland, Dr. Tanner. The work included a network of lines surveyed with an inclinator, and outcrops in the way were also studied ; detailed survey of the most interesting indications was made and explorations of the Kaunisvaara ore-bodies were conducted. The whole survey was completed during one short summer season at a very low cost.

Magnetic Surveys of Geological Horizons.—Extensive magnetic surveys have been carried out during the last few years in the Skellefte area. Strong magnetic anomalies were very common here. In no case, however, were they caused by iron ore,

but by pyrrhotite, generally as an accessory constituent in graphitic phyllite (black schist) and also as the main constituent in the sulphide ores. Most of the sulphide ore-bodies discovered were non-magnetic and therefore the magnetic survey could not be used as a general method, but it was of great assistance in interpreting electrical indications and also in the study of the structure where bedrock was extensively covered by glacial moraine. The magnetic black schists form a characteristic horizon in the rock series close to the ore horizons and are now used as the key horizon, especially when planning electrical surveys. The mapping of magnetic key horizons in areas with heavy overburden has been done to very great extent in North America in iron and copper-bearing ranges around the Great Lakes.

Magnetic Surveys in North America.—The magnetic methods of surveying came from Sweden to the United States as early as the 18th century and a great many bodies of iron ore were located by these methods in New Jersey and New York. The Swedish influence may also be seen in some of the names of these discoveries; for example, Dannemora. The sun dial compass was used mostly for this work and this instrument was also later used in the sensitive surface work of the iron ore ranges of Lake Superior, although these were carried out at the time when the miner's compass or its modified form, the dipping needle, had been in use in Sweden for quite a long time. Later, when the dipping needle was introduced into the United States, the inclinator was being used in Sweden. In the United States and Canada the dipping needle still seems to be preferred to the inclinator, although the latter gives the simplest and clearest picture of the magnetic conditions. Probably this is because of the misconception common also in Sweden, that the inclinator is not equal to other instruments as a field instrument for rapid reconnaissance, where great accuracy is required. However, this is a misunderstanding which the work of the Geological Survey of Sweden has shown clearly [1] and it is found that with the inclinator one can make the observations farther apart than with the older instruments and still be able to combine the results into a picture of the magnetic anomalies. In recent years, a very sensitive magnetic instrument, namely, the variometer, has been built and used for tracing certain geological formations.

The Value of Magnetic Surveys to the Swedish Iron Ore Industry.—From the above review, it may be seen that the Swedish iron ore industry, owing to the magnetic methods, as early as the 17th century was provided with new ore-bodies which were necessary to keep up the production, and that the new finds during the later periods largely exceeded consumption. Conditions, however, were not so fortunate in the case of providing new sulphide ore-bodies, as the old large ones were mined out. The large discoveries of sulphide ore in Bergslagen during the Middle Ages and the 16th and 17th centuries were made entirely from outcrops or the occurrence of gossan, the discoveries being made as colonization gradually penetrated the forests. As it was not feasible, with the weak-magnetic disturbances caused by the sulphide bodies, to prospect for them with the sun dial compass, the wealth of the copper-silver-lead ore industry culminated as early as the 16th or 17th century. It is true that an increased production occurred in the 19th century, but this was mostly caused by improved metallurgical methods and also because zinc-blende became of commercial value. Some compensation for the ore mined was also obtained when the Kaveltorp and Saxberget mines were discovered (by magnetic surveys, as mentioned above) but, generally speaking, the decrease in ore reserves could not be compensated. The situation became acute during the Great War, when Sweden was practically deprived of the import of metals, and the insufficiency of the ore reserves of the country became very evident. All ore-bodies outcropping had been found, also most of those that could be found by means of magnetic methods or by diamond drilling on geologically favourable areas. The success of the magnetic prospecting methods made it probable that electric methods might be developed into something of similar usefulness.

Electrical Prospecting.—The idea of prospecting for ore by means of electricity is old. Several experiments pertaining to electrical prospecting for ore were made during the 19th century, but the first methods of practical usefulness were not developed

[1] By using the inclinator it is possible to take 500 to 700 readings in eight hours. Then one square mile with observations at every 100 ft. could be covered by one observer and two hands in about one week. On the other hand, with the magnetometer about 100 readings may be taken per day and with a variometer about 20 to 30.

until during or after the Great War. It is interesting, however, to review the first experiments. Scarcely was galvanism known, when studies were begun on the electrical currents surrounding metalliferous ore.[1]

Utilizing Current Flowing in the Ground.—In 1830 Robert Fox read before the Royal Society in London a paper entitled "The Electro-Magnetic Properties of Metalliferous Veins in the Mines of Cornwall."[2] By means of a sensitive galvanometer, he had discovered that an electric current flowed in a copper wire connecting ore separated by country rock, and concluded that currents were generated in ore veins. He suggested that a prospecting method be devised to utilize these currents. Experiments were then made by several others and some time later, about 1844, Reich in Freiberg, Germany, made some experimental tests, using these currents for finding new ore-bodies. Reich found that these currents were caused by chemical reactions in the ore-bodies, but he did not reach any practical result.

The first systematic investigation of currents occurring around ore-bodies was carried out by Carl Barus in Nevada about 1880. He concluded that, with more highly developed apparatus and with systematic investigation of these currents, information could be gathered as to the position and shape of the ore-bodies.

Using Artificial Electrical Fields.—Some time previous, in the sixties, another method was tested. Metallic ore is generally found to be a good conductor for electrical current. It was thought that the presence in the ground of a body of high conductivity could be detected by direct resistance measurements taken between pairs of electrodes placed in contact with the ground at fixed intervals. In practice, however, it was found that the resistivity so obtained was determined almost entirely by the nature of the contact of the electrodes with the ground.

Introducing Alternating Current Fields.—Later on, in the nineties, in making such resistance observations, an Englishman named A. Williams also tried alternating current sent into the ground by means of electrodes. The electrical field was studied by means of a telephone receiver connected with two movable secondary electrodes. Williams found that ore-bodies changed the intensity of the electrical field and he developed an ore-finding method on these principles, which is known as the Daft and Williams method, being named after Williams and an American electrical engineer named Daft. This method was patented in several countries in the beginning of the 20th century. Changes in the electrical field, caused by the presence of an ore-body, were observed by means of a sensitive telephone receiver, the diaphragm of which vibrated more strongly or weakly according to the intensity of the electrical field. The dependability of the observations, however, relied greatly on the personal impression and skill of the observer and, at least under less simple conditions, very protracted detail work was required.

Up to the beginning of the 20th century, no practical methods had been developed and the reason for this is now readily understood. The field technique was faulty and lacking in systematic planning of the work; often the methods were tested on ores that were not suitable; and, last but not least, the plotting and mapping of the survey results were not clear and rendered very little information.

First Practical Result.—However, Muenster, of Kongsberg, Norway, seems to have made most progress, for as early as 1907 he made a new find of ore. He used the self-potential method as described by Barus in 1882, but as to field technique, he followed the systematic methods of the Swedish magnetic surveys, making observations along a number of profiles. This first discovery of ore made by electrical prospecting was located in Sweden in Nautanen, Lapland. Later, in 1912 and 1913 Professor Carl Schlumberger, of Paris, developed and patented a method of systematically observing and mapping current of spontaneous polarization for locating ore-bodies.

Almost from the beginning the development of electrical methods was followed with great interest in Sweden. Thus, in 1907 the Swedish Institute of Iron and Steel organized an official systematic test of the Daft and Williams method. It is to be regretted that the results arrived at by this test were not followed up, although by this time the possibilities were clearly visualized. In 1912

[1] Under certain conditions, where oxidation of the ore mineral is in progress, potential differences are generated in an ore-body spontaneously so that current is set up in the surrounding country.

[2] See Dr. W. R. Jones in *The Mining Magazine* for May and June.—Editor.

further experiments with the Daft and Williams method were carried on by the Geological Survey of Sweden by Tegengren and Bodman and the following year also by Bergstrom, who instituted the use of equipotential surveys.

Detailed studies and tests were made with this new method and it was ascertained that the apparatus filled all requirements of field efficiency, but that the survey maps were still difficult to interpret.

By this time Schlumberger in France also had independently developed a method of tracing and mapping equipotential lines of an electrical field set up in the ground, although he was using direct current.

The object of the early experiments in Sweden was chiefly to locate non-magnetic specularite ore, the interest in sulphide ores at that time being only slight. With the change in conditions during the Great War, experiments were again taken up, and it was hoped that the shortage of sulphide ores could be remedied. In spite of the difficulty of not always understanding the results of this method, experiments showed that suitable technique could be developed and by adopting the linear electrodes, first used by Lundberg and Nathorst in 1918, a method of electrical surveying was devised which, in clearness and efficiency, was comparable with the magnetic method. During this period of sulphide shortage, geological reconnaissance for sulphide ore had delimited several areas where a reliable method for locating ore-bodies under the glacial moraine was all that was required. When the problem seemed solved by the introduction of linear electrodes, large areas were immediately subjected to test by this method.

Ideal Conditions for Electrical Prospecting in Sweden.—The situation was very favourable, with high prices for the base metal sulphides, and even pyrite, which theretofore was considered worthless, brought good prices. With intimate co-operation of economic geologists, with the benefit of the great field experience in previous magnetic surveys and, further, the occurrence of types of ore and geological conditions very suitable for electrical methods —all offered ideal conditions. It is, therefore, quite logical that in Sweden electrical prospecting should become one of the most important instruments of the mining industry. The results from electrical prospecting came almost immediately. In 1918 a deposit of large bodies of pyrite and chalcopyrite were found in Kristineberg in the Skellefte region and in 1919 another one at Remdalen in the Vasterbotten Mountains.

Introducing Electromagnetic Methods.—A third group of electrical methods, the electromagnetic, had been suggested as early as 1904 by Trustedt in Finland, and in Germany, about 1910 and 1911 a great number of experiments and tests were made by Lowy and Leimbach. The first serious experiments with electromagnetic method, however, were made in the United States about 1917 by Conklin. Unfortunately, Conklin was experimenting on a type of ore-body which was not suitable for electromagnetic methods and therefore his results were not very encouraging, although the principles of his method are fundamental. In 1921 experiments were taken up in several places in Germany, and by Sundberg in Sweden. The first new ore-body was discovered the same year in Northern Sweden by Sundberg's method.

Practical Results.—Both equipotential and electromagnetic methods were then used extensively in Sweden and a great number of discoveries followed, especially in the Vasterbotten region. The ore reserves of copper, gold, silver, and zinc in Sweden all increased rapidly, and at the present writing the tonnage of the new finds exceeds the extraction of centuries. The new sulphide and gold deposit, Boliden, is among the largest of its kind known in the world. Thus, in a few years electrical prospecting saved the sulphide mining industry in Sweden which was once so important but was declining rapidly by the time of the war.

In the same way that magnetic prospecting in the 18th century was introduced in North America from Sweden, it also transpired that Swedish engineers were the first to discover, by electrical methods, ore of economic importance in North America, around 1924, and complete recognition of electrical prospecting may be dated as of 1926, when the large ore-bodies at Buchans, Newfoundland, were discovered.

Re-opening of Shinyanga district to prospecting.—In September last the Shinyanga district of Tanganyika Territory was closed to prospecting. It is now announced that this interdict has been revoked and that the Governor is prepared to consider applications for authority to prospect in the district.

A SKETCH OF THE HISTORY OF CANADIAN MINING

By H. C. COOKE, Ph.D., Geological Survey, Canada

Mining in the territory now known as Canada may be said to have originated with the Indians. At Mamainse Point, on the east end of Lake Superior, old trenches and pits have been found on veins of native copper, together with the old stone hammers used by the natives to break up the rock. Native copper from the Coppermine River, north-east of Great Bear Lake, has been employed by the Eskimos for generations for spear and arrow points, knife-blades, and other tools. It seems evident, however, that peoples without iron tools, without explosives, and without a knowledge of extracting metals from their ores must have confined their mining efforts to those rare deposits where native metals occur.

The advent of the French marks the beginning of real mining effort, although the French, as the earliest settlers, devoted themselves mainly to agriculture and fur-trading. The coal beds of Cape Breton Island, outcropping prominently on the shore cliffs, first attracted attention, and as early as 1672 were mentioned by Nicholas Denys in his description of the coasts of Northern America. For many years these deposits were untouched, except by ships needing fuel; the crews commonly broke out with crowbars what was required and carried it off without permission or payment. In 1720 systematic mining was begun, to supply fuel to the forces building the fortress of Louisburg; and from that time the industry has grown gradually to its present production of approximately six million tons annually.

Outline Map of Canada and Newfoundland.

Showing position of Trail, Sullivan, Britannia, Anyox, Premier, Flin-Flon, Central Manitoba Mines, Red Lake, Porcupine, Cobalt, Kirkland Lake, Sudbury, Rouyn, Thetford (asbestos), Sydney (coal), and Wabana (iron).

Another result of early French exploration was the discovery, in 1686, of what is now the Wright mine, on the eastern shore of Lake Timiskaming. The mine was a rich deposit of lead-silver ore; but it did not attract the French, presumably because of its inaccessibility and the consequent difficulties of mining, smelting, and transportation. Had this early exploration brought to light the rich native silver of Cobalt, only a few miles to the west, who can tell how greatly the course of history might have been changed thereby.

The bog iron ores of St. Maurice District, Quebec, were the next to attract attention, and in 1737 the first blast-furnace in Canada, known as St. Maurice Forges, was erected to

smelt them. Others followed, and were operated for longer or shorter periods. Two, the Radnor Forges and McDougall and Co., are still working, as the iron produced, though small in quantity, is particularly adapted to the manufacture of car wheels.

In 1767 a trader named Henry rediscovered the copper veins at Mamainse Point, Lake Superior, and three years later an English company was formed to work them. The vein on which they mined, however, narrowed to a width of 4 in. about 30 ft. from the surface, and the project accordingly failed.

Mineral discoveries became more numerous after the beginning of the last century. Iron was found in various places in eastern Ontario, and smelting furnaces were erected in Leeds county (1800), near Marmora (1820), and in several other places; but the high cost of teaming the ores and castings over bad roads, and the necessity for using expensive charcoal as fuel, made most of the operations unprofitable. The completion of the St. Lawrence canals about 1848 caused the ultimate extinction of most of these projects, as cheap foreign iron was thereby brought in.

Other early discoveries, which can be no more than mentioned, were those of the gold placers of the Chaudiere River in Quebec, which are said to have produced, between 1860 and 1876, some two million dollars in gold; the silver discoveries of Thunder Bay, first found in 1866, of which Silver Islet, the most famous, yielded more than three million dollars worth of silver between 1870 and 1884; and the discoveries of gold veins in Nova Scotia in 1862. Some of the latter are still working and altogether these veins have yielded nearly nineteen million dollars worth of the precious metal.

Meanwhile, on the other side of the continent, public excitement was raised to fever pitch by the discovery of the rich placer fields of Fraser River, in 1858. It is estimated that between 14,000 and 23,000 persons left San Francisco between April and June of that year, bound for the Fraser diggings. The majority of these, disheartened by the difficulties of travelling through the country, did not remain; but the more hardy who succeeded in penetrating the interior found placers in several localities, including the extraordinarily rich diggings of Williams and Lightning Creeks. Continued exploration was followed by new discoveries, in Omineca district in 1868, Cassiar in 1874, and Atlin in 1898, and each find was followed by a new influx of prospectors, many of whom became permanent residents. The placers proved a source of great wealth. For the six years from 1863 to 1868 the yield of gold averaged more than three million dollars annually, and the total yield, to the present, has been more than 78 million. The deposits are now pretty well exhausted.

The completion of the Canadian Pacific Railway in 1885 was perhaps the most important event in the mining history of the country. From this main artery of communication prospectors readily penetrated a great area of hitherto inaccessible territory, and discovery after discovery of ore deposits resulted. One of the most important was that of the great copper-nickel deposits of Sudbury, Ontario. First found in 1856, but then regarded merely as of academic interest, it was re-discovered during construction of the road in 1883, and brought into production in 1887. These deposits, which now supply 90% of the world's nickel, have become increasingly productive during their forty years of life until in 1928 there were recovered more than 48,000 tons of nickel and 33,000 tons of copper with a total value of some 31 million dollars. Not only are immense bodies of ore known still to be present in the producing mines, but new ore-bodies, of which the Frood is the most outstanding, have also been discovered in recent years, rendering the field of vast potential value.

During the ten years following the construction of the railway many small deposits of gold were found in the vicinity of the line in Ontario. In Haliburton county, along the north shore of Lake Huron, and north of Lake Superior many of these became small producers and operated for varying, though usually short, periods. The most important were the discoveries in Lake of the Woods district, west of Lake Superior, where veins were opened up carrying rich shoots of coarse free gold. These discoveries caused immense excitement and the usual orgy of stock speculation and company promotion. The most valuable mines, the Sultana, Mikado, and Regina, were worked for periods of 10 to 15 years, and in that time each produced gold to the value of half a million to a million dollars. By 1906 most of the activity in the district had ceased, though spasmodic attempts have been made since to reopen one or other of the mines.

In British Columbia progress was about

equally rapid but more important and permanent. Drifting along the great waterways south from the Canadian Pacific Railway and north from the United States, prospectors combed the country between the railway and the border with the result that hundreds of discoveries of valuable mineral were made which later were developed into producing mines. One of the first, in 1882, was that of the Bluebell Mine on Kootenay Lake, a silver-lead mine still producing ore. In 1890 the principal claims of the great Rossland district were first staked; then in rapid succession followed the discovery of Greenwood in 1891, of the Slocan in 1892, and of Kimberley, also in 1892. This famous galaxy of mines has produced immense wealth. Rossland, which came into full production after the construction of the Trail smelter in 1895, yielded copper, gold, and silver to the value of more than three million dollars annually till 1916. The exhaustion of the ore-bodies then caused production to decline, and it is very small at the present time, although until 1921 it was maintained at over a million a year. The Greenwood discoveries proved to be large bodies of rather low-grade ore which on that account were not brought into full production until 1900. Between 1900 and 1920, however, gold and copper were recovered from them to the value of more than one hundred and five million dollars. The ore-bodies are now practically exhausted. The numerous mines of the Slocan district have produced chiefly silver, lead, and zinc, maintaining a fairly steady though not spectacular yield from 1895 when they came into full production, to the present. In the period of 32 years to 1926 they yielded metals to the value of about 50 million dollars or an average yield of more than one and one-half millions yearly. At Kimberley a number of mines were opened up, the most spectacular of which is the immense Sullivan ore-body which became the mainstay of the Consolidated Mining and Smelting Company of Canada. Although staked in 1892 systematic development was not begun till 1900, when some ore was shipped. In 1903 a smelter was erected near Kimberley to treat the ore, but metallurgical difficulties rendered treatment unprofitable, so that in 1907 mine and smelter were closed, and later seized for debt. In 1909 the property was taken over by the Consolidated Mining and Smelting Company of Canada, which proceeded to active development and to solving the metallurgical problems. By 1914 the Sullivan had become the largest lead producer in Canada and has maintained that position ever since. The ore-body is a deposit of solid sulphides varying from 150 to 270 ft. in thickness, although not all of this is ore. The most valuable constituent is the lead, with a good proportion of zinc and some silver. Production in the thirteen years from 1913 to 1925 was more than 85,000,000 dollars, more than half of which was recovered in the last three years of that period. In 1927 the output of ore was increased from 3,000 to 4,000 tons per day, resulting in a production, in 1928, of more than $7\frac{1}{2}$ million ounces of silver, nearly 160,000 tons of lead and nearly 82,000 tons of zinc, with a total value of more than 34 million dollars. This great mine still has enough ore in sight to maintain production for another century, at the present rate of mining.

After the great developments of the early nineties, discoveries continued to be made, though more slowly. In general these have been in areas readily accessible from the coasts. The Tyee mine, found on Vancouver Island in 1896, was a lens of ore from which more than 11,000 tons of copper were recovered between 1903 and 1907. About the same time the copper deposits of Texada Island were uncovered, from which large tonnages have been shipped. In 1898 the Britannia Mine on Howe Sound was located. This great property, however, was not brought to the productive stage until 1905, and on account of the low grade of its ores did not begin to be developed on a large scale till some years later. Between 1916 and 1927 it produced copper to the value of nearly $4,000,000 annually, while the 1928 production was valued at about six million. In 1903 the copper deposits at Anyox, on Granby Bay, were found, now worked by the Granby Consolidated Mining, Smelting, and Power Company. In the six years from 1919 to 1927 these deposits yielded an average return of more than $5,000,000 annually, principally in copper. The last great mine discovered, the Premier, was found in 1910 in the Salmon River district at the head of Portland Canal. Its rich gold and silver ores yielded approximately $29,000,000 in the seven years from 1921 to 1927, out of which more than eight millions were distributed in dividends.

The whole record for British Columbia since 1892, when lode mining may be said

to have begun, is one of immense advance in the amount and variety of its mineral production. This advance has not been regular, but rather shows sudden spurts as new districts were opened up, followed frequently by temporary recessions as properties or districts were worked out. In 1892 metal mines produced practically nothing; in 1928 metals to the value of nearly 49 millions were mined. In 1892 coal production was less than $3,000,000; in 1928 it was more than $11,000,000. Other products brought the mineral production for 1928 up to the grand total of $63,913,159. The Province furnished nearly all the lead and zinc produced in Canada and more than half the copper, as well as a large proportion of the silver and gold.

This great production made British Columbia for more than two decades the premier mining province of the Dominion, but the centre of interest was now to shift eastward to Ontario. Here again is made evident the influence of railway building on discovery. In 1902 the Ontario Government commenced the construction of a railway to open up an area of arable land lying northwest of Lake Timiskaming, and in the autumn of the following year, as construction operations were being carried on near what is now the town of Cobalt, the first discovery of silver was made by a blacksmith named La Rose, who used to prospect in his spare time. When the news was published, a tremendous influx of prospectors from all parts of the continent took place, and numerous discoveries followed. Some silver was mined in 1904, and by 1908 the camp had become one of the world's largest silver producers. In the period between 1904 and 1922 this area produced and shipped more than 333 million ounces of the precious metal, and paid over $87,000,000 in dividends. Since 1922 production from the Cobalt area proper has decreased to about 3½ million ounces, which is about the same quantity as the combined output of the outlying districts of South Lorrain and Gowganda.

From Cobalt and from the railway, as it was pushed northward, prospectors spread over the adjacent country, with the result that in 1909 the Porcupine gold district was found, and three years later the smaller Kirkland Lake field. The Porcupine district was brought to the producing stage in 1912, and by the end of 1928 had yielded more than $229,000,000 in gold, furnished mainly by the Hollinger, Dome, and McIntyre mines. In the same length of time gold to the value of about $48,000,000 had been recovered from the Kirkland Lake field, the annual yield of which has risen beyond $12,000,000.

The second transcontinental railroad built in Canada was the Canadian National, traversing the country north of the Canadian Pacific. It was completed in 1915, but although construction was attended by a number of small discoveries, its full effects on the progress of discovery were deferred for years, as the country was drained of men by the war. Since the end of that struggle prospecting has gradually been resumed with encouraging results. In the vicinity of the road in Quebec large deposits of copper and copper-gold ores have been found within the last four years in the Rouyn area, a district which promises to become one of the great mining areas of the Dominion. Already, in 1928, the first year of production, Noranda Mines have yielded more than 33 million pounds of copper, valued at nearly five million dollars, and gold to the value of more than a million dollars. Farther west, promising gold deposits are reported in the Red Lake area of Western Ontario, to the north of the new railroad; and in Northern Manitoba the discovery of the copper-gold-zinc deposits of the Mandy, Flin-Flon, Sherritt-Gordon, and other properties followed directly on railroad construction. In British Columbia results have so far been small, although one gold-silver deposit near Topley is reported as promising.

Next to the metalliferous mines, which furnish the bulk of the mineral wealth of Canada, are the coal deposits. These are confined to the eastern and western parts of the Dominion, with the natural result that central Canada, particularly Ontario and the western part of Quebec, finds it necessary to secure its coal supply principally from the United States. On both eastern and western coasts some of the coal deposits were known and mined for many years prior to Confederation, but the progress of discovery has since revealed many more, and coal mining has grown until it is the largest individual mining industry in the Dominion. In the years 1927 and 1928 the annual production was approximately 17½ million tons, made up of about 13 million tons of bituminous coal, and 4½ million tons of sub-bituminous coal and lignite from the provinces of Alberta and Saskatchewan. Of

this amount between five and six hundred thousand tons are exported.

The asbestos deposits of Southern Quebec furnish more than three-quarters of the world supply at the present time. Mining of asbestos commenced in 1876 and has now reached large proportions. In 1928 some 273,000 tons were shipped, valued at more than $11,000,000; and altogether more than 2½ million tons of this mineral have been produced.

No account of the mining history of the Dominion would be complete without at least brief reference to the placer deposits of Yukon territory. Gold in paying quantities was first discovered in 1881 in the sands of the Big Salmon River; and from that time forward exploration proceeded steadily until, in 1896, the phenomenal richness of Bonanza Creek, in Klondike District, was made known. The rush of 1897–8 followed, and more than 30,000 persons poured into the district. Gold production leaped from a quarter of a million dollars in 1896 to ten million in 1898, sixteen million in 1899, and 22 million in 1900. It then fell off gradually, but remained at about four million annually up to 1917. Altogether Yukon district has yielded more than 182 million dollars worth of placer gold.

Other valuable resources which have been developed during the last sixty years include platinum, cobalt, gypsum, salt, natural gas, oil, talc, and others. The total value of the mineral products of the Dominion in 1928, exclusive of such products as stone, brick, and cement, was more than $223,500,000.

It is interesting to compare the growth of the mineral industry with that of the population. In 1886, when statistics for the whole of Canada were first collected, the value per capita of the annual mineral production was $2·23. Ten years later it had doubled, to $4·38. The next decade showed an increase to $12·81; while in 1928 it was $28·31. Of this amount about 54% consisted of fuels and building materials almost entirely consumed in Canada.

THE RUSSIAN BAUXITE DEPOSITS

By ROBERT J. ANDERSON, D.Sc., Consulting Metallurgical Engineer

(*Concluded from July issue, page* 15)

7. Descriptions of some Individual Deposits.—Following are brief descriptions of several of the separate deposits in the Tikhvin area which have so far been more or less fully investigated.

Krasno-Roocheiski Deposit.—The northern end of the Krasno-Roocheiski bauxite deposit is situated at the juncture of Piardomets creek and Krasno Roochei creek, about 15 miles south of the Bolshoi Dvor station on the Northen Railway (cf. Fig. 1). From this point, the deposit extends in the form of a strip 558 to 1,476 feet (170 to 450 metres) wide to the south. It has been followed up a distance of about 11 miles to Krootoi creek. Prospecting work was stopped here, but the deposit is thought to extend further and probably joins with the deposit at the Nikomla river. The Krasno-Roocheiski deposit is bounded on the west by outcrops of the Devonian formations, but the eastern boundary has not been definitely determined. Towards the east, the thickness of the bauxite bed diminishes to about 3·3 feet (1 metre) and less. Also the quality becomes inferior, the bed turning to aluminous clays. Hence, prospecting work has not been carried further. One line of drill holes set down towards the eastern side of the deposit showed that the aluminous clays are overlain here by limestones. Fig. 2 is a map of the Krasno-Roocheiski area, showing the location of the drill holes and test pits which have been sunk. Fig. 3 is a longitudinal section of this deposit extending through the line AB (cf. Fig. 2). Fig. 4 is a cross-section of the deposit through the line CD, and Fig. 6 is a section through the line EF (cf. Fig. 2). The area for which reserves have been computed, based on sampling, in this deposit is about 0·22 square mile (0·576 square kilometre). The surface of this area slopes toward the south from Piardomets creek, the altitude increasing from about 394 to 443 feet (120 to 135 metres). To the east, the slope is upwards also. At the northern end of the deposit, i.e., at Piardomets creek, the bauxite outcrops from beneath the glacial clays. Towards the south, the overburden increases in thickness, and the bauxite lies under the sandy-clayey complex. Blue, sky-blue, and red clays of the Upper

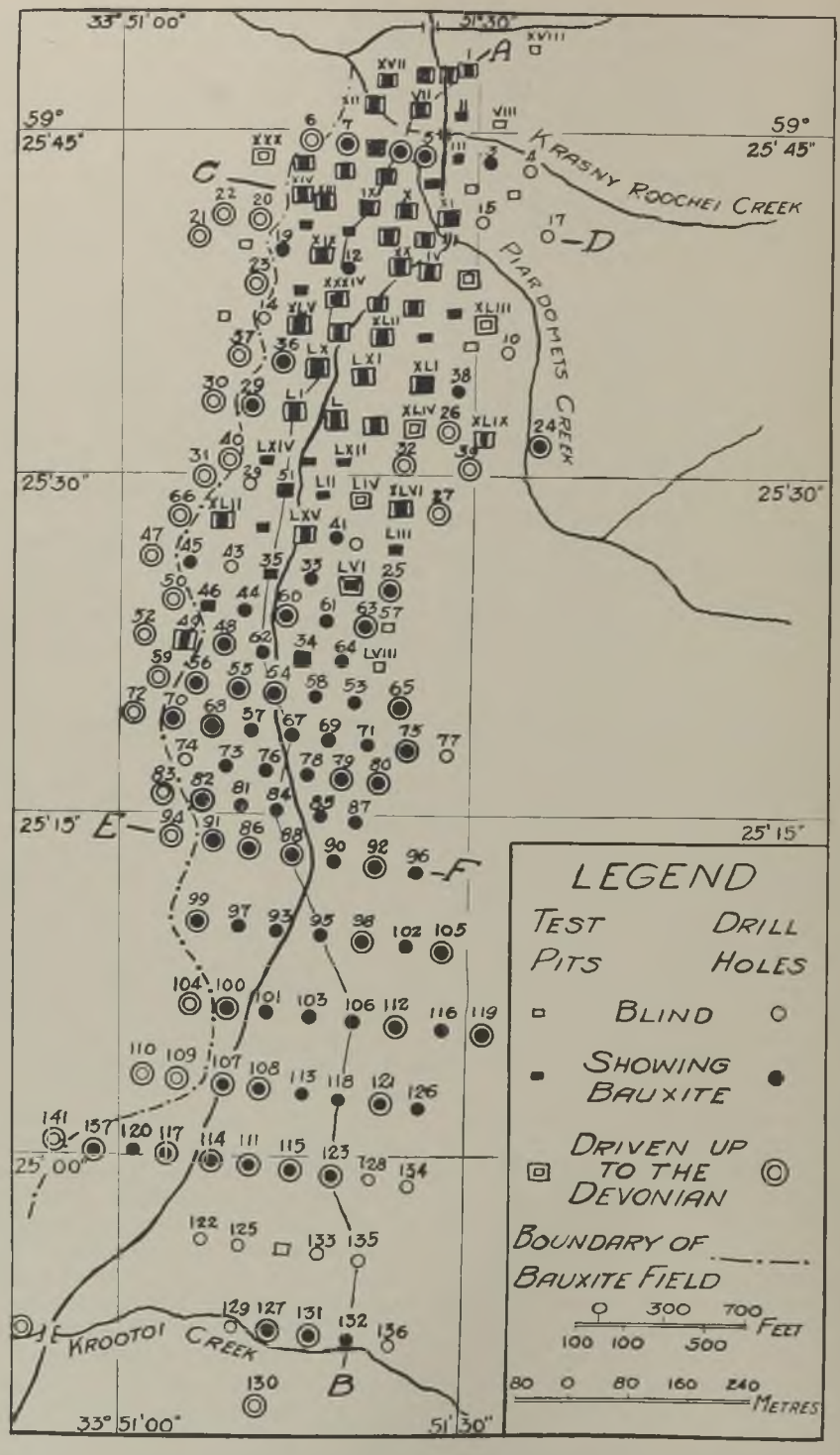


FIG. 2.—PROSPECTING OPERATIONS AT THE KRASNO-ROOCHEISKI BAUXITE DEPOSIT.

Devonian are found at the base of the bauxite bed. In the southern part of the area, the surface of the Devonian base has the shape of a trough, whereas the northern part suggests enlargements like lake bottoms. Usually, a bed of spotted clay lies immediately on the Devonian clays. It shows traces of repeated washings. The bauxite deposit lies on this bed of spotted clay. The thickness of the bauxites varies from about 6·6 to 39 feet (2 to 12 metres). A complex of non-plastic clays of the so-called "sukhari" type is bedded over the bauxite. However, the contact face with the ferruginous bauxites is not sharply expressed, particularly where

calculated by Meeshariev, according to the classification given above, are as follows :—

Estimated Reserves of the Krasno-Roocheiski Bauxite Deposit.

Grade	Metric tons.
"Prima"	253,000
I grade	201,000
"Prima" + I grade	454,000
II grade	459,000
"Prima" + I grade + II grade	913,000
III grade	1,003,700
Total, all grades	1,916,700

Thus, the reserves having an average composition of "Prima" + I grade amount to 454,000 tons of proven ore. The chemical

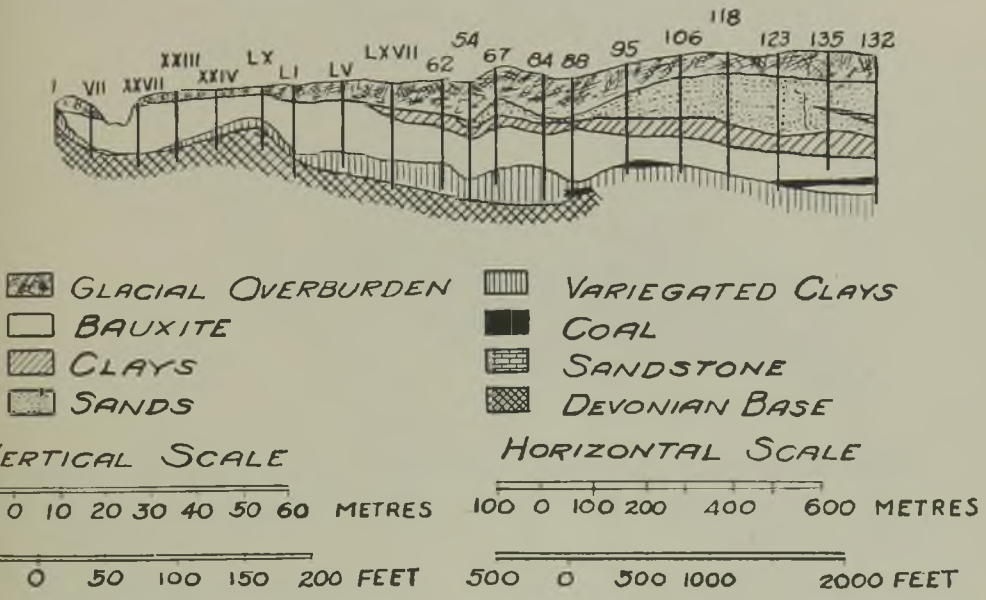


Fig. 3.—Longitudinal Section through the Krasno-Roocheiski Bauxite Deposit; line *AB* of Fig. 2.

these bauxites also contain considerable percentages of silica. The non-plastic clays are overlain by plastic clays, these latter varying in colour from grey to black. The total thickness of these clays varies up to about 13 feet (4 metres), as may be noted in Fig 4. In turn, the clays are covered by sands (of different colours). In the lower part of the section, these sands are cemented, forming brittle sandstones. The colours become lighter towards the top. Finally, the sands are overlain by glacial matter (boulder clay), the thickness of which is about 13 to 20 feet (4 to 6 metres).

The amounts of bauxites of different grades in the Krasno-Roocheiski deposit, composition is, roughly $> 52\%$ Al_2O_3 $< 9\%$ SiO_2, and about 16% Fe_2O_3.

Goobsko-Pochaevski Deposit.—This deposit is situated in the vicinity of Gooba village and Pochaevo farm. Bauxites have also been found within the area of Gooba village itself. The Goobsko-Pochaevski field occupies an area of about 0·39 square mile (1 square kilometre). The bauxite is bedded in layers. At the west, the deposit lies on coal-bearing grey clays belonging to the sandy-clayey complex of Lower Carboniferous age, while at the east it is bedded directly on the Upper Devonian formations, these being expressed here chiefly by a series of variegated micaceous clays and in

part by sands. In some parts of the deposit, the overburden (of boulder clay) increases from west to east and attains a thickness of about 49 to 56 feet (15 to 17 kilometres). However, at the western edge of the deposit, on a rather small area, the bauxites are bedded immediately under a shallow layer of top soil. The thickness of the aluminous complex varies from about 6·6 to 33 feet (2 to 10 metres). The eastern boundary deposit. An attempt has been made here to show the boundaries of the aluminous complex by curves of equal thickness for each grade separately. Fig. 7 is a cross-section through the deposit at the line *AB* and Fig. 8 is another section through the line *CD*. The bauxite deposits here are generally similar to the Krasno-Roocheiski deposit. There is the same absence of distinct foliation in both ; disturbance of the bedding

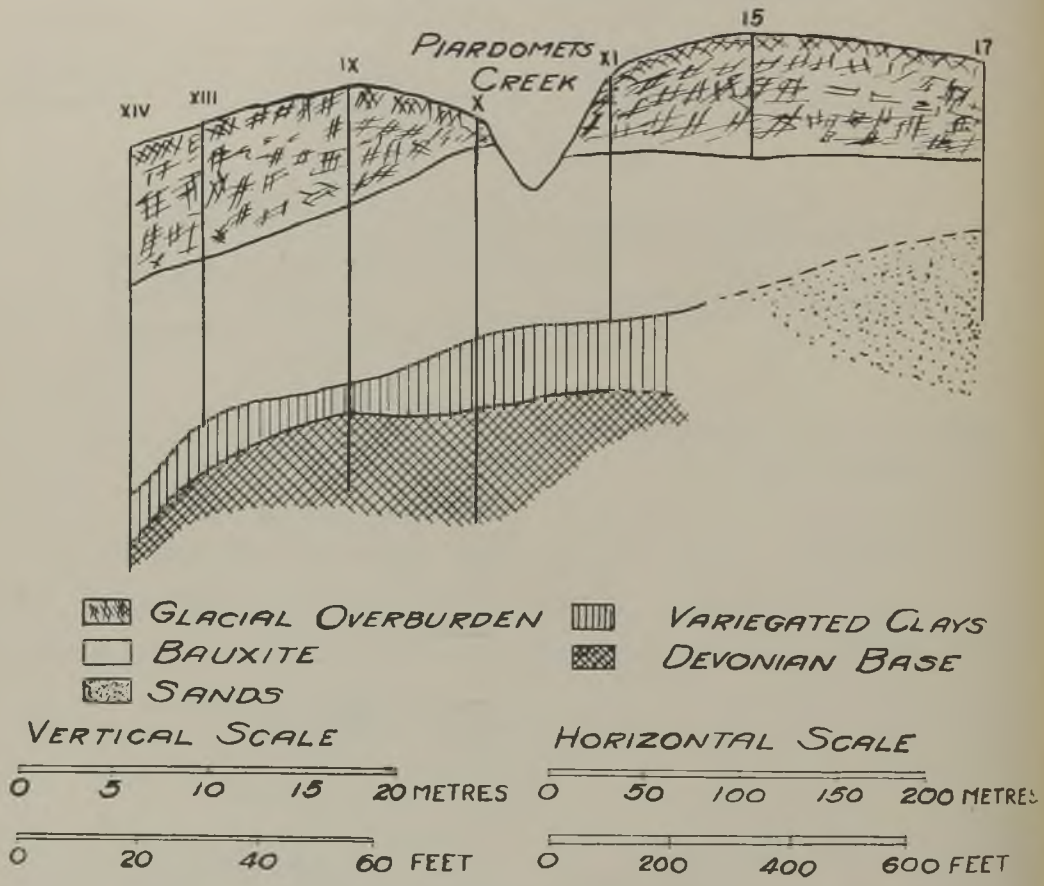


FIG. 4.—CROSS-SECTION THROUGH THE KRASNO-ROOCHEISKI BAUXITE DEPOSIT ; line *CD* of Fig. 2.

of the deposit has not been determined. Considerable difficulty was had, during the prospecting work, in running drill holes here because of the many large hard boulders present in the glacial overburden. So far as the prospecting work was carried, it was found that the bauxite became inferior and of low grade towards the eastern part of the deposit. The best grades of bauxite are found in the south-western part of the prospected area.

Fig. 6 is a map of the Goobsko-Pochaevski

under the overburden caused by glacial movement is plainly evident. In the Goobsko-Pochaevski deposit, the chemical composition varies considerably both through the thickness and the length and width. The best bauxite occurs in the lowest part of the section, while aluminous clays are found largely in the upper part. To the south, in the direction of the Veselets property, a prolongation of the deposit is likely to exist, but it is thought that the grade will be poor. The probable reserves of the Goobsko-

Pochaevski deposit, as calculated by Volkov, are as follows :—

ESTIMATED RESERVES OF THE GOOBSKO-POCHAEVSKI BAUXITE DEPOSIT.

Grade.	Metric tons.
" Prima "	120,000
I grade	195,000
" Prima " + I grade	315,000
II grade	131,000
" Prima " + I grade + II grade	446,000
III grade	383,000
Total, all grades	829,000

locality at three separate places. The eastern area beginning at Krasnaya Glinka and stretched out, evidently, up to Radyn creek, has been examined merely by surface prospecting. Alluminous clay largely is found in this area.

The pockets west of Krasnaya Glinka and north of Podsosna village have been developed to a greater extent. These two pockets occupy the gently sloping parts of this locality ; they are separated from each other and surrounded by Devonian formations,

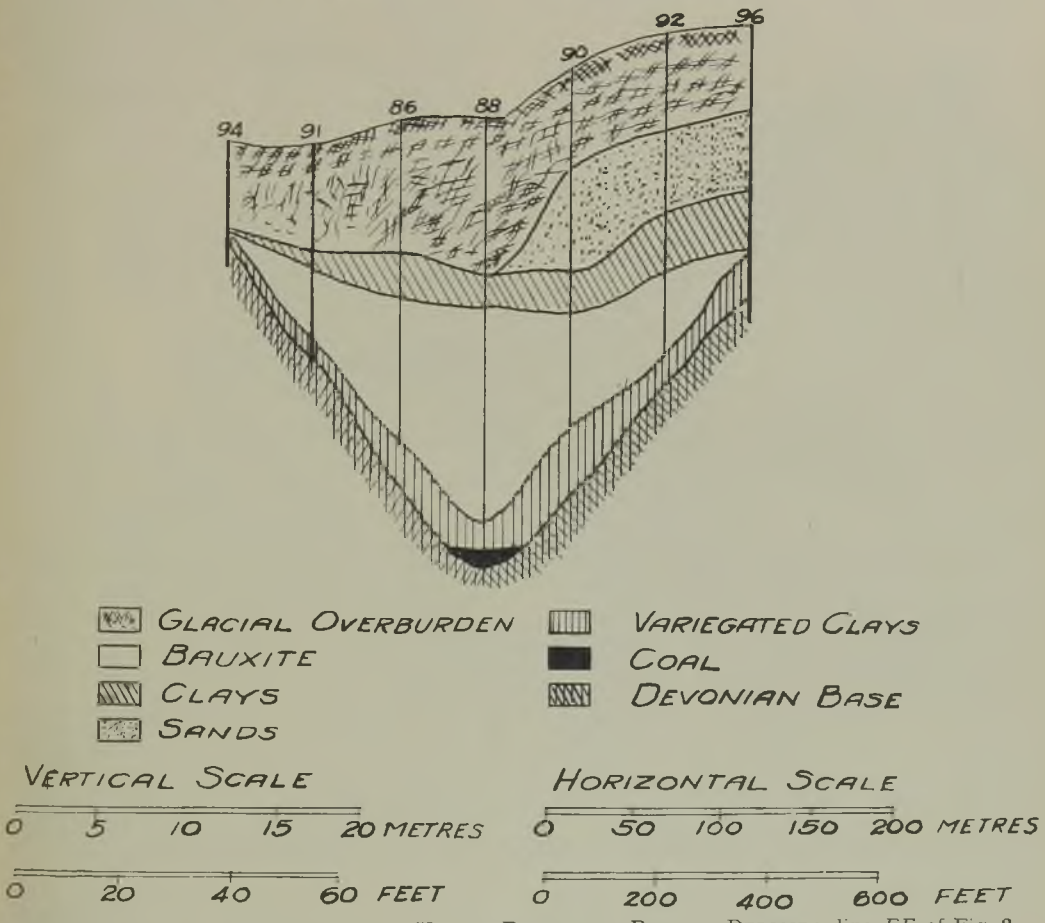


FIG. 5.—CROSS-SECTION THROUGH THE KRASNO-ROOCHEISKI BAUXITE DEPOSIT ; line *EF* of Fig. 2.

Reserves having an average composition of " Prima " + I grade amount to 315,000 tons. The chemical composition is given as > 53% Al_2O_3 and < 13% SiO_2.

Podsosnenski Deposit.—North from the Goobsko-Pochaevski deposit there is a group of deposits near Podsosna village. This group is referred to as the Podsosnenski deposit. Bauxite has been found in this and hence probably represent the remains of a single washed out deposit of larger extension. The overburden here is thin, and usually the ore is bedded immediately under top soil. Total thickness of the deposit ranges from about 10 to 26 feet (3 to 8 metres). Micaceous clays and sands are found at the base, while the overburden consists of sands. The reserves of the

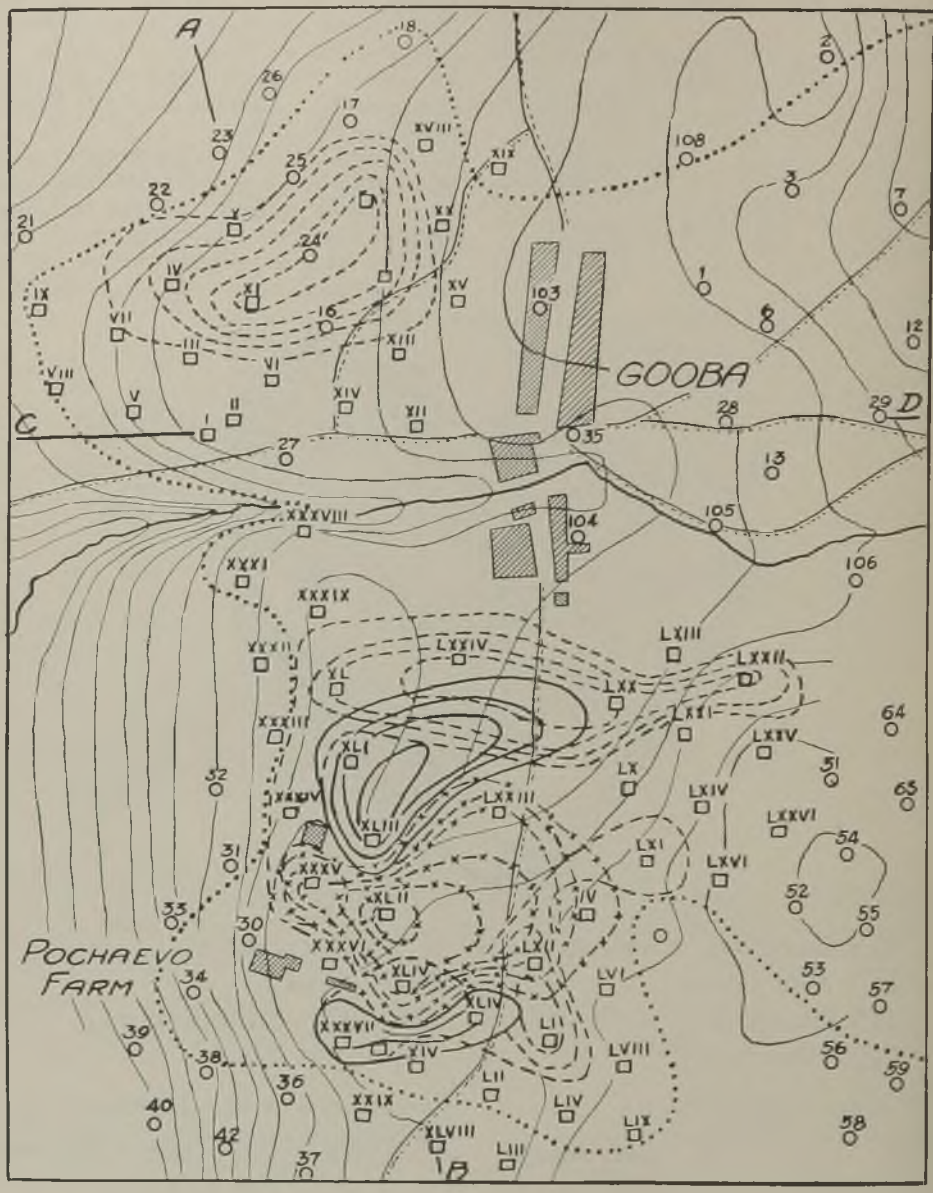


FIG. 6.—SKETCH MAP OF THE GOOBSKO-POCHAEVSKI BAUXITE DEPOSIT.

northern pocket are estimated to be as follows :—

I grade .	. 22,000 metric tons.
III grade .	. 34,000 metric tons.

Average composition of I grade is given as 58·28% Al_2O_3 (+TiO_2), 13·18% SiO_2 and 14·74% Fe_2O_3.

In the southern pocket, the alumina runs as high as 62%, but the silica content is also high, being rarely as low as 7%. The average composition of this pocket may be regarded as II grade. Total reserves of this pocket are figured as 115,000 tons, and the average composition is given as 51·70% Al_2O_3 (+ TiO_2), 24·84% SiO_2, and 13·71% Fe_2O_3.

by surface prospecting, indications being that the grade is inferior (evidently aluminous clay).

8. Reserves of the Tikhvin Region.—The reserves of the Tikhvin area, as calculated by Russian geologists, are as shown in Table 2. These figures apply to the deposits that have been prospected and are based on drill-hole and/or test-pit records. Offhand, the data in Table 2 may look imposing, but it should be remembered that the bulk of the material shown in the table is of inferior grade. Only the so-called "Prima" grade is suitable for use in the Bayer alumina process, and its quality is inferior to what is normally desired and

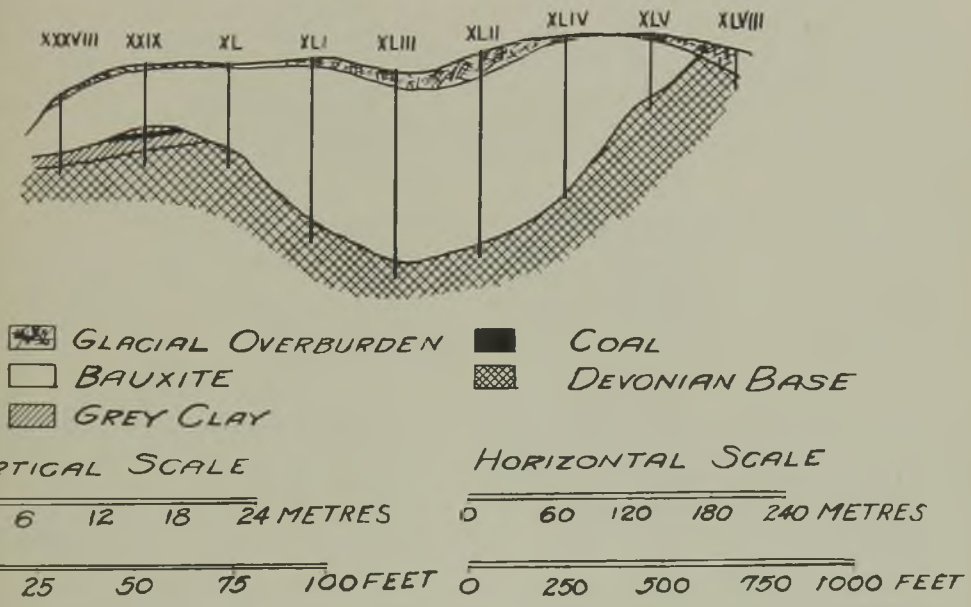


Fig. 7.—Cross-Section through the Goobsko-Pochaevski Bauxite Deposit; line *AB* of Fig. 6.

Other Deposits.—The deposits in the vicinity of Segly, Batkov Konets, and Senno villages are chiefly aluminous clays and II grade material is rarely found. However, the available data regarding these occurrences are at present so meagre that it is impossible to classify them. Drill-hole operations of a deposit of Oosadische village, which is fairly close to the Krasno-Roocheiski deposit, showed an enriched zone in the central part. Preliminary calculations indicate that this enriched portion contains about 182,000 tons of bauxite of I grade. Sufficient data are not available to determine fully the quantities and grades present. The deposits north of the railway line (along Veleekii and Sarooya creeks) have been examined only

employed. The I grade would be suitable for aluminous-cement manufacture, but none of the grades is suitable for chemical purposes (aluminium-salt manufacture) or for abrasives or high-grade refractories. Certain of the grades might be used for some refractories. On the whole, the quality of the Tikhvin bauxites is poor, but some utilization may be made of them.

9. Miscellaneous Notes.—A word may be said about the possibility of beneficiating the Tikhvin bauxites. Work has been done on this problem by the Ore-Dressing Institute at Leningrad, and while actual beneficiation has been made by concentrating methods, the writer believes that the cost will be high. It will be recalled that the quartz in these

bauxites is present in a finely comminuted state; elimination of the free silica by ore-dressing methods will evidently be difficult. Further work is being done on the beneficiation problem.

When the writer visited the Tikhvin region near the end of 1928, mining operations were being carried on in a small way at the Krasno-Roocheiski deposit. Small open-pits were being worked, as well as underground galleries from shafts. The cost of this mining was about 12 rubles per metric ton ($6·18). No excavating machinery was being used. With suitable excavating and other proper machinery, the engineer in charge of the work expected to be able to mine for 1·5 rubles per ton (77 cents). Peasant miners receive 1 ruble 66 kopecks per day. Mining on piece work, it was thought that the rate of pay would be 1 ruble 80 kopecks per cubic metre of rock removed (both bauxite and overburden). Operations at a small shaft using two men underground in galleries and two men at hand winches gave 5 cubic metres of rock per day of eight hours. About 200 tons of ore were taken out between June 1 and September 1, 1928, at this deposit, and much of it was shipped to State plants for use in experimental work. Mining is possible only between the months of April and November, winter operations being practically out of the question because of the severe weather. In 1926–1927, about 840 tons of inferior grade material were shipped from the Tikhvin region for use in experimental paint work and 290 tons of I grade for other experimental purposes. The schedule called for active resumption of mining in 1929.

During July to November, 1926, the Aluminium Company of America had a field party in Russia examining the Tikhvin bauxite deposits and doing prospecting work in other parts of the country. Drill-hole operations by this company in the Tikhvin area gave results which were generally confirmatory of the prior information made available by the work of the Russian geologists. It is understood that this company decided that the Russian bauxites were not worth development.

10. Other Bauxite Occurrences in Russia.—As has been mentioned earlier in the present paper, bauxite has been reported as occurring in various places in Russia other than in the Tikhvin area. Among other localities, the following have been mentioned in technical literature and elsewhere: (*a*) in the Don coal basin, (*b*) in the Ural, near Tchusovaya, about 82 miles by rail east of Perm—the so-called Zhuravlikhin deposits; (*c*) in the Ranenburg district of the Ryazan government, south-east of Moscow; (*d*) in the mountains of Dagestan on the west coast of the Caspian Sea; (*e*) in the Gandza district of Azerbeidjan; (*f*) in the district around Batum on the south-east coast of the Black Sea; and (*g*) on the northern Black Sea coast. Diaspore has been reported as occurring in the Ural. Some exploratory work has been done in the Zhuravlikhin, Ranenburg, and Black Sea areas. Preliminary investigations indicate that the aluminous deposits in the Zhuravlikhin and Ranenburg districts have no commerical value. Alunite is found in the Zhuravlikhin deposits. According to Russian geologists, laterites may be found in the Oofim government (Tartar republic), the so-called "red grounds" of Turkestan, and perhaps in the Maritima Province of the Far East. Formations with an excess of alumina over that required in kaolinite have been found in the Kungurski region of the Ural and in the neighbourhood of Krivoi Rog.

Table 2. Calculated Bauxite Reserves of the Tikhvin Region (metric tons).

Grade.	Name of Deposit. Krasno-Roocheiski.	Goobsko-Pochaevsko.	Pidsosnenski.	Oosadinski.	Segolski.	Totals.
"Prima" . .	253,000	120,000	—	—	—	373,000
I . . .	201,000	195,000	22,000	182,000	—	600,000
II . . .	459,000	131,000	115,000	—	—	705,000
III . . .	1,003,700	383,000	34,000	—	1,000,000	2,420,700
Aluminous clays.	—	3,000,000	1,192,000	—	—	4,192,000
Totals .	1,916,700	3,829,000	1,363,000	182,000	1,000,000	8,290,700

11. Summary and Conclusions.—The bauxite deposits in the Tikhvin region, south-east of Leningrad, have been discussed in this paper, largely on the basis of reported data made available by the Geological Committee of the Union of Soviet Socialist

Republics. While bauxite has been reported as occurring in numerous localities in Russia, apparently the only deposits of commercial value are those situated in the Tikhvin district. Attention is directed to two unique features of these deposits, viz., (*a*) their location between the 59th and 60th parallels north, and (*b*) their geological age (Lower Carboniferous). Their situation is the farthest north of any known bauxite deposit in the world, and their age is greater than that of any other bauxites. The Tikhvin tonnage in several parts of the world for use in aluminium reduction. Based on computations by Russian geologists, the probable reserves of the region have been summarized. Finally, reference is made to other occurrences of bauxite in Russia and to localities where bauxites may be found.

12. Bibliography.—Following are some references to published papers dealing with the Tikhvin bauxite deposits, other Russian bauxite occurrences, and with the problem of utilizing Russian ores for the reduction of

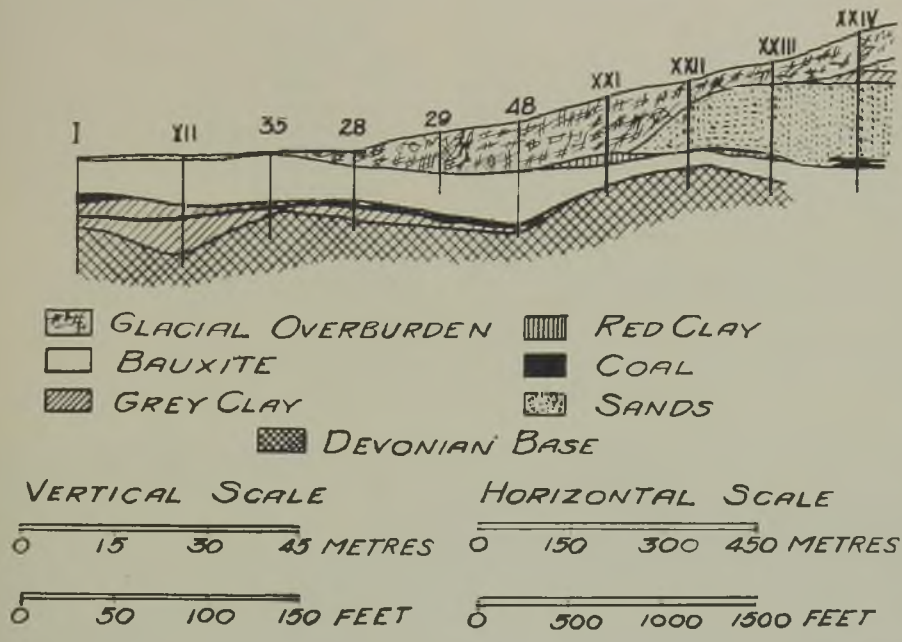


Fig. 8.—Cross-Section through the Goobsko-Pochaevski Bauxite Deposit; line *CD* of Fig. 6.

deposits consist of a group of some fifteen separate deposits. Several of the most important of these have been described in the present paper. The geology of the deposits has been discussed, and a genesis for them has been suggested. They may have been formed by the laterization of plagioclase felspars and then washed by streams into lakes. A secondary character for the existing bauxites is indicated.

The mineralogical and chemical compositions of the bauxites have been discussed, a number of analyses being given showing the compositions of the several grades available. These bauxites are characterized by moderate water content, high silica, and fairly high iron. The composition of even the best grades compares unfavourably with that of commercial ores mined in large aluminium. These are all published in the Russian language:—

1. A. Arshinov, "Aluminium Ores and the Possibility of their Occurrence in Russia." *Study of the Natural Productive Powers of Russia*, No. 6, 1916.
2. K. Vogt, "Bauxite, Alunite, Cryolite, and other Aluminium Minerals." *Study of the Natural Productive Powers of Russia*, No. 33, 1917.
3. M. Vasilievski, "Bauxites of the Tikhvin District," *Bull.* Geological Committee, vol. 37, No. 5–6, 1918, pp. 511–21.
4. M. Vasilievski, "The Tikhvin Bauxite Deposits," *Bull.* Geological Committee, vol. 40, 1921, No. 9–10, pp. 33–35.
5. G. Oorasov, "On creating an Aluminium Industry in Russia," *Technical-Economic Bull.*, 1923, No. 1–3, pp. 1–111.
6. J. Sheekhootski, "The Tikhvin Mining and Industrial Basin and its Industrial Importance," *Technical-Economic Bull.*, 1924, No. 1, pp. 37–41.

7. N. Koornakov, "Physico-chemical Analysis of the Tikhvin Bauxites and Clays," Second Metallurgical Meeting, Leningrad, 1924.
8. N. Koornakov, "The Tikhvin Bauxites and the Possibility of Using Them for the Production of Aluminium," *Technical-Economic Bull.*, 1925, No. 8–9, pp. 528–709.
9. V. Iljinski, "Treatment of Bauxites for the Production of Aluminium," *Chem. Ind. Jour.*, 1925, vol. 1, No. 3.
10. A. Koordiumov, "Calculations of the Cost of Erecting an Aluminium-reduction Plant and the Cost of Producing Aluminium," *Mem. Inst. of Applied Mineralogy and Metallurgy*, 1926, No. 28, pp. 1–75.
11. A. Koordiumov, "Bauxite as an Aluminous Ore." *Mineral Raw Materials and their Treatment*, 1926, pp. 310–315.
12. A. Kooznetzov, "On the Production of Aluminium from Tikhvin Bauxites," First Scientific and Technical Meeting of U.S.S.R., 1926, p. 104.
13. V. Komarov, "Possibility of Producing Aluminous Cements in Russia from Tikhvin Bauxites," *Mining Journ.*, 1926, No. 6, p. 436.
14. M. Bolkhowitinova and P. Markoff, "Zhuravlikhinski Bauxite Deposit," *Trans. Inst. Economic Mineralogy and Metallurgy*, 1926, No. 20, 56 pp.
15. I. Ansheles, "Microscopic Study of the Clays, Sands, and Bauxites of the Tikhvin Region," *Bull.* Geological Committee, 1927, vol. 46, No. 2, pp. 113–137.
16. S. Maliavkin, "Aluminium and Bauxite," *Min. Res. of the U.S.S.R.*, 1927, part 4.
17. J. Lileyev, "On a Process of Obtaining Alumina from Tikhvin Bauxites," *Mem.* Second Pan-Union Conference of Non-Ferrous Metals, 1927, vol. 2, pp. 252–267.
18. P. Gaevski, "Project for Creating an Electro-smelting Centre in the North-west Province of the Vygh River," *Mem.* Second Pan-Union Conference of Non-Ferrous Metals, 1927, vol. 2, pp. 337–362.
19. S. Vankov, "Project for the Erection of an Aluminium-reduction Plant in the Dnieprostroi Region," *Mem.* Second Pan-Union Conference of Non-Ferrous Metals, 1927, vol. 2, pp. 363–372.

THE DISASTER AT BRISEIS TIN MINE

Brief particulars were given in our issues of April and June of the unusually severe floods in north-eastern Tasmania which occurred early in April. The Briseis tin mine suffered the most, for not only were the workings flooded, but the plant was

destroyed, as a result of the bursting of the dam, and nine employees lost their lives. Only brief particulars have been made available in this country. The accompanying photographs will, however, give some idea of the damage done. The first shows the plant in full operation and the second the result of the flood, with the plant buried in 150 ft. of water and tailing.

The Briseis company was formed thirty years ago and has worked a number of tin properties in the neighbourhood of Derby, Tasmania, and adjoining the Ringarooma River, the course of which has been diverted on more than one occasion to facilitate mining operations. In our issue of August, 1927, we gave a sketch-plan and cross-section of the ground where the disaster occurred. The deposits have been characterized by an overburden of basalt, which has to be removed before the tin-bearing alluvium can be worked. The ground that has been the scene of the disaster was the latest to be developed. The alluvium was worked by ordinary hydraulicking methods and the high-pressure water was supplied from a dam on Cascade River, a tributary of the Ringarooma. The failure of this dam under the unusual strain of the floods was the immediate cause of the disaster, the released water rushing down the gorge and sweeping everything before it. It may be added here that the Ringarooma dam and the Briseis Ringarooma head-race were undamaged, and that the Black Creek and Dorset siphons only suffered slightly.

An independent investigation has been made as to the nature of the cloud-burst which wrought the havoc and as to the suitability of this type of dam. It is difficult as yet to judge whether any of the plant can be salved and whether it will be advisable to re-start operations, but the directors and manager are actively pursuing investigations. Mining men will sympathize with Mr. Lindesay Clark, who has been manager of the property for so many years. It is distressing to see one's life work swept away in a minute with little or no warning.

BOOK REVIEWS

The Ventilation of Mines. By Dr. HENRY BRIGGS. Cloth, octavo, 136 pages, illustrated. Price 7s. 6d. London: Methuen and Co.

This small book brings together some of the results of the great amount of work that Professor Briggs and his associates and friends have done in mine ventilation extending now over many years. Any work by Professor Briggs is sure to be interesting. His style is fresh and vivid and his illustrations are apt. This book will repay careful and repeated perusal, and is useful to any engineer handling problems of mine ventilation. It is a book likely to be taken down frequently for reference.

Ventilation factors connected with underground workings are set out and explained. The measuring of air currents and pressures is dealt with fully. Fan designs and their defects are discussed and the mathematics of fans and air currents are given, to be understood by all who have taken mathematics of degree grade.

The Steart propeller fan, which employs a series of two-bladed propellers of variable number and pitch, mounted on a shaft revolving in an open-ended cylinder, is referred to at length.

It is difficult to deal exactly with fan and ventilation problems, but this book helps greatly and should permeate both teaching and practice

HUMPHREY M. MORGANS.

The Prospector's Handbook. By Dr. W. L. GOODWIN, late Dean of the Faculty of Science, Queen's University, Kingston, Ontario. Second edition, pocket size, enlarged to 367 pages, illustrated. Price 15s. net. Gardenvale, Quebec: Industrial and Educational Publishing Co.

The demand for a new edition of this handy little book has given the author an opportunity of revising certain portions, and of adding material which longer experience has convinced him will be useful to prospectors.

The book retains the three parts into which the first edition was divided. In Part I the Table for the identification of minerals has been improved, as also has the similar table for rocks in Part II. The greatest addition has been made to Part III, particularly in the inclusion of descriptions of a large number of Canadian mineral deposits, and in extending the section on practical prospecting. The book is well illustrated.

Examination questions again appear at the end of each part, so that the book should be useful as a text-book for classes of prospectors. The old "Sourdough" will not be pleased at the inclusion of four half-pound tins of baking powder in the list of food for two men for one month, and why the six loaves of bread?

It is encouraging that this reliable, accurate, and very readable little book has reached its second edition. Such good seed can only bring forth good fruit.

The New Company Law. By HERBERT W. JORDAN. 106 pages. Price 4s., or with King's Printers' copy of the Act, 9s. London: Jordan and Sons, Ltd.

In the very interesting preface to his book Mr. Jordan expresses the welcome opinion that the new Companies Act which will come into operation on November 1 will not lead to greatly increased litigation. In his view there is little need for alarm at the additional obligations imposed on company officials by the amended Act, and abuse of the law will be more difficult. The language of the Act is simplified and the arrangement of the sections made more logical. This re-grouping, he maintains, while temporarily inconvenient, will lead ultimately to readier reference.

Mr. Jordan's excellent manual is indispensable to those familiar with the working of the present Act and who have to accustom themselves to the new one. The two sections into which the book is divided respectively deal with the amendments affecting Private Companies and Public Companies.

In addition to a table of contents, an excellent index is provided to facilitate reference, whilst the explanations given are short and easily understood.

For directors and secretaries and, indeed, all associated with company procedure, Mr. Jordan's treatise will prove an invaluable guide to the amended law.

D. C. D'EATH.

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

NEWS LETTERS

JOHANNESBURG

July 4.

Beryl Discoveries.—Namaqualand, the home of the world's richest diamond deposits, is now known to contain the most remarkable occurrence of beryl ever discovered. About five years ago, Mr. A. Sleight, a prospector, while prospecting for mica at Jackhaal's Water, some 15 miles north of Steinkoff, found a very large beryl crystal. He retained a sample of the beryl, and it remained among his effects until a few months ago. About the middle of February last, Mr. Sleight heard of inquiries being made for beryllium ore and forwarded a sample to Mr. Ernest Sheppard, of Johannesburg. The sample was analysed and yielded 12% of beryllium. A syndicate was formed in Johannesburg and prospecting work was started in the pegmatite where the crystal was found. From an excavation measuring 5 by 5 by 5 ft. over ten tons of beryl were recovered in the course of a few days. Later assays indicate that this beryl carries up to 15% of beryllium which is priced at £12 10s. per lb. Towards the end of May an enormous "crystal" was excavated. Its dimensions were 5 ft. by 5 ft. by 8 ft. 6 in., and its weight is estimated at sixteen tons. It is stated by interested parties that wherever beryl has been uncovered and a quantity excavated, the bottom of the excavation is seen to contain a strong continuance of the mineral. In one case, at least, large lumps of the blue variety, aquamarine, have been dug up, and there is the possibility of finding crystals of this latter variety of good quality, that is, semi-precious gem. There are indications of beryl on more than one line of pegmatites, over a large area, and where these have been examined the mineral has been found not in ounces but in tons.

The beryl-emerald occurrence in the Murchison Range, Northern Transvaal, is said to have been traced for about 30 miles, but the mineral is found there in much smaller quantities than in Namaqualand. The material carrying the beryl crystals in the Murchison Range is a mica-schist of dark colour, composed chiefly of two varieties of mica, biotite and fuchsite. The main occurrence is a lenticular mass, approximately 500 ft. long by 200 ft. wide. The cleavage of the mica-schist is diagonally across the deposit, and there is considerable differentiation of the material in alternating zones running parallel to the lines of the cleavage. In a number of these zones of differentiation the mica flakes are of much larger size. Judging from the much greater abundance and larger size of the weathered and bleached crystals, occurring thickly in the larger-flake mica zones, the conditions prevailing in them seem to have been especially favourable to the crystallization of the beryl-emerald constituents.

Further Diamond Prospecting.—Since the prospecting ban was raised in South-West Africa the Carrig Diamonds Company has made an interesting discovery on its two blocks of claims which lie one on either side of the confluence of the Kameeldoorn and Orange Rivers. Lately, the shafts sunk on these blocks have penetrated a layer of shale deposit, below the typical Orange River gravels, and have lighted upon a marine gravel deposit, containing shells typical of the Alexander Bay terraces, in which diamonds of remarkably high quality have been found. It is stated that the similarity of the deposits has been confirmed by two or three experts. Now that work is permitted, these gravels are to be thoroughly examined without loss of time.

South African Cobalt.—A message from Hamburg states that a German-Dutch company intends to work cobalt properties in South Africa, but the correspondent does not say in what part of the Union the properties are situated. There are several occurrences of cobalt in the Transvaal. Work has recently been resumed on the Kruis River cobalt mine. No recent discovery of cobalt, with the exception of that at Waaikraal and the alleged finds upon a property of the Transvaal Silver, has been reported, and the only other well-known occurrences are those of Laatse Drift No. 82, a few miles west of Kruis River, and of the farm Eenzamheid, which is situated some two miles south of Balmoral Station on the Pretoria-Delogoa Bay railway. Small amounts of cobalt, as Wagner remarks in his economic chapter in the "Handbuch der Regionalen Geologie," are present in some of the mineral deposits in the central part of the Bushveld Igneous Complex. Both at Kruis River and Balmoral the geological evidence goes to show that the cobalt lodes owe their mineralization to the basic intrusions that are known to exist in their immediate

neighbourhood. It is known that the owners of at least one of the above properties are in communication with the German-Dutch company.

MINERALS IN SWAZILAND.—Since the Swaziland administration decided to grant more favourable terms to prospectors, increasing attention has been paid to the mineral resources of that country. It was announced recently that Sir Abe Bailey had acquired two large mining concessions in Swaziland, and it is supposed that he intends to set prospecting parties at work there to look for payable deposits of gold, asbestos, and tin. Seams of chrysotile asbestos containing fibre of excellent quality are being opened up on the Havelock Concession. Turner and Newall have their eye on this property and have taken an option to purchase it for £250,000. It is hoped that the administration will be brought to see the necessity of providing better roads to the mineral concessions. Transport plays an all-important part in mining development, and unless an active policy of road-making is adopted, the mining development of Swaziland is bound to be seriously retarded. Mr. R. Starkey, the consulting engineer to Turner and Newall in South Africa, has purchased an aeroplane and hired a pilot to enable him to visit the properties in his charge.

Active development is proceeding on the Swaziland Corporation's Main Reef and Ivanhoe sections of the Forbes Concession. Some parts of the old levels have been surveyed and assayed, and although the results have not been so satisfactory as the original development work indicated, some high values have been recorded.

POSTMASBURG MANGANESE.—The Railway Administration anticipates that the branch line to the Postmasburg manganese fields will be ready to receive traffic in March next. The Manganese Corporation has purchased the freehold of the farm Beesthoek. Under the original terms on which this farm was held, the manganese ore was liable to a royalty of 6d. per ton, which, in a comparatively short time, would have meant an outlay of nearly £10,000 per annum. Although some excellent disclosures of ore had been made on Beesthoek, it had been the Corporation's intention to concentrate upon the next farm to the north, Doornfontein, where equally good ore is available. This would have involved approximately 5½ miles of extra railway construction, and possibly a later date for the start of shipping operations. Now that the royalty has been capitalized by the purchase of full rights to Beesthoek, this farm will be the first to be worked. The British Swiss International Corporation is represented on the board of the Manganese Corporation by Mr. F. N. Pickett (with Mr. W. H. S. Bell, of Messrs. Bell and Dewar, as alternate), Messrs. J. A. D. Gillespie, P. Bonds, M.Inst.M.M., H. L. Burnie, A.R.S.M., and E. Fraser Jones (managing director); and the Union Manganese Mines and Minerals is represented by Messrs. R. B. Saner, J. Dale Lace and Captain T. L. H. Shone. Mr. Pickett is chairman of the corporation.

THE GEOLOGY OF RHODESIAN COPPER DEPOSITS.—It is stated that a valuable series of papers on the geology of the Northern Rhodesian copper fields is being prepared by Dr. J. A. Bancroft, consulting geologist of the Rhodesian Anglo American, Ltd., for the coming visit of the Geological Congress. Dr. Bancroft's work will show that the centre of economic interest lies in the N'Kana Concession, which extends over an area of 1,800 square miles. It is covered by Archæan rocks, comprising granites, schists, phyllites, etc., and geological work has recently admitted of a classification of these rocks into two or three definite series, unconformable with one another, of which one, the N'Kana series, is of outstanding economic importance. The Roan or N'Kana series of sediments consists of a considerable thickness of quartzites, shales, conglomerates, and felspathic sandstones, and near the base of the series lies the copper-bearing shale which forms the ore-body of all the important copper mines and prospects in Northern Rhodesia. In the N'Kana Concession the series is disposed in synclines being roughly parallel with the boundaries. The outcrop length of the copper-bearing shale is, therefore, considerable, and the whole of it merits close prospecting. At the N'Kana mine and the Roan Antelope mine the mineralization is sufficiently developed to form very important ore-bodies, and at various other points, N'Changa (just outside the N'Kana Concession), Mufulira, Chambishi and others, encouraging values have been found which warrant high hopes of the future. The series is known at other places in Northern Rhodesia, but appears to be more highly developed in the N'Kana Concession than elsewhere.

BRISBANE

June 17.

The Cloncurry District.—The improved price of copper is causing continued activity among the miners of that metal in the Cloncurry mineral field. The bulk of the ore sent away, which is still increasing, is mined by the tributers working the mines of the Mount Elliott Company, the balance being raised by small leaseholders. The average copper content of the ore from the Mount Oxide mine is 40% and over, of a value on the field of £23 10s. per ton ; while that from several other mines exceeds 25% of copper, besides appreciable quantities of gold and silver. The Mount Oxide ore is sent to Europe for treatment, and the product of the other mines is bought for treatment at Port Kembla, New South Wales. Mr. C. Q. Schlereth, the General Manager for the Mount Elliott Company, has, with other experts, been on the field for some time inspecting the various properties of the company. As soon as these investigations are complete, plans for the reopening of the mines will be put into operation.

An important copper mine in the Cloncurry district, previously owned by the Hampden-Cloncurry Company, now wound up, has been bought by a party that previously worked it on tribute. This property is near Duchess, the station on the main Cloncurry railway from which the new branch to Mount Isa starts. During this year about 75 men have been at work, and from 450 to 500 tons of 12% ore is being mined each month. At the 200 ft. level, where the stopes had been idle for seven years, there is an ore-body ranging in width from 8 ft. to 20 ft.

Mount Isa Activities.—At last reports, the Mount Isa Company was sinking a " man and supply shaft," and concreting an air shaft, the latter to be used as an upcast for the mines when in the producing stage. At Davidson's shaft a level is to be opened at 350 ft., forming part of a scheme laid down by one of the company's experts (Mr. C. Mitke). No. 36 shaft (or No. 8 " glory hole ") has been deepened to 125 ft. below the collar. The average assay values ascertained were 10·8% lead, with 6 oz. of silver per ton, over a width of 70 in. The Belliss and Morcom compressor is supplying air where needed, and another compressor is in course of erection. On the Black Star lode No. 7a diamond drill is down to 594 ft. The ore assays from 513 ft. to 535 ft. averaged 8·1% lead, 8·5% of zinc, and 2·6 oz. of silver to the ton. The erection of the winding engine, boiler, and engine, with boiler houses, on the Black Rock lode has been finished. It is expected that the laying of the pipeline to connect the mines with the new Rifle Creek dam will be commenced immediately. Last month it was stated that the length of this pipeline will be 200 miles. This should have been 20 miles.

The Coal Position.—The latest phase of the coal hold-up in New South Wales is that the Federated Engine-Drivers' and Firemen's Association had endorsed a policy advocated by the New South Wales State branch of withdrawing its members from all mines—action which would make the coal deadlock State-wide. This move was made on account of the mass picketing by the miners of some of the collieries in which the engine-drivers and firemen were at work. An effort is now being made to stop this picketing, and thus prevent a general closure of the mines, but at the moment it is doubtful whether this effort will succeed. So far, a settlement of the original trouble—caused by an absolute and persistent refusal of the miners to accept a reduction in wages—seems to be as far away as ever. In the meantime, regular shipments of overseas coal for Australian ports have been arranged, and within the next few months large amounts of English coal will be imported into the Commonwealth. The major portion of this fuel is for South Australia and Victoria. The Melbourne Gas Company has altogether placed orders in England for 71,000 tons.

It is not expected that the Queensland coal miners will be brought into the trouble in the South, and possibly the mines of this State may benefit by the stoppage in the neighbouring State. So far, however, hardly any extra orders have been received here as a result of the southern stoppage. The principal difficulty in the Southern States is with regard to the special class of coal needed for gas making—a class which has been drawn from Maitland, in New South Wales, but which cannot be obtained in sufficient quantity from Queensland. Incidentally, it may be mentioned that the demand for coal for bunkering from the Bowen River field, North Queensland, has of late been growing somewhat, and that high praise is being given as to its quality by those who have used it. The chief engineer of one steamer says he has found the coal much superior in every way to any

other Australian coal he has used; while the captain of another vessel testifies that it is far superior, not only to Australian but also to Natal coal.

Oil Prospecting.—There are at present about 18 companies, sinking some 24 wells, in the search for oil in Queensland, and one or two others are about to start boring. All except two are in the Roma (or Maranoa) district. A number of the companies report indications which are considered to be favourable. The Roma Oil Corporation, which is the chief operator, has stopped the further sinking of its No. 2 well, as the results are not considered satisfactory, and are shifting its rig back to No. 1, which is to be further deepened. After that has been done, a third bore will be started. The absorption plant imported from America is now ready to begin extracting oil from petroliferous gas, but the supply from No. 1 well is said to be not sufficient to work the plant profitably, and sinking in this hole is to be continued in the hope of finding a larger quantity of gas or oil.

The Sardine Tin Mine.—The well-known Sardine, for several years the principal mine on the Kangaroo Hills field, North Queensland, has been forced, by the declining price of tin, to close down and seek exemption from labour conditions for six months. In 1921 this property was described by a Government geologist as one of the best high-grade tin mines in the Commonwealth, and until lately has been a good producer of tin from various payable shoots of tinstone. In the past week or two, however, there has been a considerable improvement in tin prices, and it is hoped that the closure will be only temporary.

Geophysical Research.—The Chief Government Geologist of Queensland (Mr. B. Dunstan) has just returned to Brisbane after an eight-months' tour of Europe and America, whither he was sent mainly to investigate the various methods of geophysical survey. His itinerary included practically all the important European mining centres, and special visits were made to the Polish and Roumanian oilfields.

Wiluna Goldfield.—The management of Wiluna Gold Mines, Ltd., Western Australia, has placed an order with the Western Machinery Company, Ltd., Perth, sole Australian agent for the National Gas Engine Company, of England, for the supply of seven convertible suction-gas crude oil engines, of 600 h.p. each. The engines will be assembled in Perth. The construction of the railway from Meekatharra to Wiluna has been formally started by the West Australian Minister for Railways.

VANCOUVER

July 11.

Railway Extension.—The Consolidated Mining and Smelting Company of Canada has bought the Canadian North-Eastern Railway. The purchase includes 14 miles of railway from Stewart up the Bear River valley and a charter, acquired at the last session of the Provincial Legislature, giving power for the extension of the railway from its present northern terminus by a route to be determined by survey to the Finlay River and for a branch from some point on that railway to the Yukon boundary. The charter gives authority for the issuing of bonds to the extent of $50,000 per mile of new construction. The purchase also includes outstanding bonds to the amount of about half a million dollars and all the stock issued on the original Portland Canal Short Line, with the exception of a small amount owned by private persons. The purchase was made from Vancouver Holdings, composed of London and Vancouver capital, which bought the property about two years ago from Sir Donald Mann, the well-known Canadian railway contractor. Consolidated has given out no information either as to the amount paid for the railway or the object of the purchase, but from recent happenings it seems pretty certain that the company intends to make a thorough investigation of the comparatively little-known country to the northeast of the Portland Canal division, and if the investigation turns out as happily as the company has some reason to expect it will use the railway to open up the mineral lands as they are developed. During last season Consolidated had four survey parties in that immense territory watered by the Peace River and its tributary rivers and creeks and known as the Peace River region, and the company located a large number of claims, on one group of which it kept a crew of men at developing during last winter. It also located 54 claims at Howser Lake, in the northeastern extremity of the Portland Canal Division. Recently Consolidated formed a new subsidiary, Northern Prospecting Syndicate, which has let a contract to Western Canada Airways for the transport of men, machinery, and supplies from Stewart to Howser Lake. By this aid

the syndicate will be able to commence exploration within three weeks, whereas by the old means of travel it would have been impossible to get supplies to the property in time to start work this season. In the meantime the railway probably will be put to use for transporting supplies to the George group, six miles beyond its present northern terminus, and will be completed to the George property to give an outlet for ore from that property. One other phase is worthy of consideration. The Canadian Pacific Railway Company and its friends own a controlling interest in the stock of Consolidated, and it seems likely that the two companies will work hand and glove in the mineral, agricultural, and water-power development of northern British Columbia.

Canadian National Mineral Belt.—Another important transaction is the optioning of a controlling interest in Owen Lake Mining and Development Company by Mr. Noah A. Timmins, president of Hollinger Consolidated Mines, for approximately $1,100,000. Mr. Timmins has made a cash deposit of $150,000 to bind the deal. Mr. F. H. Taylor, who organized the Owen Lake Company, remains as president and Mr. Timmins has been elected vice-president. Mr. Taylor acquired options on some 100 mineral claims on the shore of Owen Lake, situated 25 miles south of Houston, on the Canadian National Railway, late in last summer, making cash payments of about $25,000, took a sawmill in, and commenced the erection of a permanent camp. The property had been idle since 1924, prior to which a good deal of surface and some underground exploration had been done, exposing 16 approximately parallel veins of commercial ore. During camp construction a tunnel was started to open these veins at from 400 to 600 ft. below the surface by hand steel, and after winter set in machinery was taken to the property over the snow and the work was continued by machine drills. It was expected that the first vein would be cut about 3,000 ft. from the tunnel's portal, but when Mr. Timmins' engineers made their examination toward the end of June, the tunnel was in 1,750 ft. and had passed through eight veins of commercial ore, none of which had been exposed at the surface. These veins range from 2 to 8 ft. in width and $20 to $65 per ton in value. The value is chiefly in copper and silver, but the ore also carries gold, zinc, and a little lead. Mr. Taylor has also sunk a shaft for 80 ft. on one of the known veins and from that point driven more than 50 ft. in each direction on a 10 ft. vein of commercial ore. Mr. Timmins has made arrangements with the Provincial Department of Mines for work to be started immediately on a good road to the property, the cost of which is to be shared equally by the Government and the company, and as soon as this is completed heavier machinery will be taken to the property and its development pushed as rapidly as possible.

Mr. H. L. Batten, of Messrs. Stewart, Batten, and Associates, has made a report on the Topley Richfield Mining Company's property, situated eight miles from Topley, in which he recommends that plans be got out for permanent plant and a pilot mill, as he considers that if the drilling exploration now under way proves the persistence of the ore-bodies between the 200 and 300 ft. levels the construction of the plant will be justified.

Dividends.—Consolidated Mining and Smelting Company of Canada has paid a dividend of 5% and a bonus of $5 per share, covering operations for the first half of this year. The disbursement amounted to $3,184,143, and brought the company's total disbursement up to $32,743,049, on an outstanding capitalization of $12,376,575. Granby Consolidated Mining, Smelting, and Power Company has paid a dividend of $1·75 per share, covering operations for the second quarter of this year, and amounting to $766,889. This brings the company's disbursements up to $12,945,501. Premier Gold Mining Company has paid a dividend of 6%, covering operations for the second quarter of this year. The dividend amounted to $300,000 and brought the company's total disbursement up to $13,650,000. Howe Sound Company has paid a dividend of $1 per share, covering operations for the second quarter of this year, and amounting to $496,038. Crow's Nest Pass Coal Company has paid a dividend of 1½%, covering operations for the second quarter of this year and amounting to $93,174.

Portland Canal.—Mr. C. A. Banks announced just before his departure for New Guinea, where he has gone to examine a placer deposit owned by Placer Development, of which he is managing director, that B. C. Silver Mines has driven for 100 ft. in a substantial body of ore in No. 6 level. The full length of the drift is in good milling ore and the face is in ore.

Kootenays.—Consolidated Mining and Smelting Company of Canada has announced

that during the next two years it will spend between seven and eight million dollars in the erection of the first unit of a synthetic fertilizer plant, which will include a liquifaction of air and nitrogen plant, a hydrogen plant in which the hydrogen will be produced by the electrolysis of water, an ammonia plant, a 300 ton sulphuric acid plant, a phosphoric acid, and a superphosphate of lime plant. It is expected that the first unit will be in operation within two years and a second unit on the same scale will be started immediately the first unit is in operation. It is expected that the sulphuric acid plants, which will derive their sulphur dioxide from smelter fume, will render the fume harmless to vegetation.

Western Exploration Company has announced that it will start immediately on the erection of a 100 ton flotation mill and 16,000 ft. tramway to connect its Mammoth mine with the mill, and it expects to have the plant in operation before the end of the year. The mill will be designed and its erection will be supervised by Mr. W. L. Zeigler, metallurgist for the Hecla Mining Company, of Wallace, Idaho. In No. 7 level at the Mammoth the company has opened a body of ore, ranging from 25 to 35 ft. wide and averaging 13 oz. of silver per ton and 12% of mixed lead and zinc. This appears to be a huge lens, which in No. 1 level is only 2 ft. wide. In No. 6 level it is 20 ft. wide and carries a band of clean galena 4 ft. wide next to which is a 4 ft. band of clean mixed lead and zinc sulphides. The shoot of ore has been proved for 1,200 ft. on the dip of the vein and for from 150 to 300 ft. on its strike. The Mammoth adjoins the famous old Standard, which made a profit of more than $3,000,000 for its shareholders.

TORONTO

July 18.

SUDBURY.—With the expansion of the operations of the International Nickel Company and the erection of the copper refinery at Copper Cliff now in progress this district is now the principal centre of attraction in the mining industry. This is reflected on the Stock Exchange, where the shares of the base-metal companies have for some time shown continued activity during a dull season while the gold and silver issues have been much depressed. The work of excavating for the copper refinery has been started, and it is expected that construction will be sufficiently advanced to allow the buildings to be covered in before winter. The force of 250 men now employed will shortly be increased to 600. The initial capacity of the plant will be 10,000 tons of metal per month, and it will be so constructed to permit this capacity to be doubled. There will be three main buildings, one an electrolytic cell-house, and two casting buildings, one for crude copper, and the other for refined copper. The buildings will be brick and tile construction over steel. The cost of the refinery is officially stated to be about $5,000,000. The new shaft of the Frood mine has reached a depth of 3,050 ft., and it will have a hoisting capacity at that level of 7,000 tons a day. The out-and-fill method of mining, with various adaptations to suit conditions when they are met with, has been adopted as the best plan for working this deposit. Under this method the tonnage of broken ore left in the mine at any one time will be very small.

At the Falconbridge a cross-cut at the 1,000 ft. level has encountered ore proving the downward continuation of the deposit to that depth as indicated by diamond-drilling. Rapid progress is being made by the construction of the smelter. The blast-furnace will have an initial capacity of 250 tons per day, but a great part of the other equipment will be capable of handling 500 tons daily. The nickel-copper matte output will be refined and marketed in Norway by the Falconbridge Nickel Works, a subsidiary company.

The Treadwell Yukon has begun shipping zinc concentrates to Britain under contract with the British Metal Corporation, Ltd. The decision of the company as to the erection of an electrolytic zinc plant is still in abeyance, and it is stated that another year of metallurgical experiments and underground exploration will be required for a solution of the problems involved. The Sudbury Crater Mining Company, of Montreal, which has on its property a vein of massive galena, recently sent samples of this ore to Germany. A metallurgical organization there is anxious to obtain as much of this ore as can be supplied, and has asked for shipments of from 1,400 to 1,800 tons of this ore before the close of navigation.

PORCUPINE.—The output of bullion from the seven producing mines in this field during June was valued at $1,529,598, as

compared with $1,687,497 for May. The list is still headed by the Hollinger though the ore drawn from the lower levels continues to be of comparatively low grade. So far the detailed study of the geological conditions of the mine do not appear to have revealed anything of outstanding importance. The underlying porphyry which lies in the path of the downward continuation of the veins has received a large amount of attention. The vein fractures continue into this porphyry, but the values decline. Hopes have been entertained of working through or around this porphyry to an horizon where greenstone formation may again appear.

The ore now being treated at the Dome Mines, which was formerly of a rather low grade, has latterly shown considerable enrichment, and that now being handled is stated to be of higher grade than any in the Porcupine district, averaging over $9 gross per ton. Earlier operations in the greenstone were disappointing, but more recently ore-bodies have been found in this formation, and the question now remaining at issue is whether the ore occurs only in the greenstone on the margins of the sediments or if it persists to greater depths in close relationship to the contact of intruding porphyry.

The quarterly statement of the McIntyre Porcupine for the three months ending June shows improvement over the corresponding period of last year, the gross income being $1,062,611. Operating costs were $592,499, and net carnings after depreciation, etc., $441,179, an increase of $6,695. The mill is 20 years old, and much of the equipment obsolete, and the question of a new plant will shortly have to be considered by the directors, in the light of the results of deep development, during the next few months.

The transfer of the assets of the Coniaurum to a new company under the same name has been arranged subject to the approval of the shareholders. Operations have been carried on under a receivership for some months, the mill treating between 250 and 300 tons a day. The new company will carry on an aggressive campaign at depth, in an effort to improve the grade of ore. The Hayden is installing an electrically-driven mining plant, and securing power by a transmission line from Timmins. Active development will be conducted on the 700 ft. level.

KIRKLAND LAKE.—The output of bullion in this field during June amounted to $1,358,690, a substantial increase over the $1,157,028 produced in May. Work at the Lake Shore mine with a view to increasing production to 1,400 tons daily is well advanced, but a delay in the delivery of portions of the equipment postponed the expected increase, which will probably take place within the next few weeks. A further increase to 2,000 tons daily will be made about the close of the current year. The mine has very large ore reserves, only about 25% of the ore in sight having been taken out, which will render it possible to maintain the increased rate of production. The Wright Hargreaves in driving on the 700 ft. level has encountered the upward extension of a vein developed on two lower levels, and has opened up high-grade ore for a length of 100 ft. The north shaft has reached its objective at 2,200 ft., and development is being pushed on two new levels. A promising new vein has been encountered at a depth of 2,000 ft. The annual report for the Sylvanite for the year ending March 31 showed that the company had a fairly profitable year, the production being valued at $737,000, and the expenses were $655,000. The tonnage handled was 70,833 of an average gross value of $11 a ton. At the Teck-Hughes a cross-cut at the 2,980 ft. level intersected the main ore zone for a width of 80 ft. A start has also been made on the cross-cut at the 21st level toward the main ore zone. Driving east and west at the twentieth level has opened up the ore zone at this horizon for a total length of about 150 ft., and over this distance more than 100 ft. is in ore. The Kirkland Lake gold mine is meeting with highly encouraging success in its campaign of deep development. The cross-cut at the 3,600 ft. level has encountered a vein of high-grade ore stated to show greater enrichment than any yet produced in the mine. The discovery was made directly north of and opposite the shaft, which is located almost in the centre of the property, which gives the company a possible length of more than 400 ft. of ore east of the cross-cut before reaching the dyke which cuts in from the Teck-Hughes boundary. The position of the Barry-Hollinger has been greatly improved by a development of the vein discovered on the 1,500 ft. level. About 100 ft. has been opened up, the ore showing visible gold.

ROUYN.—Production of copper and gold from the Noranda mine has recently been averaging over $30,000 per day, and the output is valued at from between $900,000 to $1,000,000 a month. The grade of ore now being handled shows improvement averaging

over $30 to the ton, due to the higher copper content and the increased price of copper. The Granada is opening up good ore at the 625 ft. level and the upward continuation of the deposit has been encountered on two upper levels and is being developed. The Glenwood Mining Syndicate is developing a property of 321 acres near Rouyn, and is installing a mining plant. At the Siscoe, the mill is operating steadily with an average production of $1,000 per day, and the shaft is being deepened to the 750 ft. level. Operations will shortly be resumed on the Osisko, adjoining the Noranda, diamond-drilling having indicated favourable geological conditions. The Amulet is steadily carrying on development and diamond-drilling the unexplored portions of its territory, where it is stated favourable conditions have been met with.

Patricia District.—Good progress is being made with the construction of the mill and power transmission line at the Howey, work being ahead of schedule time. The shaft is down to the 1,000 ft. level, enabling cross-cuts to be run at four levels to intersect the vein. At the Central Patricia exploration is being carried on to ascertain the downward continuity of the surface showings which carry high values. A mining plant will be brought in during the winter. The Crow River Syndicate, financed in London, has secured 24 claims in the Crow River district on which good discoveries have been made and which will be thoroughly explored. The Bobjo, in the Clearwater Lake section, which has some very rich ore, has begun production on a small scale. The Bathurst has also reached the production stage, having turned out its first gold brick last month.

Manitoba.—All efforts of the Hudson Bay Mining and Smelting Company are at present being concentrated on the erection of the smelter and concentrating plant at Flin Flon, and the power plant at Island Falls employing a force of 2,200 men. The property is known to have several million dollars in ore reserves, much of which can be mined by steam shovel from open pits on the surface. The official estimate of ore reserves down to the 900 ft. level is 18,000,000 tons, averaging 1·71% copper, 3·45% zinc, ·074 oz. gold, and 1·06 oz. silver. Underground operations have recently been confined almost solely to the sinking of the main shaft. The Sherritt-Gordon has effected an arrangement by which its copper concentrates will be treated at the Flin Flon smelter, and it will secure its supply of power from the plant at Island Falls.

[In March it was recorded in this column that Mr. H. E. Harcourt, the managing director of the Jackson-Manion Mines, and Mr. D. M. Thomson, the manager, had been arrested for fraud in connection with the circulation of false information relating to the mine. The case was heard in June and ended with Mr. Harcourt being sentenced to 15 months imprisonment, the accusation against Mr. Thomson not being proceeded with by the ruling of the judge. Mr. Thomson is an Associate Member of the Institution of Mining and Metallurgy, and he has also been an acceptable contributor to the pages of The Mining Magazine. That the board and chief shareholders have every confidence in his honour and ability is proved by the fact that his services as manager have been retained. His friends in England and Canada will congratulate him on this vindication of his character.—Ed.]

CAMBORNE

July 31.

Tin Producers Conference.—The efforts now being made to stabilize the price of tin are being watched with great interest in the county; it being the sincere hope of one and all that they will prove successful. The formation of the Tin Producers Association is, at any rate, a step in the right direction. The recent rise in the price of the metal, although small, and not attributed to the efforts of the association, is nevertheless very welcome in the Duchy.

Re-opening of Mines in East Cornwall.—It is understood that a company is being formed for the purpose of re-opening some of the old mines in East Cornwall, including Redmoor and Kelly Bray in the parish of Callington.

South Crofty.—The effect of the steady advance in the price of wolfram is apparent when one considers the report of South Crofty for June. During this month a sum of £720 was realized for the sale of eight tons of wolfram concentrates.

Wray "Shiny Ore" Mine.—At this micaceous hematite mine, situated near Bovey Tracey in Mid-Devon, the crushing and concentrating plant has been erected, and regular production is now anticipated.

Great Rock Mine.—At this mine, which is situated near the Wray mine, and also produces " shiny ore," operations are in full swing.

Wheal Buller.—Excellent progress is being made at this property in the sinking of the main shaft ; the present depth being just over 1,000 ft. At the moment an underground electric hoist and some more powerful pumps are being installed. The mine manager, Mr. G. H. Plowman, has certainly not wasted capital on unnecessary surface elaboration and in view of the exceedingly difficult task he successfully accomplished in unwatering this old mine, it is hoped that he will be rewarded by the disclosure of good tin values by the sinking and development which is now being carried out.

Mount Wellington.—Rapid progress has been made in clearing the old adit and in development at this practically virgin tin proposition and excellent assay values have been obtained at all points.

Lambriggan.—Development work here is proceeding in accordance with the original programme initiated about two years ago. This was to clear certain old workings and to carry out development at a depth beyond the point where the old workers ceased operations. The lode is wide, varying between 2 ft. near the surface up to 10 ft. at the present bottom level. The vein filling consists of zinc blende and galena. In the upper levels remarkably high grade zinc blende is being mined (60% and over), this, however, carries but little silver. As is usual, in the West of England, the silver " follows the lead " and from this mine clean samples of galena carry as much as 40 oz. of silver per ton. The veins occur in the " killas " which in this neighbourhood is a clay-slate of lower Devonian age. The small old shaft has been cleared out and enlarged ; it now measures 15 ft. by 8 ft. inside timbers, has three compartments, and has attained a depth of 340 ft. It is intended to sink this shaft a further 100 ft., before cross-cutting to the lode, and upon results at this level the future of the property depends. Various other mines in the vicinity of Lambriggan which were worked years ago had to sink 500–600 ft. before striking payable ore in large quantity. In passing it may be noted that the greatest depth to which payable silver-lead deposits has so far been worked in the West of England is about 1,800 ft., namely at the Wheal Mary Ann mine near Liskeard. At Lambriggan the surface equipment has been confined to the bare needs of mining development, which has to date amounted to some 4,000 ft., inclusive of clearing various old workings.

Dolcoath.—Pumping operations have now been suspended but it is stated that there is no intention of dismantling the surface equipment.

Cornish Institute of Engineers.—It was not possible to include in the last letter reference to the summer meeting of the Cornish Institute of Engineers which took place on Saturday, July 6. Messrs. Joseph Blight and William Thomas were in charge of arrangements which included a tour of some interesting mines and concluded at Tregenna Castle Hotel. Polhigey mine was first visited where the party was received by Mr. Herbert Bennetts. This is a low-grade proposition and the equipment for working it is electrically operated, power being generated on the property. The mill has a battery of 12 stamps capable of 200 tons per day and at present dealing with about 180. The property next to be visited was Wheal Reeth where the visitors were received by Colonel Lake and Mr. Miles Canning. This is an interesting property of which more will be heard. A unique feature in Cornish milling practice is here to be found in the use of Holman Colorado-type ball-mills as crushers in place of the usual stamp battery. Subsequently, the party visited the Hayle Electric Power Station which supplies a very large area in West Cornwall including most of the mines, works, and china clay properties. Considerable extensions have been made here recently which include a pulverized fuel unit. Before proceeding to Tregenna Castle Hotel for tea some of the party also visited Porthia china clay works.

PERSONAL

Clyde Allan has returned from Nigeria.

Charles A. Banks has left Vancouver for Australia and New Guinea.

F. W. Beyers, South African Minister of Mines and Industries, has resigned on account of ill-health and has left for Europe.

S. C. Bullock has left for East Africa.

W. H. Cates is returning from Nigeria.

F. H. Cothay has returned from Nigeria.

E. H. Davison is leaving for Nova Scotia.

I. J. A. Diamond has removed his offices to 9 and 10, Transvaal Buildings, cor. Fox and Sauer Streets, Johannesburg.

W. A. Edwards will shortly visit the United States, Chile, and Bolivia.

Hugh Gemmell has returned from Malaya.

G. W. Gray, of the Rio Tinto Co., has joined the board of the N'Changa Copper Mines Ltd.

Frank Griffin is visiting New Guinea.

In connection with the celebration of his seventieth birthday, the directors of Hadfields, Ltd., last month presented to Sir Robert Hadfield a bust of himself.

T. C. F. Hall is home from Korea.

Sir H. P. Harris and C. F. W. Kup have left for Brazil.

Alexis P. Ignatieff has left for Panama.

C. J. Inder has left for Panama.

Charles E. Jobling is home from Burma.

F. W. Leighton has left for Panama.

H. R. Cope Morgan is home from Nigeria.

N. E. Odell, of the Department of Geology, Harvard University, is home until September, when he will return.

J. J. A. Page is returning from Tavoy at the end of August.

Frank Powell has returned from Nigeria.

Alex Richardson is visiting Canada and the United States.

Horace Robertson has left for Northern Rhodesia.

J. F. W. Rowe has left for Nigeria.

H. Mortlock Scruby has left for Nigeria.

G. Gordon Thomas has been delayed in his return to London from South West Africa.

Joseph F. Thorn has left for Western Australia.

Henry T. Tizard, C.B., F.R.S., at present permanent secretary to the Department of Scientific and Industrial Research, has been appointed Rector of the Imperial College of Science and Technology in succession to Sir Thomas H. Holland, who recently resigned.

Ludwig Vogelstein, chairman of the American Metal Company, left New York for Europe last month.

H. Whittingham has moved to 1,602, Concourse Building, Toronto, Canada.

E. S. Willbourn is visiting Cornwall.

C. H. Wray has left for Australia.

J. Norman Wynne has completed his work in Tanganyika Territory and is leaving for Rhodesia and South Africa.

F. H. Bathurst, financial editor of the Melbourne *Argus*, died on May 5. He was one of the founders of the *Australian Mining Standard*, which was first published in 1888, and was associated with it for twelve years. In the earlier days of the Magazine he acted as Melbourne Correspondent and he contributed to our columns an important article on the Mount Bischoff tin mine.

Etienne S. Bieler died suddenly in Australia, aged 34. A graduate of McGill University, Dr. Bieler served in the Canadian Field Artillery during the early part of the War, later being attached to the Research Department of the Admiralty. On demobilization he went to Cambridge and was afterwards appointed Assistant Professor of Physics at McGill. He had been granted two years' leave by his Department to take up the position of deputy Director of the Imperial Geophysical Experimental Survey, which is working in Australia. Dr. Bieler's name is generally associated with the Bieler-Watson method of electrical prospecting.

TRADE PARAGRAPHS

Head Wrightson and Co., Ltd., of Stockton on Tees, send us a catalogue of the Kirklees slurry separator, as employed in coal-cleaning practice, and one devoted to the Colorado convertible discharge ball mill.

Werf Conrad through their agents in London, Marine Works, Ltd., of 153, Moorgate, E.C.2, issue a 34 page catalogue descriptive of the Banka Hand Drill with which many alluvial prospectors are familiar.

R. H. Neal and Co., Ltd., of Plant House, Ealing, London, W. 5, inform us that they have been appointed representatives for London and South Eastern Counties of the **British Flottmann Drill Co.,** of Allensbank Works, Cardiff.

Sullivan Machinery Co., of Salisbury House, London, E.C. 2, issue information on the use of remote control for coal cutters operated by alternating current, as has heretofore been employed for direct current coal cutting machines.

J. H. Sankey and Son, Ltd., of Essex Wharf, Canning Town, London, E. 16, have published an illustrated booklet giving information about Pyruma, a plastic fire cement, use of which it is pointed out will lower furnace maintenance costs.

Adam Hilger, Ltd., of 24, Rochester Place, London, N.W. 1, have issued a leaflet describing R.V. Powder, which contains 50 elements in a suitable base for comparative use in spectrum analyses. This powder was originally developed in the Research Laboratories of the General Electric Co.

Prospektion G.M B H., of Gottingen, Germany, send us a booklet giving full particulars of their geophysical investigation services and instruments. These include seismic, electric and electromagnetic, gravimetric, radio-active and magnetic principles. Some typical examples of results obtained are illustrated.

British Industries Fair. The Birmingham Chamber of Commerce, of 95, New Street, Birmingham, organizers of the Heavy Section announce that this Fair will be held as heretofore at Castle Bromwich from February 17 to 28, 1930. In the prospectus issued, we note a section devoted to mining, including quarrying and colliery equipment. At previous exhibitions the representation of this section has been very poor.

The Mond Nickel Co., Ltd., of Imperial Chemical House, London, S.W. 1, have published the first volume of the *Nickel Bulletin*, which covers 28 pages and contains a bibliography of articles on the subject of nickel and its alloys together with a list of relevant British and foreign patents. This is the successor to the *Mond Nickel Bulletin*, of which we have received copies of the 12 issues comprising Vol. 1 (1928-1929).

The Ruth Co., of Denver, Colorado, publish a 52-page illustrated catalogue of their ore-dressing plant. This includes sections devoted to rod mills, laboratory flotation testing equipment, gradient flotation machines, and reagent feeders of different types. The company undertake the designing of a mill for a specific ore-treatment proposition and the building thereof, and the present booklet gives photographs and sectional drawings of a number of such installations.

Westinghouse Electric International Co., of 2, Norfolk Street, London, W.C. 2 (Head Office: New York) have issued a series of leaflets describing

their specialities. These include descriptions of cog belt drives for fans, compressors etc., small turbines, multiple retort underfeed stokers, steel switch-board panels, steel-clad distribution transformers, unbreakable terminal blocks, direct current motors with sealed-sleeve bearings, magnetic starters for polyphase squirrel-cage motors, 1½ and 3 k.w. turbine generator units suitable for steam shovel and like use, squirrel-cage induction motors, synchronous motors for centrifugal pump drive. They also inform us that Mr. F. A. Merrick has been elected President of the American Company.

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: One 3 ft. by 5 ft. 1-surface, type 39, Hum-mer electric screen for dry granite. For France: Six Impax pulverizers for coal; two 5 ft. by 22 in. Hardinge mills for soft sandstone; one 2 ft. by 8 in. Hardinge mill for experimental work; four No. 10 Raymond pulverizers for sulphate of lime; and one No. 00 Raymond pulverizer for litharge. For Belgium: One 3-roller Raymond mill for lithopone. For South Africa: One No. 0000 Raymond pulverizer for coal. They also issue four leaflets published by the W. S. Tyler Co., of Cleveland, Ohio, on crushing and grinding, economy in size reduction, screens and profits, and the importance of screening to crushing and grinding respectively. The last named argues the case for the removal of fines from the feed in all stages of breaking and crushing. The screen recommended for all purposes is the Hum-mer electric vibrating, save where a grizzly is used, after primary breaking.

METAL MARKETS

Copper.—The Standard copper market in London underwent moderate fluctuations during July, but, on balance, the total movement was not very appreciable. Meanwhile, the big American interests kept their own market steady, the export quotation for electrolytic in New York remaining at 18 cents per lb. With the statistical position of the metal tending to become worse, the outlook for the ultimate maintenance of prices was not particularly brilliant, but producers were reckoning upon an autumn revival in demand and on the effect of their curtailment in output to give the market a fresh fillip. In addition, Standard copper was transferred in bulk from London to New York, the object being to strengthen the market here. It remains to be seen whether copper makers will succeed in attaining their object or whether economic forces will prove too strong for them.

Average price of copper: Standard cash: July, 1929, £72 3s. 11d.; June, 1929, £74 7s. 9d.; July, 1928, £62 18s. 4d.; June, 1928, £63 13s. 11d.

Tin.—The London tin market was firm last month, but this was not due to any change for the better in the intrinsic position of the metal itself. It is true that visible supplies have, according to the monthly statistics, tended to decrease, but on the other hand large invisible stocks have been meanwhile accumulated by speculators, which must more or less counterbalance the reduction in the former. This market is, of course, always a convenient arena for speculators, and the latter have been provided with a stimulus to their activities by the recent formation of the Tin Producers' Association, which is intended to be the nucleus of an all-embracing syndicate. It is, however, very doubtful whether it will ever prove possible to get all the mines and smelters into the combination. The attempt to control the rubber industry, one recalls, broke down disastrously because the Dutch planters refused to co-operate, and there is no guarantee that the Dutch tin producers will be any more prepared to assist in controlling the white metal. Meanwhile, although tin prices still look fairly cheap, there is no immediate reason why they should be advanced further, although speculators may quite possibly succeed in getting them higher temporarily.

Average price of cash standard tin: July, 1929, £209 11s. 6d.; June, 1929, £200 5s. 9d.; July, 1928, £212 10s. 11d.; June, 1928, £217 7s. 5d.

Lead.—Fairly steady conditions ruled during July. The meeting of producers, as expected, had no real result, makers merely reserving to themselves the right to take steps to control the position should prices fall too low. What level would be regarded as too low, they have not, however, indicated. Meanwhile, the market seems to think that around present prices the metal is about fairly valued. Towards the close of the month consumers who had generally not been showing much interest, either in this country or on the Continent, bought on a larger scale, but it is discouraging to note that about the only finished lead products which are in active demand at present appear to be pipes and sheets. With the arrival of autumn, we shall possibly, however, see more favourable trading conditions.

Average mean price of soft foreign lead: July, 1929, £22 16s. 10d.; June, 1929, £23 12s. 11d.; July, 1928, £20 15s. 5d.; June, 1928, £21 1s. 11d.

Spelter.—This was a colourless market last month, and price changes were without any particular significance. With that important consumer, the galvanized sheet industry, in a poor state, demand from users was inevitably restricted, and stocks tended to increase. It must be borne in mind, however, that there is not any considerable surplus of metal about and when autumn arrives with a more active industrial demand and the increased curtailment of output by producers begins to make itself felt, we may see values harden somewhat.

Average mean price of spelter: July, 1929, £25 7s. 6d.; June, 1929, £26 2s.; July, 1928, £24 19s. 2d.; June, 1928, £25 10s. 11d.

Iron and Steel.—Naturally, the holidays have affected the demand for iron and steel considerably of late. The Cleveland pig-iron market remains pretty tight, however, despite the fact that works are now prepared to book last-quarter contracts. They have, of course, nothing to offer for early delivery, and merchants who have occasional prompt lots to sell are able to secure good prices. Works are quoting 72s. 6d. per ton for No. 3 foundry G.M.B., but merchants are getting about 1s. more than this. Hematite has been a firm market and East Coast Mixed Nos. are realizing 75s. to 75s. 6d. per ton. In British finished iron and steel, demand has slackened owing to the holidays, but works are still fairly fully booked and quotations are firm. The Continental steel markets have, however, been weak.

Antimony.—At the close of July, English regulus, which had remained steady throughout the month, was quoted at £48 to £52 10s. per ton. Small sales were taking place in Chinese at about

LONDON DAILY METAL PRICES

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

	COPPER									TIN						ZINC (Spelter)	LEAD				SILVER		GOLD
	STANDARD				ELECTRO-LYTIC			BEST SELECTED									SOFT FOREIGN			ENGLISH				
	Cash			3 Months						Cash			3 Months									Cash	Forward	
July	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	d.	d.	s. d.
10	71	13	9	72	7	6	84	0	0		—		205	10	0	208	15	0	25	16	3	22	19	3	24	10	0	24½	24⅞	84 11
11	71	13	9	72	8	9	84	0	0		—		208	2	6	211	0	0	25	12	6	22	15	6	24	5	0	24⅜	24⅝	84 10½
12	71	3	9	72	1	3	84	0	0	75	2	6	206	12	6	209	17	6	25	10	0	22	15	6	24	5	0	24⅜	24⅝	84 11½
15	71	2	6	71	17	6	84	0	0		—		210	5	0	213	12	6	25	7	0	22	16	9	24	5	0	24⅜	24⅝	84 11¾
16	70	1	3	70	17	6	84	0	0	74	2	6	213	15	0	217	7	6	25	1	9	22	14	3	24	0	0	24⅜	24⅝	84 11⅝
17	70	11	3	71	7	6	84	0	0		—		214	5	0	217	10	0	25	3	9	22	11	3	24	0	0	24⅜	24⅝	84 11½
18	71	0	0	71	16	3	84	0	0		—		210	15	0	214	0	0	25	8	0	22	11	3	24	0	0	24⅜	24⅝	84 11½
19	72	15	0	73	7	6	84	0	0	76	2	6	214	7	6	217	15	0	25	7	6	22	16	3	24	0	0	24⅜	24⅝	84 11¾
22	72	15	0	73	7	6	84	0	0		—		214	15	0	218	5	0	25	6	9	22	16	9	24	5	0	24⅜	24⅝	84 11¾
23	72	2	6	72	17	6	84	0	0	75	17	6	212	10	0	216	5	0	25	5	6	22	13	0	24	0	0	24⅜	24⅝	84 11⅝
24	72	0	0	72	17	6	84	0	0		—		214	15	0	218	15	0	25	3	3	22	10	9	24	0	0	24⅜	24⅝	84 11¾
25	72	2	6	73	0	0	84	0	0		—		212	15	0	216	15	0	25	3	9	22	12	0	24	0	0	24⅜	24⅝	84 11¾
26	72	5	0	73	2	6	84	5	0	75	17	6	213	0	0	217	0	0	25	3	9	22	13	9	24	0	0	24⅜	24⅝	84 11¾
29	72	18	9	73	13	9	84	5	0		—		214	15	0	218	10	0	25	6	3	23	0	6	24	5	0	24⅜	24⅝	84 11¾
30	73	5	0	73	15	0	84	5	0	75	17	6	213	12	6	217	7	6	25	5	3	23	1	3	24	5	0	24⅜	24⅝	84 11¾
31	73	3	9	73	12	6	84	5	0		—		213	10	0	217	10	0	25	3	9	22	16	3	24	5	0	24⅜	24⅝	84 11½
Aug.																														
1	73	5	0	73	16	3	84	5	0		—		212	17	6	217	0	0	25	3	9	22	3	0	24	10	0	24⅝	24⅞	84 11¼
2	73	5	0	73	18	9	84	5	0	77	12	6	213	5	0	217	2	6	25	3	9	23	5	6	24	15	0	24⅝	24⅞	84 11¼
6	73	11	3	74	7	6	84	5	0	78	2	6	212	17	6	216	17	6	25	4	3	23	7	6	24	15	0	24⅝	24⅞	84 11⅛
7	73	15	0	74	12	6	84	5	0		—		212	2	6	216	5	0	25	3	9	23	7	0	24	15	0	24⅛	24⅜	84 11⅛
8	73	16	3	74	13	9	84	5	0		—		211	2	6	215	2	6	25	1	3	23	7	0	24	15	0	24⅛	24⅜	84 11¼
9	73	6	3	74	3	9	84	5	0	78	2	6	209	5	0	213	5	0	24	14	3	23	2	0	24	10	0	24¼	24⅜	84 11½

£32 ex warehouse and £29 10s. to £29 15s. c.i.f. for shipment, this material having eased somewhat.

IRON ORE.—Further substantial sales on the Continent have been made for 1930 delivery, while in the case of Swedish ore a large contract has been made as far ahead as 1932 with Germany. There is practically nothing available for shipments during the remainder of this year, and prices are nominal on the basis of about 24s. 6d. to 25s. per ton c.i.f. for best Bilbao rubio.

ARSENIC.—This market rules quiet with prices unaltered at £16 per ton f.o.r. mines for high grade Cornish white.

BISMUTH.—There is no change in the official price, which stands at 7s. 6d. per lb., but latterly the market has been a little unsettled owing to some cheaper outside parcels being offered on the Continent.

CADMIUM.—Business has quietened down somewhat, but prices remain fairly steady in the neighbourhood of 4s. to 4s. 1d. per lb.

COBALT METAL.—The official price is still 10s. per lb., demand latterly being rather quiet.

COBALT OXIDES.—A steady demand is reported at the unaltered quotations of 8s. per lb. for black and 8s. 10d. for grey.

PLATINUM.—A quiet tone characterizes this market, but prices are steady at £13 10s. to £13 15s. per oz. for good parcels.

PALLADIUM.—In the absence of any business of importance, prices are none too firm at £7 to £7s. 10s. per oz.

IRIDIUM.—Only small parcels are in request, and sponge and powder are now quoted at about £50 per oz.

TELLURIUM.—No interest is shown in this metal, and quotations are quite nominal at about 12s. 6d. to 15s. per lb.

SELENIUM.—A steady business is passing in high grade black powder at about 7s. 8d. to 7s. 9d. per lb. ex warehouse.

MANGANESE ORE.—Demand remains practically at a standstill, with prices nominally 1s. 1½d. to 1s. 1⅝d. per unit c.i.f. for best Indian and 1s. 1d. for washed Caucasian.

ALUMINIUM.—There is no change in the position, quite a fair business continuing in evidence. Prices are unaltered at £95 delivered, less 2%.

SULPHATE OF COPPER.—English material is now held for about £27 10s. to £28 per ton, less 5%.

NICKEL.—A large turnover is maintained, and leading interests have little difficulty in maintaining their official price at £175 per ton both for home and export business.

CHROME ORE.—This market keeps very steady, about £4 5s. c.i.f. per ton basis still being quoted for good 48% Rhodesian ore.

QUICKSILVER.—For some time now consumers have confined their purchases to small lots on spot, and prices have not changed from their previous level of £22 2s. 6d. to £22 5s. per bottle.

TUNGSTEN ORE.—During July the scarcity of supplies grew very acute and as much as 42s. per unit c.i.f. was paid. Latterly, however, the tone has been slightly easier, although prices have not yet receded far. For forward shipment about 39s. to 41s. per unit c.i.f. represents to-day's value.

MOLYBDENUM ORE.—The scarcity of tungsten ore has diverted attention to molybdenum and prices are firm at around 40s. to 42s. 6d. per unit c.i.f. for 80 to 85% concentrates.

GRAPHITE.—Supplies seem rather in excess of demand, but sellers here are fairly firm in their ideas at about £27 to £29 per ton c.i.f. for raw Madagascar flake, and £25 to £26 c.i.f. for high grade Ceylon lumps.

SILVER.—At the beginning of July the market had rather a flat appearance, more because of the lack of buying interest than from any particular selling pressure. Spot bars, which on July 1 were 24 1/16d. fell to 23 15/16d. on July 3, although later on with some Indian support some recovery was seen to 24⅜d. on July 15. Subsequently the break between Russia and China occasioned some purchases on Indian and Chinese account and prices advanced sharply to 24 1/16d. on July 19, but later on subsided again, and at the end of July the market had a steadier appearance with spot bars closing at 24 1/16d. on July 31.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
July, 1928	828,482	38,729	867,211
August	854,172	37,691	891,863
September	819,341	38,390	857,731
October	858,945	38,775	897,720
November	832,461	40,023	872,484
December	821,582	38,179	859,761
January, 1929	840,344	36,108	876,452
February	778,559	36,725	815,284
March	830,829	35,700	866,529
April	836,474	35,649	872,123
May	858,991	38,607	897,598
June	821,352	34,677	856,029
July	853,370	36,110	889,480

TRANSVAAL GOLD OUTPUTS.

	June.		July.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	87,500	£145,025	85,500	£144,109
City Deep	93,000	26,345	89,000	25,002
Cons. Main Reef	60,200	21,811	62,700	22,495
Crown Mines	229,000	73,714	237,000	75,312
D'rb'n Roodepoort Deep	40,300	13,608	40,200	13,610
East Rand P.M.	142,000	37,788	147,000	39,804
Geduld	82,500	26,038	86,000	27,071
Geldenhuis Deep	63,000	14,476	66,000	14,999
Glynn's Lydenburg	6,300	2,142	6,600	2,226
Government G.M. Areas	194,000	£373,834	207,000	£394,820
Kleinfontein	49,200	11,191	52,100	10,352
Langlaagte Estate	79,000	£109,152	86,000	£114,566
Luipaard's Viei	22,400	5,795	23,800	6,099
Meyer and Charlton	16,800	£18,507	17,200	£19,328
Modderfontein New	146,000	73,062	153,000	73,941
Modderfontein B	69,500	24,780	71,500	25,191
Modderfontein Deep	43,000	22,730	45,900	24,225
Modderfontein East	68,000	19,881	69,500	21,152
New State Areas	75,000	£135,199	81,000	£140,442
Nourse	62,500	17,624	63,000	18,660
Randfontein	210,000	£208,873	216,000	£220,371
Robinson Deep	75,500	19,877	79,100	21,199
Rose Deep	57,000	11,816	59,000	12,369
Simmer and Jack	72,100	18,485	75,600	18,917
Springs	65,500	£136,985	70,500	£149,227
Sub Nigel	24,300	19,521	25,000	20,812
Transvaal G.M. Estates	14,650	4,943	15,160	5,366
Van Ryn	38,600	£36,905	40,000	£39,003
Van Ryn Deep	58,000	£101,094	64,000	£103,743
Village Deep	56,800	15,078	60,000	16,058
West Rand Consolidated	87,000	£92,599	90,000	£96,487
West Springs	60,100	£74,375	65,000	£80,440
Witw'tersr'nd (Knights)	53,000	£46,332	57,000	£48,593
Witwatersrand Deep	41,800	12,662	43,200	13,106

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.	£
May, 1928	2,571,900	28 0	19 7	8 5	1,084,465
June	2,500,100	28 2	19 10	8 4	1,038,851
July	2,528,600	27 11	19 8	8 3	1,048,432
August	2,530,700	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	—	—	—	—	1,065,191

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
July 31, 1928	194,584	16,695	5,189	220,345
August 31	194,788	16,553	4,839	218,578
September 30	194,936	16,724	4,783	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	197,616	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

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	—
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.

	June.		July.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,000	12,680	24,000	12,075
Globe and Phœnix	6,015	5,435	6,031	4,906
Lonely Reef	4,900	3,969	5,300	4,105
Rezende	6,400	2,949	6,400	2,908
Shamva	45,000	£24,084	—	—
Sherwood Starr	5,000	£8,675	5,000	£8,621

WEST AFRICAN GOLD OUTPUTS.

	June.		July.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	6,840	£13,163	—	—
Ashanti Goldfields	9,302	10,362	9,189	10,356
Taquah and Abosso	7,740	£13,288	8,300	£13,483

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.	New South Wales.
	Oz.	Oz.	Oz.	Oz.
July, 1928	29,399	3,208	772	154
August	37,991	2,637	690	3,447
September	32,397	3,366	644	364
October	36,565	2,632	820	256
November	31,466	3,111	865	550
December	36,097	—	493	208
January, 1929	27,384	—	260	445
February	28,177	1,997	117	474
March	25,848	2,974	816	—
April	39,166	—	617	—
May	28,026	3,018	493	467
June	33,139	—	—	—
July	28,086	—	—	—

AUSTRALASIAN GOLD OUTPUTS.

	June.		July.	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	4,902	7,517	5,155	7,617
Blackwater (N.Z.)	3,200	5,121	3,100	4,905
Boulder Persev'ce (W.A.)	5,785	13,572	6,117	15,205
Grt. Boulder Pro. (W.A.)	9,635	26,005	10,248	28,957
Lake View & Star (W.A.)	8,330	11,528	8,010	15,722
Sons of Gwalia (W.A.)	13,696	11,892	14,250	9,804
South Kalgurli (W.A.)	8,686	16,488	9,060	17,390
Waihi (N.Z.)	—	—	17,594	6,110* / 27,333†

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	June.		July.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	4,050	2,400	4,300	2,405
Champion Reef	8,055	4,967	8,285	5,072
Mysore	18,302	8,296	18,521	9,380
Nundydroog	10,495	6,642	10,510	6,652
Ooregum	14,000	7,285	13,500	6,683

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	June.		July.	
	Tons	Value £	Tons	Value £
Chosen Synd. (Korea)	8,900	13,558	8,700	12,990
Frontino& Bolivia (C'lbia)	1,480	6,139	1,493	4,903
Lena (Siberia)	—	55,351	—	—
Lydenburg Plat. (Trans.)	3,320	664*p*	3,620	801*p*
Marmajito (Colombia)	720	7,653	700	4,317
Mexican Corp. Fresnillo	89,215	141,513*d*	—	—
Onverwacht Platinum	2,320	400*p*	2,488	423*p*
Oriental Cons. (Korea)	19,431	80,051*d*	—	72,000*d*
St. John del Rey (Brazil)	—	31,200	—	39,000
Santa Gertrudis (Mexico)	50,706	129,003*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	—
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.

	May.	June.	July.
Ampang	16	—	—
Batu Caves	48	36	46
Changkat	54	25	75
Chenderiang	28½	24	27
Gopeng	83	83	83
Idris Hydraulic	41⅜	—	35⅜
Ipoh	35½	25⅝	41⅜
Jelapang	33	35	36
Kamunting	102	103	—
Kent (F.M.S.)	54	48	48
Kepong	25	34	36
Kinta	28½	—	31
Kinta Kellas	25½	26⅜	47½
Kramat Pulai	18⅜	19	17⅜
Kuala Kampar	115	115	115
Kundang	37	30	15
Lahat	17⅞	13⅝	12⅝
Larut Tinfields	80	72½	82
Malaya Consolidated	83	55	41⅜
Malayan Tin	131	125	119
Meru	14¾	13	25
Pahang	220	222	222
Pengkalen	74½	77⅞	89
Petaling	220	46	184½
Rahman	71½	71½	53⅜
Rambutan	10⅜	13½	11
Rantau	26	38	35
Rawang	70	55	55
Renong	37	60½	66½
Selayang	27	29	23
Southern Malayan	154⅜	190½	184½
Southern Perak	91¼	95½	86½
Southern Tronoh	18	30	21
Sungei Besi	46	—	48
Sungei Kinta	26	39½	28
Sungei Way	89½	89½	89½
Taiping	47	45	75
Tanjong	30	—	34
Teja Malaya	17½	14	20⅜
Tekka	45	45	45
Tekka-Taiping	48	48	45
Temoh	34½	37	37⅜
Tronoh	106	113½	108

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	May.	June.	July.
Amari	6½	5⅜	—
Anglo-Nigerian	56	50	—
Associated Tin Mines	250	260	260
Baba River	4	4⅜	—
Batura Monguna	2½	2	—
Bisichi	66	70	76
Daffo	5	7	9
Ex-Lands	50	50	—
Filani	1⅜	2½	5
Jantar	43	45	—
Jos	22½	17½	19
Juga Valley	12	17	20
Junction	8	6	4
Kaduna	32	29	—
Kaduna Prospectors	24½	23¾	—
Kassa	17	18	—
Lower Bisichi	5	6½	6½
Mongu	35	40	40
Naraguta	—	27⅜	45
Naraguta Durumi	—	15½*	12
Naraguta Extended	10	20	25
Naraguta Karama	—	16½	21
Naraguta Korot	15	13	—
Nigerian Base Metals	54	47	—
Nigerian Consolidated	20	20	20
N.N. Bauchi	160	180	140
Offin River	8	6½	4⅜
Ribon Valley	14¼	13	—
Ropp	80	81	90
Rukuba	4	4½	—
South Bukeru	14	13½	9½
Tin Fields	5	5	7
Tin Properties	15	13	20
United Tin Areas	12⅛	17½	—
Yarde Kerri	10	9	—

* May and June.

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	May.	June.	July.
Anglo-Burma (Burma)	6⅜	8⅜	—
Aramayo Mines (Bolivia)	425	338	374
Bangrin (Siam)	65⅛	67½	64½
Berenguela (Bolivia)	45	38	—
C'nsolidated Tin Mines (Burma)	72*	82	150
East Pool (Cornwall)	84⅜	85½	—
Fabulosa (Bolivia)	128	105	124½
Geevor (Cornwall)	70	70	71
Jantar (Cornwall)	23	25½	—
Kagera (Uganda)	23	23	—
Polhigey (Cornwall)	31	32	33
San Finx (Spain)	41½*	40⅜*	—
Siamese Tin (Siam)	131½	154½	169
South Crofty (Cornwall)	65½	62¾	65½
Tavoy Tin (Burma)	51	41	40
Theindaw (Burma)	3½	5½	8
Tongkah Harbour (Siam)	95	110	85
Toyo (Japan)	—	—	—
Wheal Kitty (Cornwall)	50	50	36
Wheal Reeth	—	—	13½

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		June.	July.
Broken Hill Prop.	Tons lead conc.	—	—
Broken Hill South	Tons lead conc.	5,627	—
	Tons zinc conc.	5,165	—
Burma Corporation	Tons refined lead	6,545	6,500
	Oz. refined silver	590,620	580,923
Bwana M'Kubwa	Tons copper oxide	609	626
Electrolytic Zinc	Tons zinc	3,902	3,895
Indian Copper	Tons copper	151	162
Messina	Tons copper	584	596
Mount Lyell	Tons concentrates	2,744	—
Namaqua	Tons copper	201	215
North Broken Hill	Tons lead conc.	7,930	—
	Tons zinc conc.	5,890	—
Poderosa	Tons copper ore	1,215	1,430
Rhodesia Broken Hill	Tons lead	155	80
	Tons slab zinc	930	1,081
San Francisco Mexico	Tons lead conc.	3,132	3,100
	Tons zinc conc.	3,545	4,145
Sulphide Corporation	Tons lead conc.	2,726*	1,180
	Tons zinc conc.	3,984*	2,907
Tetiuhe	Tons lead conc.	781	—
	Tons zinc conc.	1,136	—
Union Minière	Tons copper	11,500	—
Zinc Corporation	Tons lead conc.	5,512	—
	Tons zinc conc.	4,132	—

* Six weeks.

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

		May.	June.
Iron Ore	Tons	489,481	410,950
Manganese Ore	Tons	29,268	41,446
Iron and Steel	Tons	257,256	234,208
Copper and Iron Pyrites	Tons	43,760	33,960
Copper Ore, Matte, and Prec.	Tons	2,536	1,817
Copper Metal	Tons	16,789	15,240
Tin Concentrate	Tons	10,538	9,984
Tin Metal	Tons	770	1,443
Lead Pig and Sheet	Tons	26,483	19,319
Zinc (Spelter)	Tons	13,358	8,691
Zinc Sheets, etc.	Tons	1,787	1,755
Aluminium	Tons	1,430	2,162
Quicksilver	Lb.	12,040	4,086
Zinc Oxide	Tons	1,120	1,059
White Lead	Cwt.	13,463	12,733
Red and Orange Lead	Cwt.	3,459	3,885
Barytes, ground	Cwt.	54,189	66,142
Asbestos	Tons	2,892	3,178
Boron Minerals	Tons	1,199	600
Borax	Cwt.	14,770	12,155
Basic Slag	Tons	5,169	7,303
Superphosphates	Tons	18,775	5,751
Phosphate of Lime	Tons	17,939	25,501
Mica	Tons	243	209
Sulphur	Tons	4,500	3,566
Nitrate of Soda	Cwt.	74,984	99,342
Potash Salts	Cwt.	244,323	54,700
Petroleum: Crude	Gallons	39,911,994	45,813,186
Lamp Oil	Gallons	28,976,661	14,147,716
Motor Spirit	Gallons	77,033,505	59,560,992
Lubricating Oil	Gallons	8,838,337	8,972,599
Gas Oil	Gallons	9,099,016	10,017,854
Fuel Oil	Gallons	35,531,443	31,347,554
Asphalt and Bitumen	Tons	17,680	21,301
Paraffin Wax	Cwt.	102,184	122,757
Turpentine	Cwt.	20,544	52,670

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES

In Tons.

	May.	June.	July.
Anglo-Ecuadorian	13,083	15,630	16,047
Apex Trinidad	37,060	38,290	38,040
Attock	4,688	4,653	4,839
British Burmah	5,652	5,415	6,021
British Controlled	31,922	31,871	—
Kern Mex	809	827	736
Kern River (Cal.)	4,377	3,344	5,074
Kern Romana	2,637	2,605	3,771
Kern Trinidad	3,644	3,441	4,006
Lobitos	27,362	26,147	27,763
Phœnix	36,029	38,178	41,853
St. Helen's Petroleum	22,627	27,515	19,887
Steaua Romana	68,940	68,040	75,920
Tampico	2,877	2,940	2,753
Trinidad Leaseholds	32,100	30,400	31,000
Venezuelan Consolidated	1,864	2,190	5,128

QUOTATIONS OF OIL COMPANIES SHARES.

Denomination of Shares £1 unless otherwise noted.

	July 8, 1929			Aug. 9, 1929		
	£	s.	d.	£	s.	d.
Anglo-American	3	3	9	3	0	0
Anglo-Ecuadorian	1	3	9	1	0	0
Anglo-Egyptian B	2	13	9	2	10	0
Anglo-Persian 1st Pref.	1	7	6	1	7	6
,, ,, Ord.	4	6	3	4	2	0
Apex Trinidad (5s.)	1	11	3	1	8	0
Attock	2	15	0	2	16	3
British Burmah (8s.)		6	9		6	6
British Controlled ($5)		5	9		5	0
Burmah Oil	4	6	3	4	2	0
Kern River, Cal. (10s.)		7	9		7	9
Lobitos, Peru	2	6	3	2	1	3
Mexican Eagle, Ord. (4 pesos)		16	6		14	0
,, ,, 8% Pref. (4 pesos)		15	0		12	0
Phœnix, Roumania		13	0		11	6
Royal Dutch (100 fl.)	33	5	0	31	12	6
Shell Transport, Ord.	4	16	3	4	10	0
,, ,, 5% Pref. (£10)	9	17	6	9	15	0
Steaua Romana		11	0		10	0
Trinidad Leaseholds	4	6	3	4	1	3
United British of Trinidad (6s. 8d.)		9	0		8	9
V.O.C. Holding	3	12	6	3	10	0

PRICES OF CHEMICALS. August 8.

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%	,,	6	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	1
,, ,, crystallized, 40°	per lb.			8
Carbon Disulphide	per ton	24	0	0
Citric Acid	per lb.		2	1
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	,,	40	0	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	25	0	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.			5½
,, Prussiate, Yellow	,,			6½
,, Red	,,		1	9
,, Sulphate, 90%	per ton	11	5	0
Sodium Acetate	per ton	21	0	0
,, Arsenate, 45%	,,	26	0	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3¼
,, 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	44	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:	July 8, 1929. £ s. d.	August 9, 1929. £ s. d.
SOUTH AFRICA:		
Brakpan	4 10 0	4 7 6
City Deep	12 0	11 3
Consolidated Main Reef	19 9	19 3
Crown Mines (10s.)	3 7 0	3 4 6
Daggafontein	1 1 3	1 0 6
Durban Roodepoort Deep	10 0	10 0
East Geduld	1 17 0	1 15 6
East Rand Proprietary (10s.)	12 9	12 9
Ferreira Deep	6 3	6 3
Geduld	3 10 0	3 8 9
Geldenhuis Deep	4 9	4 6
Glynn's Lydenburg	2 6	2 6
Government Gold Mining Areas (5s.	2 0 0	2 0 0
Langlaagte Estate	1 1 3	1 1 6
Meyer & Charlton	9 6	10 0
Modderfontein New (10s.)	5 8 9	5 6 3
Modderfontein B (5s.)	17 3	17 0
Modderfontein Deep (5s.)	1 10 6	1 8 9
Modderfontein East	1 11 3	1 10 6
New State Areas	1 12 6	1 12 6
Nourse	9 3	10 0
Randfontein	6 0	6 0
Robinson Deep A (1s.)	13 9	13 9
" B	8 9	8 0
Rose Deep	5 0	5 0
Simmer & Jack (2s. 6d.)	3 3	3 3
Springs	3 4 6	3 5 6
Sub Nigel (10s.)	1 17 6	2 0 0
Van Ryn	7 6	8 0
Van Ryn Deep	1 19 6	1 18 0
Village Deep	4 9	5 0
West Rand Consolidated (10s.)	7 0	6 9
West Springs	18 6	18 3
Witwatersrand (Knight's)	7 0	7 3
Witwatersrand Deep	4 9	4 6
RHODESIA:		
Cam and Motor	1 16 3	1 13 9
Gaika	5 0	6 6
Globe and Phœnix (5s.)	9 0	10 0
Lonely Reef	1 3 9	1 2 6
Mayfair	1 0 0	1 0 0
Rezende	17 6	1 0 0
Shamva	7 6	5 0
Sherwood Starr	15 0	16 3
GOLD COAST:		
Ashanti (4s.)	1 4 3	1 5 0
Taquah and Abosso (5s.)	2 3	2 0
AUSTRALASIA:		
Golden Horseshoe (Pref., 5s.), W.A.	13 6	13 3
Great Boulder Proprietary (2s.), W.A.	2 3	1 9
Lake View and Star (4s.), W.A.	13 6	12 6
Sons of Gwalia, W.A.	2 6	2 3
South Kalgurli (10s.), W.A.	15 6	16 0
Waihi (5s.), N.Z.	11 9	11 6
Wiluna Gold, W.A.	1 1 3	1 1 3
INDIA:		
Balaghat (10s.)	5 0	4 6
Champion Reef (10s.)	8 6	8 0
Mysore (10s.)	13 0	12 6
Nundydroog (10s.)	15 3	16 0
Ooregum (10s.)	10 6	9 0
AMERICA:		
Camp Bird (2s.), Colorado	2 6	1 9
Exploration (10s.)	9 0	9 0
Frontino and Bolivia, Colombia	7 6	7 6
Mexican Corporation, Mexico	16 0	16 0
Mexico Mines of El Oro, Mexico	3 3	5 0
Panama Corporation	19 0	18 3
St. John del Rey, Brazil	17 0	15 6
Santa Gertrudis, Mexico	11 0	9 9
Selukwe (2s. 6d.), British Columbia	5 9	6 0
MISCELLANEOUS:		
Chosen, Korea	1 3 0	1 1 3
Ellyou (5s.), New Guinea	1 7 0	1 4 0
Lena Goldfields, Russia	4 3	3 9
COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	1 2 0	1 1 6
Esperanza Copper, Spain	19 6	19 6
Indian (2s.)	2 6	2 6
Loangwa (5s.), Rhodesia	9 0	8 0
Luiri (5s.), Rhodesia	6 6	6 0
Messina (5s.), Transvaal	18 6	16 6
Mount Lyell, Tasmania	2 0 3	2 1 6
Namaqua (£2), Cape Province	1 0 0	18 9
N'Changa, Rhodesia	3 16 3	3 7 6
Rhodesia-Katanga	2 0 6	1 18 0
Rio Tinto (£5), Spain	54 12 6	53 0 0
Roan Antelope (5s.), Rhodesia	2 7 6	2 4 6
Tanganyika, Congo and Rhodesia	2 18 0	3 0 6
Tharsis (£2), Spain	5 12 6	5 15 0

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

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

THE PROBLEM OF SECONDARY TIN IN BOLIVIA

In *Economic Geology* for July there appears a lengthy review of the secondary tin problem in Bolivian deposits, which was presented to the Society of Economic Geologists by Joseph T. Singewald, Jr. Recently interest has been aroused in the subject of secondary tin enrichment in the Bolivian veins by the paper of Koeberlin which appeared in 1926. A certain amount of corroborative evidence has been added, but no other observer has ascribed equal importance to secondary tin. Recent literature contains considerable negative evidence.

An orderly analysis of the evidence bearing on the problem of supergene tin enrichment can be made by considering it under the four groups of criteria recognized by Ransome [1] in his discussion of the criteria of downward sulphide enrichment, nameiy (1) geological, (2) mineralogical, (3) chemical, and (4) textural.

A diminution of tin values with increasing distance from the outcrop, especially in the transition from oxidized ores to sulphide ores, is a long recognized and generally accepted phenomenon of the Bolivian tin veins. Very few detailed or comprehensive quantitative data as to the ratios of tin tenor in these ores have been assembled, and opinions on the amount of the change in tenor are largely subjective and inevitably influenced by preconceived ideas of the observer. The Bolivian veins are notable among the world's tin deposits because of the abundance and variety of stanniferous sulphides they contain. In the zone of oxidation these minerals are wanting. They have been oxidized and their tin content either carried away in solution or reformed as tin oxide. Wood tin has been considered a form of secondary tin oxide, and the easy explanation was to consider it the product of the tin content of the sulphostannates. Cassiterite has been considered one of the most insoluble and resistant of minerals, and its solution and redeposition by descending waters have been conceded possible to a very limited extent only. From a quantitative standpoint, the tin content of the Bolivian ores, whether from the upper levels or the lower levels of the mines, lies in the mineral cassiterite. If the solution and redeposition of cassiterite on an important scale by meteoric waters does not take place, then secondary tin enrichment in the Bolivian veins cannot be a process of much economic importance.

In 1915 and 1919, the author had the opportunity of visiting most of the Bolivian tin districts, and his own observations accorded with the conclusions set forth by Miller and Singewald in 1919,[2] that tin enrichment in the zone of oxidation is primarily a process of residual enrichment involving the removal or reduction in amount of associated minerals and in special cases some mechanical transportation of cassiterite in that zone. Most of the oxidized tin ore is a very porous mass of cassiterite, quartz, and limonite. If the pore space were filled with sulphide instead of air, a much lower-grade tin ore would result. They stated that "the extent to which cassiterite is enriched by solution and redeposition in the zone of oxidation is a mooted question." In 1928 Ahlfeld, who agrees with Koeberlin to a greater extent than any one else who has discussed the subject, expressed a very similar opinion when he wrote [1]: "Concerning the chemical processes in the formation of secondary cassiterite we are to-day as ignorant as we are concerning the percentage it constitutes of the entire quantity of Bolivian cassiterite." Most writers have been extremely conservative as to the amount of solution and redeposition of cassiterite by supergene processes that they concede.

Koeberlin [2] has attributed great economic importance to the process of secondary tin enrichment in the Bolivian ores. He believes that the enrichment is not confined to the zone of oxidation but extends down into the sulphide ores. Residual enrichment he contends is inadequate to account for the amount of enrichment in the zone of oxidation, and of course does not apply at all to the sulphide ores. Koeberlin clearly recognized that large scale secondary tin enrichment involved repeated solution and redeposition of cassiterite to a commensurate extent, and that the difficulties of the problem could not be evaded by appealing to the stanniferous content of the sulphosalts, as they were wholly inadequate in amount, and because after the first cycle of solution further concentration depended on the solubility of the newly formed tin oxide. He frankly stated that no satisfactory chemical explanation of the process was known. The process itself is "solution of cassiterite in the upper parts of the vein; downward percolation; redeposition as tin oxide at lower levels." Koeberlin commits himself equally clearly as to the quantitative importance he attaches to the process in the statement [3]: "It is perhaps not too much to say that its economic significance with respect to tin lodes is almost as great as that of secondary sulphide enrichment in the case of copper deposits."

[1] Ransome, F. L., "Criteria of Downward Sulphide Enrichment," *Econ. Geol.*, vol. 5, pp. 205-220, 1910.

[2] Miller, Benjamin L., and Singewald, Joseph T., Jr., *The Mineral Deposits of South America*, 1919.

[1] Ahlfeld, F., "Zur Entstehung der Sulfostannate Boliviens," *Zeit. für prak. Geol.*, 1928, pp. 43–44.

[2] Koeberlin, F. R., "Geologic Features of Bolivia's Tin-Bearing Veins," *Eng. and Min. Jour.*, vol. 121, pp. 636–642, 1926.

[3] Koeberlin, F. R., "Certain Geologic Features of Bolivian Tin-bearing Veins," *Eng. and Min. Jour.*, vol. 122, pp. 819–820, 1926.

Geological Evidence.—Geological evidence in support of secondary tin enrichment is presented by Koeberlin, Brown, Lewis, and Ahlfeld.

Koeberlin says many Bolivian tin mines have been worked only in the oxidized zone, the ores of which were often very rich. The grade of the sulphide ores was considerably lower, particularly in the smaller veins. Veins worked by successive adits down the hill side seldom yielded profitable ore when the adits entered the sulphides even though the vein showed no decrease in size. Pay ore seemed to to be limited to a belt roughly parallel to the present surface. The San Fermin vein at Llallagua is described as having a barren oxidized zone and showing sudden enrichment with marcasite in the sulphide zone and a deep extension of the rich cassiterite and marcasite near a post mineral fault zone. The marcasite-cassiterite ore fades in depth to lower grade ore of uniform tenor without marcasite. More striking than the mineralogic changes in the San Fermin vein described by Koeberlin, is the coincidence of the rich ore, which consists of cassiterite, bismuthinite, and wolframite, with maximum vein width. This suggests that the rich ore occurs in primary ore shoots localized in the widest parts of the veins. Additional evidence cited by Koeberlin is that at Oruro high grade silver and tin ores diminished in tenor with increasing depth, the tin the more rapidly, so that in the lowest levels the ore is workable only as silver ore. In the Pazña district, at Totoral and Antequera, is a zone of oxidation with good values passing downward into low grade sulphides. The Totoral veins unite down the dip to form one vein which in the sulphide zone becomes narrow and has low tin values associated with pyrite and sphalerite. The outcrops of the adjoining Avicaya veins run down the mountain side and the veins were workable over a much greater vertical range for that reason. At El Salvador, north-west of the Pazña district, the veins outcrop over a vertical range of 500 m., but good silver and tin values are not found much more than 50 m. below the outcrop. Below the tin ores are zinc ores with low silver and tin values. It is interpreted as a case of low grade zinc ore with an overlying secondarily enriched silver-tin zone. Potosi is mentioned as an important example of enrichment, but the evidence is not presented. At least some of the rich ore shoots at Potosi have been worked at depths greater than those to which secondary enrichment is likely to have reached. The Colorado Vein at Chocaya is cited as a case in which enrichment did not take place. Without naming the locality Koeberlin describes two parallel veins 300 m. apart with a dip of 60°. One of the veins without topographic expression has a filling of quartz, pyrite, siderite, and uniformly distributed cassiterite. The other vein, marked by a topographic depression, has had its vein structure destroyed by solution or crushing, or both, and the pyrite removed. The tin ore is finely crystalline, nearly amorphous oxide associated with disintegrated quartz, and lies in lenticles on the footwall side of the vein. He adds that the physical condition of the vein absolutely excludes the possibility of mechanical migration of the tin to the footwall, and regards the case as evidence of solution and redeposition of the tin.

Brown says in the Quimsa Cruz district are numerous small veins about 5 inches wide which contain extremely rich—up to 30% tin—sulphide ore within a few feet of the surface, but the high grade ore disappears within 10 to 20 feet along both strike and dip. He suggests that this ore may represent the remaining portion of an enriched zone. The description fits better an occurrence of small lenses and pockets of primary ore,—a characteristic phenomenon of narrow tin veins.

Lewis says wide experience in Australia and Tasmania has brought to his attention many cases of pay ore in the outcrops succeeded by low grade ore in depth. Often the ore is richer than could be accounted for by the oxidation of pyrite and in some cases pyrite was never present. In other cases barren outcrops have rich oxidized ore beneath. These phenomena are cited as favouring secondary enrichment in Australia and Tasmania.

Ahlfeld says the high temperature veins carry mainly pure cassiterite and show no secondary enrichment, whereas the lower temperature veins carry cassiterite contaminated with iron and stannite, and show enrichment. Vila Apacheta at Chayanta is described as having an oxidized zone of 50 m. depth, a cementation zone from 50 m. to 160 m., and a primary zone that has been worked to a depth of 200 m. The vein shows leaching of stannite and deposition of wood tin. The Animas mine at Atocha is described as having an oxidized zone of 70 m. of rich *pacos* ores with compact secondary cassiterite and a little silver and an underlying zone of primary cassiterite, stannite, and pyrite with secondary silver ores that has been followed to a depth of 264 m. The Veta Colorado at Colcha has been developed to a depth of 250 m. A shallow oxidized zone contains a little cassiterite, and the underlying sulphide ore a little stannite. Encrusting siderite and pyrite on all levels are crystals of pure cassiterite which Ahlfeld suggests may have been deposited by descending solutions. After citing these specific instances of probable secondary cassiterite derived from stannite, Ahlfeld follows with the general statement that frequently a rich tin hat is succeeded by primary pyrite and sphalerite with a fraction of a per cent of tin, and names Esmoraca, Tasna, and Porco as examples. He says these ores represent concentration of tin from a great overlying vein height. If copper is present, the tin was derived from stannite; in the absence of copper cassiterite must have been the source.

Spurr in editorial comment on Koeberlin's first article characterizes the evidence as impressive and says "one is impelled to respect his conclusions." Other statements in the editorial suggest that the comment is an acceptance of the conclusions.

Somewhat similar geologic evidence but differently interpreted is presented by Sznapka, Kozlowski, Jakowski, and Winkelmann. Sznapka discusses both primary and secondary differences in depth. As a primary difference in depth he cites an impoverishment in tin and silver and an increase in sphalerite with increasing depth. The diminution in the tin tenor is more rapid than that of silver. The increase in sphalerite with depth is especially marked in the tin vein type, as in the Quimsa Cruz region. In the discussion of secondary differences in depth, he says the *pacos* ores are richer in tin because of the removal of pyrite, and that the value of the oxidized ores is greater than that of sulphide ores of the same tin content because the latter have to be roasted.

Kozlowski also recognized a rapid decrease with depth in the tin content of the tin vein type, and a decrease in both silver and tin in the argentiferous

stanniferous type. At Oruro veins that to a depth of 100 m. yielded ores with a tenor of 5 to 10% tin, at 300 to 400 m. carried 1 to 2% or less tin. Tin tenor dropped more rapidly than did the silver. The first mineral to form was pyrite, and in depth the pyrite filling of the veins is more compact. Potosi is described as exhibiting the same phenomena. Kozlowski considers these primary changes in depth and not due to supergene processes.

Jakowski recognizes an unequal downward distribution of the tin content of the Bolivian veins but refers the change to primary causes. He suggests a rapid change in the amount of tin deposited in the transitional zone from gaseous to liquid state of the ascending mineralizers in which zone a medium grade vein might suddenly become very rich and then terminate above in a barren zone.

Winkelmann, studying a suite of ores collected by the late Professor Scheibe, recognized enrichment of cassiterite in the oxidized zone but says it is analogous to the formation of eluvial placers. The cassiterite was not attacked by the oxidation.

Scrivenor in a discussion of Koeberlin's article says that in the Malay States there is no evidence of solution and redeposition of cassiterite. Kittl,[1] who has a wide knowledge of the Bolivian tin deposits, criticizes Ahlfeld for taking up the "little proven and much exaggerated" ideas of Koeberlin. He says he has carefully studied the question and finds secondary cassiterite not nearly so abundant as claimed, but considers it is an advance to point out that all cassiterite is not primary.

Dr. Robert M. Overbeck, who has had more experience in the careful examination of Bolivian tin mines than any other geologist, told the author that he had seen no evidence of secondary enrichment being of economic importance.

The geologic evidence cited above establishes the occurrence of rich oxidized tin ores in the Bolivian veins underlain by leaner sulphide ores characterized by further diminution of tin content with increasing depth. Secondary cassiterite deposition is not a necessary conclusion from these facts. So far as the tenor of the oxidized ores is concerned it is a matter of personal opinion whether it can be adequately accounted for or not by processes of superficial alteration in the zone of oxidation that do not involve considerable solution and redeposition of cassiterite. Decrease in the content of a valuable metal in sulphide ore with increasing depth may be a phenomenon of primary mineralization and is not necessarily the indication of a fading zone of cementation.

In evaluating the significance of the foregoing geologic evidence, it is necessary to keep in mind the paucity of quantitative data and the irregularity in the distribution of the tin content of the primary mineralization itself. Information concerning relative tenors of ores from the zone of oxidation and from the underlying sulphidic ores is so general that it is not possible to separate the residual enrichment in the zone of oxidation due to the oxidation and leaching of sulphides and other more readily soluble constituents of the ore from such enrichment as may be due to solution and redeposition of cassiterite, and thus actually determine the quantitative importance of the latter. The veins that carry profitable primary ores and have been worked to greater depths are characterized by variations in tenor laterally and vertically and by the occurrence of the mineable ore in ore shoots of restricted extent. Careaga[1] describes a marked variation in primary metallic content with increasing depth in the Veta Colorado at Chocaya. The 12th level ore was richer than that of the 11th level, an impoverishment followed to the 14th level, and the 15th level was again as rich as the 12th level. This variation is said to show a close relation to the physical character of the fissure. Where the vein is wide and well formed, or at junctions with the closely paralleling Llampera vein, the ore is rich. Where the vein splits up into stringers, the ore is lean. The vicissitudes of the Caracoles mine in the Quimsa Cruz region exemplify this condition in a very striking way. If those veins were not worked by a company with adequate financial resources to push through barren vein areas, they would have been abandoned long since, because repeatedly known ore shoots have terminated and only barren ground lay ahead. This feature of the veins would explain in part the shallow depth of so many of the Bolivian tin mines. Among the many outcrops of veins, those veins are chosen for exploitation that show an outcrop of workable ore. Such an outcrop represents an outcropping ore shoot. Within limited vertical depth, the ore shoot is passed through and unworkable leaner material is encountered below. The vast majority of Bolivian tin mines have been worked in primitive fashion with very limited capital. The operators have not had the equipment nor the means to conduct systematic prospecting through barren areas to find out what lay beyond or below an ore shoot. Consequently when an ore shoot was exhausted, many mines were abandoned and other outcropping ore shoots were sought. This condition would falsely suggest a relation between present surface and rich ore. To prove or disprove such a relationship requires more information than has been presented or is available. Stope sheets showing the size and distribution of ore shoots in the oxidized and primary zone and the tenor of ore and total metallic content of the shoots alone can furnish determinative data for the solution of this problem. Very few of the Bolivian tin veins have been extensively enough worked to be capable of supplying such data. In the case of only a few veins have such data been assembled. So far as I know such information has not been available to those who have discussed the distribution of the tin content of the Bolivian veins.

The geologic evidence of secondary cassiterite enrichment is not adequate to prove that it played an important part in the formation of the workable tin ores. It cannot be rated as doing more than supporting the possibility of its effectiveness and suggesting the desirability of closer consideration of other possible lines of evidence.

Mineralogical Evidence.—The tin-bearing minerals of the Bolivian tin veins are cassiterite, wood tin, and the sulphostannates. None of these minerals is exclusively of secondary origin, so that there are no tin minerals which are unequivocal evidence of downward enrichment.

[1] Kittl, E., "Zur Entstehung der Sulfostannate Boliviens," *Zeit. für prak. Geologie*, 1927, p. 187.

[1] Careaga, José M., "Estudio sobre la mina Chocaya La Vierga," *Revista Minera de Bolivia*, 1928, pp. 150–154, 193–203.

Though a secondary origin has been ascribed to the sulphostannates, it will be shown in the discussion of the textural evidence that there is almost unanimity of opinion in referring these minerals to the hypogene mineralization. Furthermore, as Koeberlin himself has pointed out more than once, the rôle of the sulphostannates is a subordinate one and the problem of downward enrichment involves the oxide of tin and not the sulphosalts. The statement of Ahlfeld [1] that Oruro primary stannite is always massive and intimately intergrown with other minerals and that the secondary stannite is pure and crystallized, even though accepted, has no practical bearing on the problem. Davy [2] says there is no evidence of secondary tin sulphides unless an unknown secondary mineral which he observed be a tin mineral. Greene [3] speaks of a secondary tin mineral in the oxidized zone at Llallagua but gives no description of it. Koeberlin [4] thinks the sulphostannates at Llallagua are secondary because marcasite is interlaminated with franckeite and associated with greenockite.

There has been a tendency to regard wood tin as of secondary origin formed by descending solutions, but many instances are now on record of its deposition by hypogene solutions. The fairly abundant occurrence of wood tin in Bolivia is consequently not necessarily evidence of supergene deposition, and there is considerable evidence to show that some of it was deposited by ascending solutions. Ahlfeld [5] says through decomposition of stannite, porous cassiterite or banded masses of wood tin can result. Davy [6] thinks the oxidized character of the material associated with wood tin suggests its secondary origin and derivation from stannite. He finds that it has probably replaced both crystalline quartz and cassiterite, two minerals notably insoluble in acid solutions. Hence he presents the difficulty that a pronounced change from acidity to alkalinity in the supergene tin-bearing solutions would have to be accounted for. Gruner and Lin suggest the slow solution of stannite as the source of the tin deposited in lower levels as wood tin. Kittl [7] considers the iron hydroxide content of wood tin as evidence of secondary origin and believes it is formed in the zone of oxidation. Again [8] he refers to its association with marcasite as evidence of its secondary origin. Whether cassiterite or wood tin is formed he thinks depends on the composition and temperature of the depositing waters.

It is not necessary to cite many examples of wood tin of hypogene origin from other regions. A notable example is that described by Knopf [1] in Nevada. Collins [2] has described wood tin from Durango with crystals of cassiterite on it and in cracks in it together with quartz, tourmaline, and chlorite. Their significance is that wood tin may be of hypogene origin and its presence in an ore cannot be accepted as proof of supergene transportation of tin oxide.

The only possibility of distinguishing between primary and secondary cassiterite would be because of differences in crystal form or other physical properties. Ahlfeld and Greene consider needle tin of supergene origin. Ahlfeld [3] regards needle tin evidence of secondary deposition from primary stannite or other sulphostannates. Greene speaks of needle or honey tin occurring generally on wurtzite and of secondary origin. The needle tin at Monserrat coats the other vein minerals and seems to be the last in the paragenetic sequence. But it is not associated with secondary minerals and is probably of late hypogene deposition. Winkelmann [4] describes needle tin at Uncia in pneumatolytically altered rhyolite in tourmaline zones and in cleavage planes of colourless mica. This must be of hypogene origin. Kittl and Koeberlin recognize secondary cassiterite because of associated minerals. Kittl [5] describes cassiterite from Huanuni associated with limonite and natrojarosite but concedes that the cassiterite may be the remains of an earlier pyrite-cassiterite ore. Koeberlin [6] cites the association of marcasite with cassiterite in the rich ore shoot of the San Fermin vein at Uncia with a limited downward extension. Since marcasite is a low temperature mineral, he does not consider the associated cassiterite primary. This is a rather dubious inference.

One is forced to the conclusion that there are no tin-bearing minerals in the Bolivian veins whose mere presence is evidence of secondary tin enrichment. Mineralogic criteria cannot be marshalled in support of important secondary tin enrichment in these veins.

Chemical Evidence.—It has already been pointed out that if secondary tin enrichment played an important rôle in the Bolivian tin veins the process involved mainly the solution, transportation, and redeposition of cassiterite. Let us test the probability of the effectiveness of such a process in the light of knowledge concerning the solubility of cassiterite.

The outstanding characteristic of cassiterite under usual conditions of rock decay and weathering is its insolubility and resistance to those influences. This is attested by the fact that over half of the world's tin production consists of placer cassiterite. Those constituents of ore deposits and rocks accumulate in placers that resist solution. This is very strong *a priori* evidence against the occurrence

[1] Ahlfeld, F., *Zeit. für prak. Geologie*, 1927, pp. 81-85; *Revista Minera de Bolivia*, 1927, pp. 145-157.

[2] Davy, M. W., "Ore Deposition in the Bolivian Tin-Silver Deposits," *Econ. Geol.*, vol. 15, pp. 463-496, 1920.

[3] Greene, G. U., "Solubility of Tin Minerals," *Eng. and Min. Jour.*, vol. 122, pp. 417-419, 1926.

[4] Koeberlin, F. R., *op. cit. supra.*

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

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

[7] Kittl, E., "Genesis de los minerales estanniferos de Bolivia," *Revista Minera de Bolivia*, 1926, pp. 1–24, 33-53.

[8] Kittl, E., *Revista Minera de Bolivia*, 1927, pp. 257-267.

[1] Knopf, Adolph, "Wood Tin in the Tertiary Rhyolites of Northern Nevada," *Econ. Geol.*, vol. 11, pp. 652–661, 1916.

[2] Collins, J. H., "Additional Notes on Wood Tin," *Mineralogical Magazine*, vol. 16, pp. 30–34, 1910.

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

[4] Winkelmann, H., "Beiträge zur Kenntnis der Zinnerzlagerstätten von Bolivien," *Zeit. für prak. Geologie*, 1927, pp. 97–112.

[5] Kittl, *op. cit. supra.*

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

of secondary cassiterite on a large scale. It must be recognized, however, that minerals which resist solution under certain conditions may succumb under other more favourable conditions. A very striking example of such a difference is cited by W. H. Emmons[1] in the case of gold. Gold is very resistant to solution and easily reprecipitated so that under ordinary conditions in veins it migrates with great difficulty. The consequence is that outcrops of gold veins are commonly removed by erosion more rapidly than the gold moves downward, and the gold accumulates in placers. Emmons found that manganese in the vein filling facilitates solution and retards reprecipitation, thereby making possible a more extensive downward migration of the gold. In such veins the descent of the gold may be more rapid than the denudation of the outcrop. No placers will be formed and the veins will be characterized by secondary gold enrichment. This marked difference in behaviour of gold in two neighbouring mines is illustrated by the Cable and Granite-Bimetallic mines in the Phillipsburg District, Montana.

[1] Emmons, W. H., "The Agency of Manganese in the Superficial Alteration and Secondary Enrichment of Gold Deposits in the United States," *Trans. Amer. Inst. Min. Engrs.*, vol. 42, p. 58, 1912.

(To be concluded.)

THE TREATMENT OF FINE LEAD-ORES AND CONCENTRATES

At the February meeting of the American Institute of Mining and Metallurgical Engineers, L. D. Anderson, of Salt Lake City, Utah, presented a paper on the handling of fine ores and concentrates in Salt Lake Valley lead smelters.

After outlining the advance in metallurgical technique introduced by the development of sintering, the writer points out that a new set of sintering problems are introduced by the changes in milling practice, particularly by flotation processes. As some help to the elucidation of these new problems he records the present practice at the Salt Lake Valley Smelters.

The greater proportion of the sulphides smelted are flotation concentrates. They are usually high grade, sometimes as high as 70% in lead, and are extremely fine, many mills grinding the ore so that from 60 to 80% is *minus* 200 mesh. The physical condition in which many of these concentrates reach the smelters is disconcerting. Some are of about the consistency of putty, others are of a sticky, slimy nature, while others are veritable powders. Remembering that the down-draft sintering charge for the best results must be porous enough to let air be drawn through it reasonably well, must be thoroughly mixed, and must have some coarse material in it to segregate out and form a layer on the grates, it will be understood that the advent of this extremely fine material has made necessary still further elaboration in the equipment and processes of preparing sulphides for the blast-furnaces. The high metal contents of the concentrates have brought about another difficulty caused by the incipient fusion of the lead which caused the material to frit together, close off the passage of air and end the roasting operation before the necessary amount of sulphur had been removed. In addition the resultant sinter was weak and friable so that the blast-furnaces which had been running freely with the old hard sinter from crude sulphides were choked.

Probably the biggest step in the solution of the problem came in the development of the "double roast," wherein, after a first rough sintering, the entire mass resulting is crushed and sintered again usually with an admixture of a small percentage of new material, both sulphide and oxide. This probably developed from the practice of screening the sinter and returning the fines to the charge for resintering. As the sinter from fine concentrates began to get weaker, the proportion of these fines became greater until finally the first sinter was returned for a second sintering, adding just enough new sulphides to bring the sulphur content up to a point where it would ignite again. It was found that the "pop corn" articles from the first roast were effective in opening the charge for the passage of air. The second sintering also brought the sulphur down in the final product to about half of what it was in the first sinter. The lumps of sticky concentrate which did not sinter the first time over, were at least dried so that they mixed better with the second charge. As observed in the Salt Lake Valley this second or double sinter is a better product than that which was obtained when fine concentrates were first sintered. It is still rather weak as compared to that made from crude sulphides. Two materials have from time to time been added to the charges to strengthen the sinter, namely crushed or granulated slag, and matte. Although these materials undeniably do strengthen the sinter, their use is not always an ultimate economy.

Reduction of the double sinter in the blast-furnace seems a little more difficult, as fairly high percentages of coke are used together with considerable scrap iron. The three smelters are using on the average about 13% of a by-product coke running 85 to 87·5% fixed carbon. At times the amount used is as low as 12%, or less, and occassionally up to 14% or more. The amount of scrap iron used on the charge has considerable influence on the amount of coke found necessary for good reduction. High blast pressures prevail generally. In fact, the Murray plant uses pressures which are said to reach at times heights twice as great as those considered safe a few years ago. Tooele has been using a blast pressure of 44 oz. per sq. in. and Midvale about 48 to 52 oz., measured at the blowers. Murray operates on the principle of a fixed amount of air per minute letting the blast pressure go where it will, within bounds. This is somewhat the practice at Midvale although there the maximum is limited to 52 oz. At Murray, it is stated, it has gone to 60 and 70 oz., and even more, momentarily. This is an innovation when compared to the old practice of keeping the pressure fairly uniform, regulating the quantity to so maintain it. Ten

years ago the blast pressures were more commonly in the neighbourhood of 36 to 42 ounes. Piston blowers are used to obtain these pressures, cycloidal blowers having too great a slip. The reason for this is that a charge composed mainly of sinter, which is weak and friable though porous, the blast-furnace charge column now has a multitude of small passages for the blast instead of the comparatively smaller number of larger passages existing in the days of strong sinter in large cakes. While the actual amount of air per ton of charge is probably no greater, if not less, than in former days, nevertheless the resistance is very much greater, hence the higher pressures. These higher blast pressures although difficult to handle, together with the higher percentages of lead on the charges, have naturally resulted in fast running and new records in tonnages per square foot of hearth area. Without taking into account the so-called " concentration " charges for resmelting matte, which always ran extremely fast, the present rate of smelting is 5 to 6 tons of charge exclusive of coke, per square foot of hearth area per 24 hours. Five tons is about the general average from day to day, without allowance for lost time. At times when the furnaces have become well " crusted up " the rate is not so good. On the whole, however, there has been a gain in speed. This plus the higher percentage of lead on the charges, has in turn brought about a rapid running of bullion from the lead wells. The furnaces need close watching, for if they do start channelling or blowing through, the effect is rather startling. Nevertheless they run surprisingly quietly with the high blasts.

At the Tooele smelter of the International Smelting Co. all lead plant roasting is at present done on 10 Dwight-Lloyd machines, four of which are used for the first or rough roast sinter and six for the finished sinter. The proportioning of the charges is effected in the conventional manner by individual feeders from the respective bins, all discharging on to one common belt conveyor. Most of these feeders are of the revolving disk, or modified Challenge, type. For sticky concentrates, however, rubber belt feeders have been installed under separate auxiliary hoppers. Concentrates drop into these hoppers from the overhead bins. By this means an opening is left between the hoppers and the bins through which a pokebar can be manipulated to bring down the concentrates when they hang up in the bins above. This pokebar is a piece of pipe attached at one end, through a valve, to a length of air hose, making it possible to use compressed air to further assist in dislodging hung-up material. The first conveyor collecting material from the feeders discharges into a large mixer. This is like a flat inverted frustum of a cone. Four arms driven by bevel gears and having ploughs mounted in them turn the charges over and work them into the central discharge hole through which they drop on to the conveyor belt leading up into the sintering building proper. A third conveyor belt distributes the charges into the respective machine hoppers by means of a travelling tripper. From these hoppers the material is fed on to the machines by adjustable revolving disk feeders. A reciprocating swinging chute distributes the charge uniformly across the width of the sintering machine pallets. This same device is used at the Midvale plant of the United States Smelting, Refining and Mining Co.

For ignition all three of the valley smelters use a furnace fired with coke breeze and supplied with a gentle blast of air. The uptake of this furnace makes a complete 180° turn, discharging the gases of combustion downward on the moving bed of charge on the sintering machine. This furnace has proved useful in getting a good ignition of the charges, being in fact much better than the oil-fired muffles originally used. The entire first sinter is taken to the sulphide mill in railroad cars and crushed down to $\frac{1}{4}$ in. to $\frac{3}{8}$ in. size. After this crushing it forms about 70% of the second or finishing sinter, the remaining constituents of which are about 10% siliceous diluent, 10% crude sulphides and 10% miscellaneous. On discharging from the machines the sinter drops over a grizzly with $\frac{3}{8}$ in. openings into railroad cars for transport to the blast-furnace charge bins. The return fines through the grizzlies go back to the first or rough sinter where they are of benefit in opening up a charge which would be otherwise fairly dense, composed as it is of flotation concentrates, both oxide and sulphides, dust from the Cottrell precipitator, fine diluent, etc. The first sinter charges run about 12½ to 13% sulphur and are roasted down to about 6%, while the finishing charges run about 9½% sulphur and are roasted to as low as 1·7%. The importance of getting the finished roast as low as possible in sulphur so as to keep the matte fall from the blast-furnaces low is self-evident. The ores received at the valley smelters generally have present appreciable percentages of copper so it is not feasible to eliminate the matte fall entirely as is done in some other districts.

At the Murray plant of the American Smelting and Refining Co. three Dwight-Lloyd machines are engaged on rough pre-sintering and four on finish sintering. The entire product of the first three machines falls on a chain type pan conveyor which carries it to a pair of Linkbelt toothed rolls, from which the crushed sinter is conveyed to a pair of straight face rolls. After rolling to about $\frac{3}{8}$ in. size or smaller product goes to bins from which it is fed out as the principal ingredient of the second sinter. Some of this first sinter is used also as diluent on new charges of first sinter. Belt feeders from the respective bins discharging on to one main conveyor are used to proportion the charges which are conveyed to conical hoppers over the sintering machines. Under these hoppers are horizontally revolving tables acting as both feeders and mixers through the action of stationary ploughs, which turn over the material and work it to the edges of the plates and then down on to specially shaped chutes to spread it over the pallets. At an intermediate point in the conveyor system, where direction changes, one conveyor drops the charges through a Steadman disintegrator. This machine, originally installed to break up lumps of concentrates, has proved to be also an excellent mixer. Its action plus that of the horizontal mixer tables puts the charges on the machines in a condition approaching the ideal state of thorough mixture. Multiple-hearth roasters of the Wedge type are used to pre-roast high-sulphur concentrates, such as pyrite, before submitting them to the sintering treatment. These iron concentrates are particularly troublesome to sinter, making weak cakes unless mixed in the proper proportions with other material of better sintering qualities. Dusting

was particularly troublesome on these roasters until the adoption of a mechanism for moistening the calcines as they were discharged. One detail of practice at Murray which has been helpful in the handling of the troublesome flotation product is the manner in which it is bedded with crushed crude sulphides in the unloading bins before transport to the charge bins of the sintering plant proper. By this means the drier and coarser crushed crude sulphides add their characteristics to the wetter and finer flotation concentrates resulting in a mixture which can be carried on the conveyor belts to the charge bins and out on the feeder belts without too much trouble. However, even this expedient does not insure against the appearance of lumps of concentrate which would cause much difficulty were they not broken down by the Steadman disintegrator previously mentioned.

At the Midvale plant of the United States Smelting, Refining and Mining Co. there are one McDougal and five Wedge furnaces and six sintering machines. High-sulphur concentrates, such as pyrite, are given a pre-roast on the former, the sulphur being brought down to around 12 to 18%. With the fine concentrates are mixed certain plant by-products such as speiss, etc. Rough bedding together of these materials, somewhat as at Murray, lessens the difficulties of keeping the fine material moving. Most of these furnaces have belt feeders, but feeders of the apron type such as installed on the McDougal furnace are more positive in their action on fine concentrates. Regardless of what type of feeder may be used close watch of the bins must be maintained to guard against hang-ups. The calcines were formerly very troublesome on account of the dust. This difficulty was overcome by taking off a spray from the water-cooling system of the revolving arms on the bottom hearth, thus making this a moistening and mixing floor rather than a roasting hearth. The calcines treated in this manner cause no further special difficulty in handling beyond that inherent in the poor sintering qualities of high-iron concentrates. From the calcine bins into which this material is carried by conveyor belt from the multiple-hearth roasters it is transported in V-body tilting cars to the charge bins of the sintering plant. The same cars also haul the other ingredients of the sintering charges from the sampling mill reject bins where they are unloaded. The siliceous fines used for diluent are ordinarily screened from the oxidized ores as they pass through the sampling mill and are distributed by a travelling belt tripper into composite beds in the sample mill bins, beneath which run the V-body cars. The charge bins at the sintering plant therefore draw their supplies from two sources, the pre-roast calcine bins and the sample mill reject bins. Belt feeders under the respective bins discharge on to one common belt, which delivers the proportioned charges to the bins over the sintering machines. A weighted roller riding on this main conveyor at a point where there are three closely spaced straight idler rollers underneath gives some assistance in breaking down lumps. From the sintering machine bins the charges are drawn out by rubber belt feeders and dropped into cylindrical revolving barrel mixers, 20 in. dia. by 5 ft. long. These mixers, driven through bevel gears, slope downward toward their discharge ends at about $2\frac{5}{8}$ in. per ft. Interior lifting rabbles were tried but finally discarded. These mixers have done quite well. Midvale has been compelled to adopt the double sintering plan. The details of practice are not set hard and fast, varying with the materials to be dealt with. Grizzlies in the discharge chutes are not used at present. The first sinter, discharged into railroad cars, is hauled to the sampling mills and crushed to about $\frac{1}{4}$ to $\frac{3}{8}$ in., and then brought back to the charge bins to be proportioned out as the principal constituent of the second or finishing sinter. It is frequently used over again, in small part, as diluent for a new first sinter. Sulphur in the first sinter charge runs about 12 to 13%, being roasted down to 6 or 7%. The second sinter charge runs about 9% and is roasted down to about 3 to 4%. Discharged into railroad cars without screening it is hauled to the blast-furnace charge bins.

This outline of the practice of the Salt Lake Valley smelters in sintering does not give a full picture of the difficulties encountered in handling fine ores. The greatest change in practice and undoubtedly the most helpful is the double roast or sinter. But the fact remains that the concentrates have to be roasted two, three or more times before they are fit for good reduction in the blast-furnaces. Direct reduction of high-grade concentrates with scrap iron in reverberatory furnaces has been discussed but does not as yet seem quite practicable. The very high grade of some of the flotation concentrates has directed attention to the possibilities of reduction on the Scotch hearth. However, for this work the grade must be maintained at 70% and better, which is not regularly possible. Furthermore, some experimental work along this line appeared to indicate that troublesome dust problems would occur. If a stronger final sinter could be obtained a lower blast could be used. Perhaps a saving feature in connexion with the smaller sinter obtained is the small by-product coke now used. The two mix together fairly well making a sort of thick porous mat which takes air more uniformly through the general mass than the old charges of solid ore and large coke, although at the expense of high pressure and the liability to burst through in case of any uneven charging.

An element which influences the difficulty encountered in handling flotation concentrates is the percentage of moisture in them. A difference of 2 or 3% makes a surprising difference in the workability of the material. The more closely this can be controlled the more easily can the sintering charges be handled. Mills with inadequate filtering capacities send in wet, slimy material which is a bugbear. Some well-filtered concentrates move surprisingly well. At the other extreme are concentrates which have been fairly well filtered and then given an air-drying under a hot sun, resulting in baking the material together in lumps which actually required crushing before they could be sintered. Since it must be admitted that it is difficult to control the moisture at the mills the smelters assumed the duty of taking everything as it came. One plant reports that by carefully regulating the moisture in the charges as compounded for the sintering machines considerable improvement in the strength of the product has been effected. From $7\frac{1}{2}$ to 8% moisture on the first sinter and from 5·8 to 6% on the finished sinter appear to give the best results.

NOTES ON MALAYAN TIN-DREDGING PRACTICE

At a meeting of the Malayan Tin-Dredging, Mining, and Research Association held on April 24, A. J. Kelman, general manager of Malayan Tin Dredging, Ltd., read a paper on Tin-dredging in Malaya.

The author said that dredging for tin in the Federated Malay States is quite a recent method of winning tin, the first dredge starting work in the latter part of 1912. That dredge was the Malayan Tin No. 1. This machine is still in operation and it is only necessary to compare it with the latest Southern Malayan dredge to note the wonderful improvement that has taken place in that time. Some improvements have resulted from local experience, but others have been taken from the experience gained on the large gold dredges working in California. Although these gold dredges have become very efficient, they would not be entirely satisfactory working in the average class of ground in Malaya.

Most dredges in California are digging a very heavy gravel wash which requires more power than the average Malayan ground, but in most cases they are working on a soft bottom. On account of the heavy ground and the large capacity buckets employed a much larger digging motor is required. A dredge equipped with 18 cu. ft. buckets and digging 80 ft. below the surface requires about a 600 h.p. bucket motor, and consequently it was found impossible to get head lines of a reasonable size to stand up to the strain, so that some other method of keeping the dredge up to the face had to be devised. Eventually a spud was designed for this purpose and the speaker believed that most dredges in California are equipped with spuds.

The speaker knew of no case in Malaya where spuds were used, but did not think they would be suitable except when working on a soft bottom, as when working on an uneven limestone bottom they would be too rigid. A few of the advantages of spuds were :—

(1) They keep the buckets up to the working face, thereby avoiding trouble with head line backers pulling out.

(2) When working ground with heavy timber there is not the same trouble as with head lines, which are continually getting caught in stumps, etc.

(3) There is less danger of the buckets coming off the lower tumbler.

When working on a spud dredge it is necessary to use a stacker otherwise it would be impossible to dispose of the tailings. Fig. 1 shows the digging and the stacking of tailings on a spud dredge. The spud is fitted to the dredge at the stern of the pontoon near the position marked A, and the dredge when working pivots on this point. The buckets swing through the arc BC and cut a face in the form of a semi-circle, the stacker swinging and dumping the tailings between the points DE. The length of the stacker required depends on the class of ground being worked, whether the dredge is working a high face, or working in swampy ground.

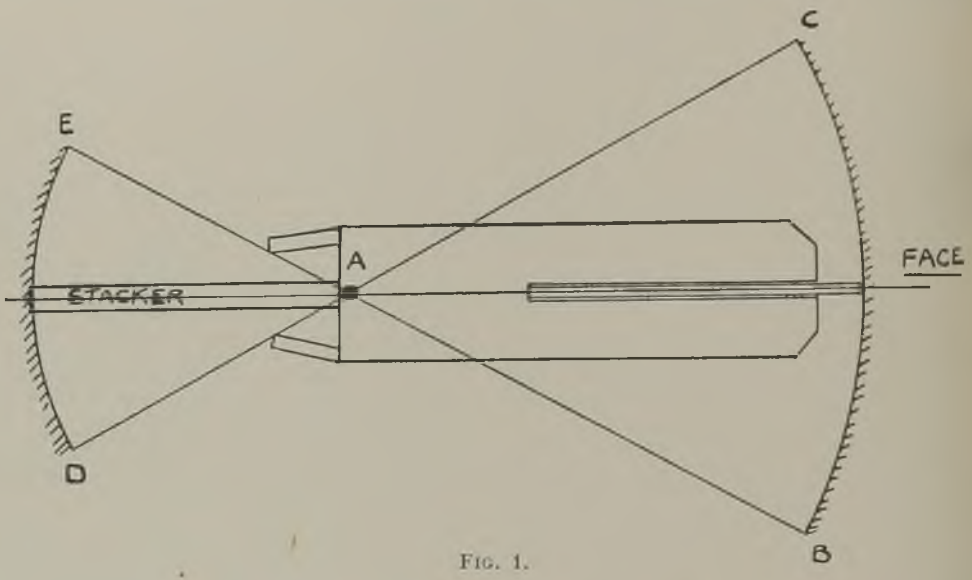


FIG. 1.

On a head line dredge the buckets come off the lower tumbler much more easily than on a spud dredge. When working with a head line it is not always possible to keep the bucket ladder in a straight line with the head line, whereas the ladder on a spud dredge is always in line, also the spud is practically rigid and the dredge cannot swing back. compare Fig. 2. When the dredge is digging out the corner of a paddock it is usually necessary to angle the dredge, and this is sometimes necessary when working swampy ground in order to concentrate the tailings behind. If, when working a dredge with a head line on the angle the slack of the buckets were to catch on a pinnacle, the buckets would almost certainly come off the lower tumbler. The head line has always a certain amount of give, which allows the dredge to swing back a few feet, with the result that it swings back more or less sideways, the buckets being pulled hard to one side and led up on to the flange of the lower tumbler.

When cleaning up the bottom the ladder should be kept as straight as possible in line with the head line. In swampy ground it is usually possible when stripping down to the pinnacles, to angle the dredge sufficiently to concentrate the tailings behind, and the small amount of material that is dug when cleaning bottom does not affect this to any extent. Care must be taken in selecting positions for head line backers when working swampy ground, as only by correct placing is it possible to keep a bank of tailings behind the dredge.

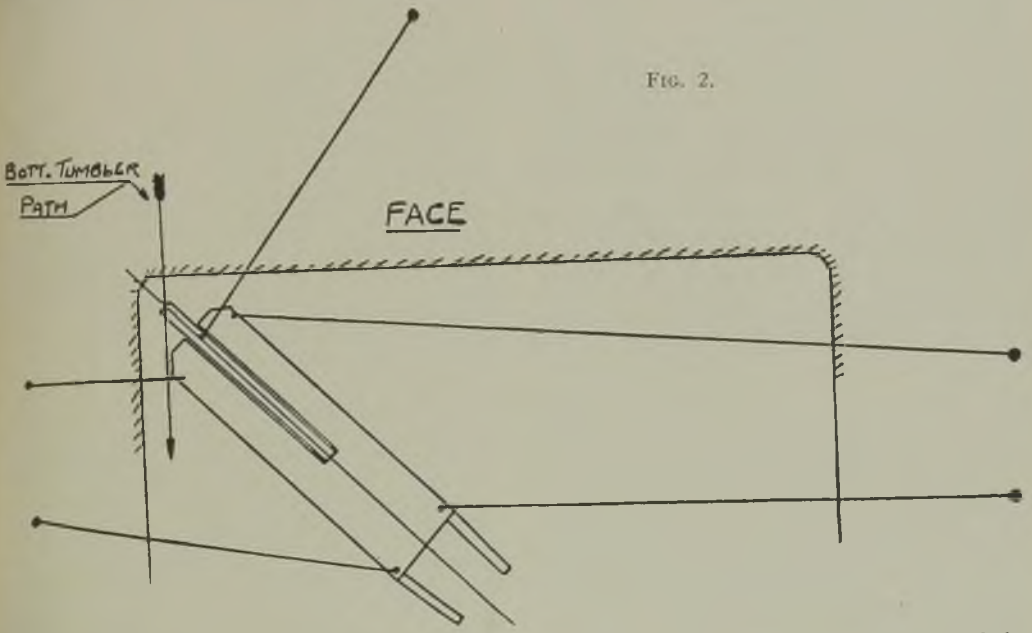
One of the principal improvements that have been copied from the Californian dredges is the use of cast manganese-steel close-connected buckets. Some dredging engineers are opposed to the close connected type, but engineers are in general agreement that the manganese bucket is superior to the old fashioned built-up type. One objection advanced against the close-connected type is the amount of spill when tipping on the top tumbler, but when a bucket idler is installed this is not serious. The reason this is fitted on a dredge is to keep the drop chute out as far as possible under the top tumbler to catch the maximum amount of the spilled material, when the buckets are tipping. A large saveall chute may also be fitted when an idler is installed, and by this means everything can be caught and nothing can drop down the well hole. The use of bucket idlers is standard practice in America.

Another improvement on Malayan dredges in the last few years is the installation of the Hartz jig. The first tin dredge to fit this jig was a small one erected in Portugal some years ago. This machine had four small two-cell jigs, but was not altogether satisfactory.

A few years ago the Yukon Gold Company came to Malaya, and found that the largest capacity machine working here was somewhat about 100,000 cu. yd. per month, also that this size was governed by the concentrating capacity of the dredge. Experiments were conducted, and the late Mr. Newsom patented the Newsom classifier and jig system on dredges. The industry is greatly indebted to him for this great step forward in the concentrating of tin on dredges. A number of dredges installed this system, but after a trial it was found that the jigs would work equally well without the use of the classifier, the perforated screen being sufficient classification for this purpose. It has been proved from experience that dredges fitted with jigs can treat much larger yardages with a much better recovery.

In the past much dredging work in Malaya was carried on in a very slap-dash method ; now depth charts record the depth of each cut and other information to be entered in the log sheets. This information is a great help to the management. The depth chart, for example, enables the dredge-master to know exactly what yardage is being cut from day to day and whether the winchmen are getting the best out of the dredge, also who are the best winchmen. The chart is also invaluable to the winchmen as from it they learn the contour of the bottom of the previous cut and when they are likely to come up against limestone pinnacles, etc. The intelligent study of these charts gives most valuable information to everyone in a responsible position on a dredge.

FIG. 2.



A number of rules and regulations are posted up on every dredge and generally they are there for the prevention of accidents. It is important for the responsible men on the dredge to see that these rules are observed. It must be remembered that probably 80% of the coolies on a dredge can neither read nor write, so the mere fact of posting rules and regulations in a prominent place is not sufficient, all of them should be explained through the Kepalas.

In the case of a serious accident the dredge-master should be called, but pending his arrival certain precautions should be taken :—

(1) In the event of the *bucket band parting* the buckets usually run off the top tumbler and the end drops down the well hole, the other end is, as a

rule, somewhere on the ladder, but it may be under water; on no account must the ladder be lifted until that end is made secure. The head line should be tight and the point of the ladder pulled hard into the face. If the buckets are showing above water they should be made fast to the ladder as soon as possible. If they are not above water steps must be taken to find out where they are and make the end secure. If the buckets are allowed to drop off the end of the ladder and both ends are lost especially when working in deep ground, it may be impossible to recover them except at enormous cost.

(2) *Ladder Line Breaking.* This may be a serious accident, especially on dredges with very long ladders; one of the worst things that may happen in an accident of this kind is for the line to come out and jamb between the sheaves. The first thing to do is to secure those ends of the line that are available and prevent any more line running out of the sheaves; if there is sufficient line left in the sheaves it may be possible to lift the ladder, but, if not, extra tackle must be fastened to the ladder to assist. If a line comes out of a sheave and gets jammed, the ladder can usually be lifted by uncoupling the dead end and heaving from both ends at the same time.

(3) *Breaking of Ladder Hangers.* Apart from the actual sinking of the dredge this, in some aspects, is the most serious accident that can occur on dredges with very long ladders. In this case it is impossible to do any lifting on the hangers and the usual way is to drop strops as far as possible down the ladder and heave from that point. The ladder hoist blocks would be available for this purpose.

(4) *A Sinking Dredge.* A dredge is very like a ship except that it has a flat bottom, and much less freeboard. On board ship one of the crew is told off to examine the various compartments at regular intervals and see that it is not making any water; it is just as important, if not more so, to do the same thing on a dredge. The most dangerous part of the pontoon is in the well, as when lifting the ladder it is possible that a log of wood may get caught between the side of the ladder and pontoon, and tear off a chafing iron or spring a joint. When lifting the ladder it should always be seen that it is quite clear and nothing is jammed in the sides. There have been cases where ladders have been broken due to heavy logs floating about a few feet under the surface, and getting across the well hole under the pontoon. Should the winchman find the ladder very heavy to lift when it is down he should immediately investigate, as a timber across the well hole may be the cause of the trouble. On electrical dredges the ammeters are placed in such a position that the man working the motor can always see what load is being taken and should know at a glance when the motor is exceeding the power necessary.

In conclusion the necessity of cutting down stoppages to the absolute minimum, should be emphasized. The loss to the company when a dredge is not working is very large. For example, a dredge may be recovering 600 piculs of tin ore working 600 hours per month. For every hour that the dredge is stopped one picul of ore less is recovered. Assuming the price of tin to be £220 per ton, which is equivalent to $66 per picul, and the cost of wages on a large dredge to be $10 per hour, this would mean a loss of $76 for every hour that the dredge is stopped. To reduce stoppages to a minimum it is necessary to look ahead. Tools should be kept in readiness so that no time is lost when the dredge does stop.

TIN IN BRITISH COLUMBIA

In the *Canadian Mining Journal* for July 5, there is an account by Victor Dolmage (late of the Canadian Geological Survey) of the occurrence of stannite in the Revelstoke district, British Columbia. The vein has been under development for some time by the Snowflake Mining Company who hoped to discover workable shoots of silver-lead-zinc ore. On the surface the vein is exposed by open cuts, short tunnels and natural outcrops over a distance of 700 ft. and consists of quartz with small bodies of silver-lead-zinc ore.

Last year a long cross-cut was started with the object of cutting the vein at a depth of 600 ft. and a distance from the portal of 900 ft. At the point where this tunnel cut the vein it was found to contain considerable amounts of galena, zinc blende and a dark grey mineral closely resembling tetrahedrite, and assays indicated high silver values. At the suggestion of F. W. Guernsey, Consulting Engineer to the company, the grey mineral was tested by G. S. Eldridge & Company. On finding no antimony a qualitative analysis was run by Mr. Eldridge, who discovered the presence of tin and copper and classified the mineral as stannite. The mineral has since been tested by the Division of Mineralogy of the Geological Survey of Canada whose determinations agree with those of Mr. Eldridge. Later, stannite was found in almost all of the workings and in places is present in large quantities. At the invitation of Mr. Guernsey the writer accompanied him on an examination of the property.

Reports on the property were published in a special publication issued by the British Columbia Bureau of Mines at the end of 1928 entitled "Reports on the Snowflake and Waverley-Tangier Mineral Deposits."

The geology of an area lying immediately south of the deposits was reported on by R. A. Daly in Memoir 68, issued in 1915 by the Geological Survey of Canada. The geology of a much larger area, including that mapped by Daly and also the Snowflake and other deposits, was mapped in 1928 by Dr. H. C. Gunning of the Canadian Geological Survey and will be published at an early date in part "A" of the Survey's Annual Summary report for 1928. The writer is indebted to Dr. Gunning for access to his maps and report from which much of the following information pertaining to the geology of the deposits was obtained.

The vein is one of a number of large and persistent parallel quartz veins which can be traced for several miles along the steep mountain sides of this rugged district. It outcrops at elevations of 5,500 to 6,000 ft., 6 miles due north of a point on the main line of the Canadian Pacific Railway 20 miles east of Revelstoke. It is reached by a good horse trail which leads to the foot of a precipitous slope 1,000 ft. below the camp up to which passengers and freight are raised in a skip drawn by a gasoline driven hoist.

The veins occur in black, highly carbonaceous, in places graphitic, argillites. These are part of a thick series of quartzites, greenstones, argillites

and limestones which occupy almost this entire region and are part of a still larger group of metamorphosed rocks known as the Shuswap series, which is widely distributed in British Columbia and considered to be of pre-Cambrian age. According to Gunning the argillites which enclose the veins are underlain by the quartzites, greenstones and limestones and the whole series folded into a close syncline overturned to the southwest and plunging to the southeast.

South of the deposits, in the neighbourhood of the railway, the steeply folded sediments are intruded by a vast number of parallel sheets of granitic rock. Besides these intrusions, which are confined largely to the lower members of the series, Dr. Gunning found also many small stocks of granitic rock which cut the argillites as well as all the other members of the series. Two of these granitic stocks are situated 5 or 6 miles to the north of the tin deposit and another 8 miles to the south, while the lit par lit injections come within 3 miles or less of the deposit. All of these granitic rocks are similar in appearance and consist of granite, granodiorite, and quartz diorite, differing from one another only in the amount of orthoclase and in the kind of plagioclase present. Many of the parallel injections are pegmatitic in character and in some of them Gunning found, along with the orthoclase, microcline, and mica, small amounts of beryl thus proving their true pegmatitic character. Contrary to Daly's interpretation, Gunning considers all these intrusions to be much younger than the sediments and would classify them with the Mesozoic intrusions of similar composition which are widely spread throughout the province. This interpretation is well established and accepted by the present writer as substantially correct. The presence in the area of so many intrusions of closely related, granitic rocks, strongly suggests the probability of the presence at considerable depths of a very large body of similar rock, of which the smaller intrusions are mere appendices and which was probably the source of the solutions which deposited the tin and other metals.

The main veins are parallel to the bedding of the sediments which strike northwest and dip from 30° to 60° to the northeast. The veins vary from 3 to 15 ft. in width and usually contain near their margins sheet-like inclusions of argillite which make their widths rather indefinite. For example, in No. 3 tunnel the tin vein consists of 5 ft. 10 in. of quartz, 3 ft. 2 in. of argillites and 5 ft. 7 in. of mixed quartz and argillite. Large portions of the veins are devoid of metallic minerals, though in other places pyrite, galena, zinc blende, etc. are abundant, either in solid streaks or disseminations.

In all the veins quartz is the only gangue mineral. The metallic minerals are pyrite, galena, stannite, zinc blende, tetrahedrite, scheelite, wolframite, ruby silver (proustite), chalcopyrite and native silver. Chalcopyrite and native silver are present in only minute quantities and are visible only under the microscope. In the No. 1 vein on the Snowflake property stannite is present in almost all the exposed parts of the vein where other sulphides are present, and in the newest workings, extending from the long low-level tunnel, it is very abundant. In a raise, which, at the time of the examination was up 80 ft. from a drift east of the main tunnel, it is more abundant than any of the other sulphides except pyrite. The vein in the raise is from 4 to 7 ft. wide and in places it appears to contain as much as 10% or more stannite. At the time of the examination tin had not been discovered in any of the other veins of the district, but since then stannite is reported to have been found in other veins on the Snowflake and also on the Regal Silver property.

Under the microscope the stannite can be seen to contain numerous small rounded particles of chalcopyrite in places so abundant as to give the stannite a bronze-like colour. This is a feature common to stannite from other parts of the world. Small amounts of ruby silver and a few specks of native silver were observed in the stannite. Ruby silver was seen also in specimens examined by Dr. Gunning. An analysis of the stannite by G. S. Eldridge gave: tin 26%, copper 31%, iron 3%, sulphur 29% and tests for silver showed it to be present in considerable quantity. As pure a piece of stannite as could be selected was analysed by E. Poitevin of the Division of Mineralogy of the Canadian Geological Survey, Ottawa, with the following results: tin, 26·65%; copper, 31·55%; zinc, 7·72%; iron, 3·65%; sulphur, 29·76%.

In the rich section of this vein scheelite and wolframite are present in small amounts. The most remarkable feature of the vein, in which respect it differs from all other known tin bearing veins, is the entire, or almost entire, absence of cassiterite. None has yet been positively identified in this vein, though small black crystals resembling cassiterite were observed in certain of the polished sections of stannite but have not yet been identified with certainty. It is possible that at greater depths this most common tin mineral may be found.

The order of deposition of the minerals in the vein was not readily apparent even from the microscopic study. The wolframite and scheelite crystals are intergrown with each other in a manner which indicates that they were deposited simultaneously. The sulphides are, in the main, later than the quartz but appear to have all been deposited during the same general period of mineralization. The ruby silver occurs in small veinlets in the stannite and is probably of slightly later origin, but neither it nor the native silver appears to be of supergene origin.

In their composition and geological associations these veins resemble more closely than any others the tin-silver veins of Potosi, Bolivia. Both are in old slates or argillites associated with comparatively young granodiorites and granites. All the metals and nearly all the minerals present in the Snowflake vein are also present in the Bolivian veins and, while many other minerals have been found in the Potosi veins which have not yet been discovered in the Snowflake deposit, it is very probable that some or all of these will be found as it is further developed. The differences which stand out at present are the absence of galena at Potosi and the absence or great scarcity of cassiterite from the Snowflake.

The Refining of Magnesium.—In *Chemical and Metallurgical Engineering* for June, H. A. Bakken of the American Magnesium Corporation, describes a method of obtaining magnesium of high purity by sublimation.

Commercial magnesium is produced by electrolysis of fused magnesium chloride. This

salt of high purity can be obtained from certain salt deposits. The metal is also produced by electrolysis of calcined magnesite in a fused electrolyte of fluorides. The purity of the metal produced by these processes depends primarily upon the purity of the raw materials employed; but under certain conditions it may not be feasible or even desirable to employ pure raw materials. For this reason a process has been developed to purify metal made from a relatively impure and therefore cheaper ore. It may be mentioned that such a process of purification is of value also in the recovery of scrap metal.

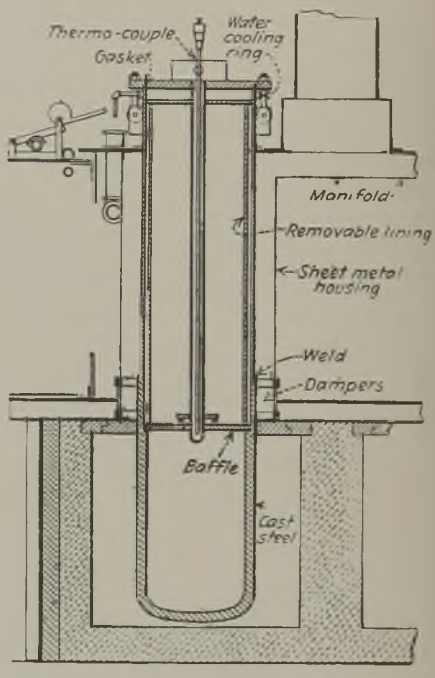
Magnesium has a relatively high vapour pressure and this property suggested purification by distillation. According to the estimated values of Johnston (*Ind. Eng. Chem.* v. 9, p. 873, 1917), magnesium has a vapour pressure of 100 mm. at 920° C. At 860° C. the vapour pressure is 50 mm. of mercury, while at 620° C. the vapour pressure is 1 mm. Therefore, if magnesium be heated to a temperature above its melting point, 651° C., in a closed container, under reduced pressure, distillation of the metal will occur. If a suitable arrangement of retort and condenser be provided the metal vapour will condense to a liquid of high purity.

In the operation of the distillation process (U.S. Patent No. 1,594,345, Aug. 3, 1926) it was found that crude or impure metal having a total magnesium content of 90 to 95% could be converted into a product with a purity of 99·99% magnesium. An operating procedure was worked out to permit of continuous operation by charging metal into the retort at intervals through a vacuum lock arrangement, and similarly at intervals tapping off the condensed molten liquid into moulds contained within a vacuum chamber. In this manner the purified metal could be produced in ingot form without oxidation or the formation of air reaction products.

The distillation process, however, proved expensive and in addition there were difficulties in keeping the low residual pressures necessary in the retort, condenser and tapping chambers, and also in maintaining correct temperatures in the system. Certain results led to the consideration of the possibility of substituting a sublimation process (U.S. Patent No. 1,594,344, Aug. 3, 1926). This process operating at a lower pressure, at temperatures below the melting point of magnesium, reduced the expensive wear on plant and larger units were permissible.

The accompanying figure is a longitudinal cross-section of a single unit in a battery of sublimation retorts. Supported vertically in a suitable structure is the metal retort comprising a cast-steel boot welded to a thinner wrought-iron condenser. The open end of the retort may be closed by a quick-acting cover. A gasket is employed between the cover and retort. It has been found necessary to water-cool the joint in order to maintain a satisfactory vacuum within the unit. Within the condensing end of the retort a closely fitting, removable lining is provided upon which the condensed metal deposits. The lining is split longitudinally in order to facilitate removal of the deposited magnesium.

In operation each retort is charged with metal to be refined, placed in a furnace, and connected to a vacuum line. The retort for approximately one-third of its length is heated in any suitable manner, preferably by a well-distributed gas flame. The upper part of the retort, which serves as a condenser, is surrounded by a sheet-metal housing, having dampers at its lower end and connected at its upper end to a manifold. Control of the condenser temperature is obtained by the amount of damper opening. The temperature of rapid sublimation may vary from approximately 300° C. at 0·001 mm. pressure to 651° C. at 2 mm. pressure. Experience has shown that successful operation consists in heating the charge to a temperature of approximately 600° C. for a period of from 5 to 6 hours under an absolute residual pressure within the condenser of approximately 0·5 to 0·15 mm. of mercury. Under these conditions the evolution of vapour will be rapid. If proper condensation facilities are provided the rate of sublimation within limits will depend upon the quantity of heat applied to the metal in the retort.



LONGITUDINAL CROSS SECTION OF SUBLIMATION RETORT.

It is essential that the temperature in the condensing area be below that of the metal being sublimed, since the difference in vapour pressure resulting from this difference in temperature is the driving force which causes the rapid transfer of magnesium vapour from the subliming to the condensing end of the system. As indicated above, in order that the temperature at the condensing end of the retort may be varied, dampers are provided to control the quantity of cold air passing around the outside of the condenser. Very satisfactory temperature control may be accomplished in this manner.

Under the conditions outlined, magnesium does not melt but passes directly from the solid to the vapour state. The vapour rises to a cooler position where it condenses on the lining in the form of a coarsely crystalline aggregate. When the charge of metal has been sublimed (which can be determined

by tabulating the average temperature, amount of charge, and time, or perhaps more simply by noting a sharp temperature drop in the condenser), the retort unit, after having been sealed under a vacuum by a suitable valve arrangement, is removed from the furnace and allowed to cool. The retort is then opened, the condensate and residue removed, and the retort is recharged. In operation a group of units is carried through the cycle—i.e., while one group is being cooled a second group is being charged and a third group is being heated.

During sublimation the materials of the charge having a higher boiling point, such as iron, aluminium, and silicon, remain behind as a residue. Very often, however, impure magnesium may contain metals which are volatile under the conditions of operation. In actual practice it has been found possible to effect a separation of volatile metals. If sodium-containing metal, for example, be refined, the more volatile sodium will, during the process, rise to a cooler position in the condenser than will magnesium vapour. Under suitable conditions of temperature control a deposit of sodium somewhat contaminated with magnesium will be found separated from the main body of deposited magnesium. In general it can be said that the degree of separation will depend upon the difference in boiling points of the metals under consideration.

Magnesium purified by sublimation is substantially free from metallic impurities, as illustrated by the following analysis: Silicon, 0·003%; iron and aluminium, 0·007%; magnesium by difference, 99·99%. The purity shown compares very favourably with the purest obtainable zinc, tin, copper, aluminium, and iron. Because of the absence of reactive gases during the process, the deposited mass is free of admixed oxides or nitrides. In addition, magnesium so purified is free from non-reactive but soluble gases, as, for example, hydrogen.

Geological Surveys in the Crown Colonies.—In his presidential address to Section C of the British Association for the Advancement of Science, Sir Albert E. Kitson dealt with "The Utility of Geological Surveys to Colonies and Protectorates of the British Empire." After touching on the history and benefits of such surveys he proceeded to their functions, and we quote his remarks in full herewith.

In considering this kind of geological survey it should be remembered that it differs greatly from the geological surveys of old countries in the mode of operations necessary.

The fact that it functions in a young undeveloped and comparatively unknown country, probably devoid of detailed maps, and with poor and slow means of transport, compels it to adopt methods and undertake duties entirely foreign to surveys long established. These surveys are able to place at once, on accurate maps, while in the field, the geological features of any district that is being examined. The geologist of the Colony, however, has not the great benefit of such maps, nor usually any reliable maps with good contours, and so, where field mapping in detail has to be done, or special areas surveyed, a ground-work map has to be made by himself. The collection of all information and the preparation of the topographical map involve the expenditure of by far the greater portion of the time, labour, and expense of such a survey. This may represent upwards of four-fifths of the time in certain types of country, the geology of which is not of great variety. When comparing, therefore, the character and production of maps and reports of a young colony with those of Great Britain, due allowance should be made for these different conditions.

Opinions differ as to how the work is to be commenced. One geologist may consider it advisable to make first a series of rapid reconnaissances through the various districts, along natural boundaries such as the coast-line, large rivers, main paths or roads, railways, if any, or through promising belts of country; then later a series of rapid cross-traverses connecting with the first series, and later still numbers of others linking the two series in various directions. This method enables him to get, in the quickest manner, a general knowledge of the geology of the country as a whole. The mapping, in detail, of the geology in conformance with a mathematical scheme of division of the country, can be done later as opportunity offers.

Another geologist may prefer to survey in detail certain areas, such as a known mining field, a belt of country, or the main lines of communication, leaving outlying districts for later work.

Both methods have their advantages and disadvantages, but these cannot be discussed in this address. The particular features of the country and the wishes of the Government will determine the system of work.

The following remarks indicate various activities of a survey of this kind.

Reconnaissances and rapid surveys through the country, noting specially the physiography, nature of rocks with their structural features (anticlines, synclines, strike, dip, foliation, cleavage, jointing, faults, dykes, and reefs), nature, occurrence and testing of minerals in rocks and gravels of streams by crushing and panning. Kinds of soils, nature and volumes of streams regarding irrigation and water-power, underground water supplies, sites for dams and reservoirs, archæological notes, collection of rocks, minerals and concentrates, with general reports on all, and preliminary special reports on mineral deposits and other interesting features.

Detailed surveys and reports on particular areas, deposits and occurrences, such as mentioned in the preceding paragraph.

Special reports on the country along routes of proposed railways, water-power, sanitation, and other matters.

Assistance and advice to other Departments on geological matters.

Surface and underground surveys of mines, with reports, maps, and sections.

Advice to mining companies and prospectors on the examination of their mines, areas, and specimens of rocks and minerals.

Assays, analyses and other determinations of samples of minerals collected by the survey, or received from the public, with reports on them.

Advice to Government regarding operations of prospectors and prevention of fraudulent flotation of companies.

Assistance to educational institutions by information supplied and descriptive museum collections.

Scientific (mainly geological and geographical) reports, with microscopical and chemical descriptions of rocks, maps, and photographs.

Special examination of minerals in concentrates and reports on them.

Publication of reports, maps, sections, assays, analyses, etc.

Formation of a geological museum, mainly of practical geology, with descriptions and uses of the materials therein.

There are numbers of other kinds of geological work that need enlargements of the staffs of the Geological Surveys before they can be undertaken, such as observations with regard to :—

Transport of sediment and chemical character of water in streams.

Inland denudation, and coastal erosion.

Underground flow of water through rocks.

Decay of rocks under tropical conditions.

Sir Albert then proceeded to describe briefly the main features of the method adopted in the Gold Coast in the rapid examination of country possessing no reliable maps.

Traverses are made, by bicycle mainly, with (*a*) the prismatic or pocket compass, for direction ; (*b*) cyclometer, or measuring wheel, for distance ; (*c*) aneroid barometer, with thermometer attached, for altitude and temperature ; and (*d*) watch, for time.

On leaving a camp all four observations are taken, but instead of the traverse being tabulated in columns as usual—which method gives no graphic idea of the orientation of the traverse—the graphic method is used. This shows at once the direction being taken, for the bearing of each line is roughly plotted in the field-book, as to direction and length, and a continuous traverse obtained, in which, in its relative position, each natural feature is placed. The observations embrace features, such as sites of camps, and prominent landmarks, edges of stream flats and banks, water-levels, gullies, tops of rises or ridges or plateaux, edges of plateaux or hills, huts, villages, outcrops of rocks, showing dips, strikes, characters and any special features. All four observations (*a*—*d*) are taken at each of such places, except the occasional omission of that for time when stoppages are frequent. But at places where the stoppage is for ten minutes or more the time observation also is taken on leaving, for the purpose of correction for altitude because of change in air-pressure.

As far as possible samples of the gravels of all streams, as well as the loam beside outcrops of quartz reefs and dykes, and the material from road-gutters or paths, are panned, and concentrates of heavy minerals obtained. (In certain types of country panning is the most useful aid to prospecting, not only in the discovery of gems and stable metallic minerals, such as native gold, platinoid minerals, oxides of tin, thorium, titanium, iron, chromium, tungsten, and manganese, but also of many rock-forming minerals, which indicate the probable character of the rocks at the spot, or in the basin of the stream tested.) Specimens of rocks and samples of quartz are collected for reference, museum purposes, microscopic examination of thin sections, or testing by assay, analysis, or other methods. Coal, lignite, limestone, and other economic rocks, brick and pottery clays, and pigments are sought ; also fossils, which, if found, are used to determine the age of the strata associated with them.

In addition to the general observations indicated, notes are made of the colour, kind, and thickness of soil, the nature of the vegetation, size and kind of stream and gravel, and measurement of volume of water—when there is opportunity, and if of possible economic value, with regard to domestic supplies and possible hydro-electric power and irrigation.

It will thus be seen that the geologist in a new country, by taking the opportunity to make the observations mentioned in the last section is helping his colleagues in other departments by collecting evidence of probable future value.

On the completion of several traverses roughly parallel with one another, particularly if they have been made across the strike of the rocks, a large amount of useful geological and topographical information is available. From this a map can be prepared, with possibly a connexion with some definitely fixed point, and on it all natural features observed can be shown, sufficiently near to accuracy to serve fully the purpose of a map to a comparatively small scale.

To this can be added the geology and mineral occurrences, the various geological divisions present in the area being shown in their respective colours, in agreement with the general scheme adopted for African geological surveys.

It will, therefore, be seen that in a young country which has no topographical survey of its own, or one which is only partly surveyed, it is imperative that some such method as outlined should be adopted before anything approaching a real representation of the features can be shown.

Leaching Manganese Ore.—An interesting process for manganese extraction, in view of the shortage of manganese ores in the United States, is described in the *Engineering and Mining Journal* for June 29 and July 6. The account deals with the application of the Bradley process to siliceous iron ores from the Cuyuna Range, Minnesota, which carry about 15% manganese.

First, the rock to be treated is crushed and ground to pass 65-mesh, the size found most effective. It is then roasted in a reducing atmosphere, using blast-furnace gas, partly burned water gas, or producer gas, at a temperature of about 750°. F. Thereby the MnO_2 in the rock is reduced to MnO and the Fe_2O_3 is reduced to Fe_3O_4, with a minimum of reduction to FeO. MnO and FeO are soluble and Fe_3O_4 is insoluble in ammonium sulphate in aqueous solution.

The reduced ore taken from the roasting furnace, after being cooled partly out of contact with air, is dumped into ammonium sulphate liquor, the latter at a temperature of about 190° F., as it is obtained from evaporators which are in the circuit. The resulting action is known as digestion, and the tank in which it takes place as a digester. This digester consists of three shallow trays and is equipped with paddles revolving on a vertical central shaft, for the purpose of promoting contact between ore and liquor in each tray.

The manganese oxide in the ore is dissolved and becomes manganous sulphate. This reaction generates ammonia gas, according to the equation :—

$$MnO + (NH_4)_2 SO_4 = MnSO_4 + 2\ NH_3 + H_2O.$$

The ammonia is withdrawn by an exhauster and piped to ammonia towers, or precipitators, for further use. In these precipitators the ammonia gas comes in contact with sprays of the liquor containing the manganous sulphate, with the result that the manganese is precipitated as manganous hydroxide, according to this reaction :—

$$MnSO_4 + 2\ NH_3 + 2\ H_2O = (NH_4)_2SO_4 + Mn(OH)_2.$$

The manganous hydroxide requires to be further oxidized by atmospheric air in order that the precipitate may be stable and heavy enough for settlement in the liquor. This is accomplished by allowing air to enter on the minus-pressure side of the ammonia gas exhauster, where it mixes

with the ammonia gas, oxidation occurring in the towers as precipitation takes place :—

$$2\ Mn(OH)_2 + O = 2\ MnO.OH + H_2O.$$

Leaching and precipitation are both produced by a reversible chemical reaction. The direction in which the reaction proceeds depends on the degree of concentration of manganous sulphate in the liquor and on the excess of ammonium sulphate present. Control of the process is accordingly secured by the order in which the flowing liquor encounters the metals and the ammonia gas. It is desirable that the liquor going to the precipitator shall contain a maximum of manganous sulphate and a minimum of ammonium sulphate. In this condition its susceptibility to reaction with ammonia gas is at a maximum, and, consequently, manganese may be most readily precipitated.

The precipitate is stable and may be settled, washed, dried, and sintered. Application of air in changing the unstable manganous hydroxide to a stable precipitate of manganic hydroxide was a point developed by Bradley.

The process has been tested on a semi-commercial scale, the experimental capacity being 4 tons of ore per day, and plans are in hand for a larger plant.

Helium Occurrences in New Zealand.—*Chemical Engineering and Mining Review* for May 6 quotes a paper appearing in the *New Zealand Journal of Science and Technology* by C. C. Farr and M. N. Rogers describing investigations into occurrences of helium in natural gas in New Zealand. A large number of examinations were made, eighty samples being collected, nearly all of which showed the presence of helium. Though none of these indicated the presence of helium in commercial quantities they showed widespread distribution in New Zealand natural gases. The following table gives the results of analysis of 64 samples from 11 regions :—

Region.	Number of sources.	Helium. %
Kotuku	5	0·022
Masterton	3	0·034
Pongaroa	4	0·015
Weber	5	0·016
Taranaki	14	0·0045
Rotorua	5	0·002
Morere	7	0·022
Gisborne	7	0·012
East Cape	12	0·006
Queensland	1	0·042
Hanmer	1	0·120

Though none of these occurrences is of commercial value, as already mentioned, the possibility of using the gas at Hanmer for providing experimental quantities of the gas must not be overlooked. The gas contains up to 96% of methane which is easily condensed by liquid air, and the helium thus readily extracted. The quantity of gas available is about 8,000 cu. ft. per day and the recoverable helium 10 cu. ft. per day.

SHORT NOTICES

Geology and Engineering for Dams and Reservoirs.—In *Technical Publication* No. 215 of the American Institute of Mining and Metallurgical Engineers, C. P. Berkey, Kirk Bryan, O. E. Meinzer, C. Terzaghi, G. H. Matthes, L. W. Fisher, R. D. Ohrenschall, C. K. Wentworth, L. C. Glenn, and H. T. Stearns contribute papers concerning the geology of dam and reservoir sites.

Coal-cleaning.—In *Technical Publication* No. 219 of the American Institute of Mining and Metallurgical Engineers, W. L. Rennick and G. B. Jones describe the Hydrotator process for cleaning fine coal.

Roasting of Zinc Sulphide Ores.—In *Technical Publication* No. 220 of the American Institute of Mining and Metallurgical Engineers, H. R. Hanley, C. Y. Clayton, and David Walsh publish results on the formation of insoluble zinc compounds during roasting.

Australian Zinc Slags.—In *Technical Publication* No. 222 of the American Institute of Mining and Metallurgical Engineers, Philip S. Morse describes the slags formed by the use of high zinc charges in Australian lead-smelting practice.

Flotation Reagents.—In *Engineering and Mining Journal* for June 22, A. M. Gaudin gives statistics concerning the annual consumption of reagents used in flotation.

Flotation of Lead-Silver Carbonate Ores.—In *Engineering and Mining Journal* for June 15, L. J. Christmann and S. A. Falconer describe tests on reagents for the flotation of oxidized lead ores.

Underground Coal Conveying.—In the *Colliery Guardian* for June 28, there is a report of the investigation by the Midland Committee on the underground conveying and loading of coal by mechanical means.

Ventilation Problems.—In the *Transactions of the Institution of Mining Engineers* for June, W. E. Cooke and I. C. F. Statham give results on experiments to determine the resistance to flow of air at bends and in straight airways.

Coarse Sand Flotation.—In *Canadian Mining Journal* for May 24, A. W. Fahrenwald and C. Thorn give experimental results of a process embodying flotation, classification and tabling.

Pennsylvanian Magnetite.—In *Economic Geology* for June, W. H. Callaghan and W. H. Newhouse give the results of a study of the magnetite ore-body at Cornwall, Pennsylvania.

Hematite Mining.—In *Engineering and Mining Journal* for June 22, there is an account of mining hard hematite in Michigan by L. Eaton.

Gaspe Zinc-Lead Field.—In the *Canadian Mining Journal* for June 7, 14 and 28, F. J. Alcock gives an account of the zinc-lead field of Central Gaspe.

Huelva Ore-bodies.—The *Geological Magazine* for July, contains an account of the structural relationships and genesis of the pyritic ore-bodies of Huelva, by G. V. Douglas.

Deep Winding.—The *Journal of the South African Institution of Engineers* contains a paper by W. Elsdon-Dew, on the winding equipments at No. 4 Shaft, City Deep.

Sulphuric Acid Manufacture.—*Industrial and Engineering Chemistry* for July contains a description of the new contact sulphuric acid process and plant of the Selden Co., of Pittsburgh, written by the inventor, A. O. Jaeger. The contact masses used in this process contain as their active ingredients non-siliceous base-exchange bodies in which vanadium oxide is present in the non-exchangeable nucleus. It is claimed that the catalytic reaction is not vitiated by the presence of " catalyst poisons " in the gases, and that low-grade smelter gases can be used with success.

Calculations in Ore Dressing.—In *Technical Publication* No. 214 of the American Institute of Mining and Metallurgical Engineers, W. Luyken and E. Bierbrauer aim to show that it is possible

to set up a positive method for calculations in ore dressing, whether it is desired to compare enrichment results on similar or dissimilar ores, or to make the comparison on the basis of either the absolute or the economical efficiency, despite the number of factors upon which the result depends being large.

RECENT PATENTS PUBLISHED

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

34,493 of 1927 (312,097). I. G. FARBENINDUSTRIE A.-G., Frankfort-on-Main, Germany. Improvements and additions to Patent No. 259,447, which dealt with the manufacture of chromates from chromium ore.

5,511 of 1928 (285,824). I. G. FARBENINDUSTRIE A.-G., Frankfort-on-Main, Germany. Improvements in the electrolytic production of metals, whereby a uniform passage of electrolytes through the cells is ensured.

5,978 of 1928 (312,395) and **11,966 of 1929 (312,403).** ELECTRO-BLEACH AND BY-PRODUCTS, LTD., and HOLLINS, J., Middlewich, Chester, and JEPSON, D., of Glossop, Derby. Improvements in the electro-deposition of metals, particularly dealing with the prevention of the accumulation of anode-sludge.

7,715 of 1928 (312,719). W. B. MAKINS and BROWN AND MAKINS, Ltd., London. A means and apparatus for preserving wood, whereby air is extracted from the wood by a vacuum, prior to spraying with preservative.

9,467 of 1928 (312,441). GENERAL ELECTRIC CO., LTD., London, and R. W. W. SANDERSON, Wembley, Middlesex. Manufacture of nickel-iron alloys by simultaneous electro-deposition from solutions containing compounds of both the metals.

9,712 of 1928 (313,242). THE SILICA GEL CORPORATION, Baltimore, Maryland. Improvements in or relating to the manufacture of silica and similar gels.

22,311 of 1928 (313,797). L. JONES, Muncie, Delaware. A method and apparatus for the reduction of the amounts of impurities in molten metals, using a slag layer which oxidizes the impurities.

22,669 of 1928 (302,994). FRIED KRUPP A.-G., Essen, Germany. An improved iron-nickel alloy which possesses a high initial permeability.

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.

Provisional Geological Map of the Gold Coast and Western Togoland. With brief descriptive notes by Sir ALBERT E. KITSON. Scale $\frac{1}{1,500,000}$. Nineteen plates, price 2s. 6d. Published under the authority of the Governor of the Gold Coast.

Advanced Mine Rescue Training. Part III: Protection against gases encountered in mines. By J. J. FORBES and G. W. GROVE. Paper backs 53 pages, price 15 cents. Miners Circular 35. Washington: Bureau of Mines.

Graphical Terrane Correction for Gravity Gradient. By DONALD C. BARTON. Paper backs, 12 pages, price 10 cents. Technical paper 444. Washington: Bureau of Mines.

Precipitation of Lead and Copper from Solution on Sponge Iron. By G. L. OLDRIGHT, H. E. KEYES, VIRGIL MILLER, and W. A. SLOAN. Paper backs, 131 pages, price 35 cents. Bulletin 281. Washington: Bureau of Mines.

Kigugwe Copper Deposit. By G. M. STOCKLEY. Eight pages, with map. Short paper No. 3. Geological Survey Department. Dar es Salaam: Government Printer.

The Mineral Wealth of the Black Hills. By JOSEPH P. CONNOLLY and CLEOPHAS C. O'HARRA. Bulletin No. 16 of the Departments of Geology and Mineralogy, South Dakota School of Mines. Paper covers, 418 pages, 64 plates.

Ore Deposits of Magmatic Origin. Their genesis and natural classification. By PAUL NIGGLI. Translated by H. C. BOYDELL. Cloth, quarto, 84 pages, illustrated. Price 9s. 6d. London: Thomas Murby and Co.

Elements of Mineralogy. By FRANK RUTLEY, revised by H. H. READ. 22nd edition. Cloth, octavo, 394 pages, illustrated. Price 6s. London: Thomas Murby and Co.

The Bituminous Sands of Alberta. By K. A. CLARK. Report No. 18 of the Scientific and Industrial Research Council of Alberta. Paper backs, 33 pages, with 2 map figures.

Safety Lamps. Report on an investigation at the Mines Department Testing Station, Sheffield, of the Safety of Miner's Electric Cap Lamps when the battery is short-circuited. By C. B. PLATT and G. A. CUTLER. Mines Department.

The Prospector's Handbook. By W. L. GOODWIN. 2nd edition. Cloth, pocket size, 367 pages, illustrated. Price 15s. Quebec: Industrial and Educational Publishing Co. Reviewed elsewhere in this issue.

Applied Geophysics. In the search for minerals. By A. S. EVE and D. A. KEYS. Cloth, octavo, 253 pages, illustrated. Price 12s. 6d. Cambridge University Press.

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.

Summary of Progress of the Geological Survey of Great Britain, for the year 1928. Part I. Paper covers, 103 pages. Price 2s. London: H.M. Stationery Office.

The Geology of the Shabani Mineral Belt, Belingwe District. By F. E. KEEP. Geological Survey Bulletin No. 12. Salisbury, Southern Rhodesia.

Proceedings of the Australasian Institute of Mining and Metallurgy. Nos. 64, 65, 71, 72, 73. Melbourne.

Geological Map of the State of California. Reprinted 1929. State Mining Bureau.

Surveying. By JOHN WHITELAW, revised by COL. SIR GORDON RISLEY HEARN. Cloth, octavo, 578 pages, illustrated. Price 16s. London: Crosby Lockwood and Son.

The Mines Handbook Copper Chart for 1928. Compiled by the MINES INFORMATION BUREAU, INC., Paper. New York.

Winning and Working. By PROF. IRA C. F. STATHAM. Cloth, octavo, 536 pages, illustrated. Price 21s. London: Sir Isaac Pitman and Sons, Ltd.

Analytical Principles of the Production of Oil, Gas and Water from Wells. By STANLEY C. HEROLD, PH.D. Cloth, quarto, 659 pages, illustrated. Price 35s. California: Stanford University Press and London: Oxford University Press.

COMPANY REPORTS

Tanganyika Concessions.—The report for the year ended December 31, 1928, shows that the output of copper of the Union Minière was 112,456 tons, as against 89,155 tons in the previous year. The major portion of the increase is due to the reverberatory furnace at Panda, which came into full operation during the year and produced 41,908 tons of copper. A further notable feature is 1,049 tons of copper from the test leaching plant at Panda, and the report states that the full leaching plant is nearly completed and is expected to be working before the end of this year. The ore reserves are 78,000,000 tons averaging about 6·5% copper, 1,911,000 tons having been mined during 1928. The output of cassiterite was 364 tons, which was treated at Hoboken, where 419 tons of refined tin were produced during the year. The Oolen plant produced 450 tons of cobalt in various forms, whilst the radium plant increased its sales from 26 to 42 grammes. The second unit of the electrolytic copper refinery at Hoboken is complete, and during the year 39,000 tons of electrolytic copper were produced. Among other interests of the company, the Kansanshi mine has been developed to some extent and large reserves of payable ore are said to be indicated. Prospecting work continues in the Southern Sudan and Uganda, and also in the Luano mineral areas. The accounts show receipts from dividends, etc., equal to £303,739 and £271,537 profit on the sale of shares, the net profit being £495,497. Dividends amounting to 7½% have been paid.

Bwana M'Kubwa Copper.—The report for the year ended March 31, 1929, shows that 301,901 short tons of ore was delivered to the mill and leaching operations on 235,150 short tons yielded copper oxide equal to 6,160 short tons of refined copper. The ore reserves to the 250 ft. level and in the dumps were estimated at 2,708,005 tons. The drilling programme at the N'Kana mine has been vigorously pursued and as a result a total reserve of 35,000,000 tons has been indicated—31,000,000 tons sulphide and 4,000,000 tons mixed oxide and sulphide. The average grade was 4·2% copper. During the year work progressed steadily on the N'Kana concession under the direction of the Rhodesian Selection Trust, Limited, with satisfactory results. On the year's operations there was a debit balance of £23,687, but this and also the debit balance of £289,458 at March 31, 1928, have been met by the surplus of £107,129 arising on the sale of shares acquired in respect of a participation in a mineral venture in South Africa and by transferring £206,016 from premium on shares account.

Otavi Mines and Railway.—The output for the year ended March 31, 1929, was 161,000 tons of ore and 47,000 tons, with an average content of 12·4% copper, 28·2% lead, and 257 grammes silver per ton, were shipped. The output of the smelter was increased to 14,727 tons of copper matte, with an average content of 35% copper, 23·2% lead, and 450 grammes silver per ton ; and also 5,004 tons metallic lead averaging 96·7% lead and 788 grammes silver per ton. Notwithstanding the downward tendency of the German steel industry, the exports of ferro-vanadium were increased. The gross receipts were £865,617 and the net profit £151,655, from which £133,333 was distributed as dividend, equal to 16·66%.

Shamva Mines.—In the report for the year ended December 31, 1928, it is stated that 573,400 tons of ore were crushed producing 76,305 oz. of gold, value £326,089. The ore reserves were estimated at 725,000 tons, averaging 3·2 dwt. per ton, which includes 99,000 tons in the Asp mine running 5·0 dwt. per ton. The profit was £36,619, increased by the amount brought forward to £49,589, and £45,000 was distributed as dividend, equal to 7½%.

Taquah and Abosso Mines.—The report for the year ended March 31 last shows that 115,587 tons of ore were treated yielding 41,046 oz. of gold, value £174,384. Ore reserves were 261,206 tons, value 34s. 6d. per ton. The report shows a loss for the year of £8,599, which was mainly due to adjustments necessitated by the introduction of new power plant holding up the development of richer ore, the mill becoming temporarily dependent for supplies on the lower grade sections of the property.

Transvaal Gold Mining Estates.—During the year ended March 31 last 187,994 tons of ore were milled for 61,569 oz. of gold. The revenue was £262,000, equal to 27s. 10d. per ton milled. Working expenditure was £236,274, or 25s. 1d. per ton, and working profit £25,725. The ore reserves at the end of the financial year totalled 509,362 tons, of an average value of 7·5 dwt., a decrease of 98,415 tons and of 0·2 dwt. in value. Dividends at the rate of 5% absorbed £25,599.

Great Boulder Proprietary Gold Mines.—During last year the mine continued to be partly worked on tribute, the company's share of bullion amounting to £180,242. Expenditure totalled £156,809, leaving a credit balance of £23,433. The ore reserves at the end of 1928 were 81,122 tons, as compared with 83,002 tons at December 31, 1927, the grade being a little better at 9·1123 dwt. The policy of developing new ore simultaneously with tribute operations is being continued and the manager expresses the view that favourable results will be obtained from work at the 800 and 900 foot levels between Edwards and Lane shafts.

South Kalgurli Consolidated.—The report of this company for the year ended March 31, 1929, shows that 102,548 tons of ore were treated, yielding 45,180 oz. of gold, value £191,911. The working cost of 30s. 4·65d. per ton shows a reduction of 8·8d. per ton in comparison with the preceding year. The ore reserves at the end of the financial year were 236,000 tons blocked out, average value 9 dwt. per ton, and 93,000 tons " probable ore," average value 6·24 dwt. per ton. The working profit for the year amounted to £31,766, of which £31,251, or 2s. 6d. per share, was distributed as dividend.

Blackwater Mines.—During the year ended December 31, 1928, 39,907 tons of ore was treated for gold value £70,525. The tonnage milled shows a decrease of 1,455 on the preceding year, but the yield per ton was 2s. 1·82d. higher. The estimated ore reserves at the end of the year were 76,030 tons of an average value of 9·12 dwt. over a width of 42 inches, an increase over the preceding year of 5,160 tons, but the lode width has decreased by 1 in. and the value by 0·56 dwt. Working profit for the year was £12,148, but, after allowing for all expenses, there was a debit balance of £33, which, when deducted from the amount brought forward from 1927, left £7,559 to be carried forward.

Bisichi Tin.—The report for the year 1928 shows that the output of tin concentrate was 398 tons, as compared with 301 tons the year before. The steam shovels commenced production in June, 1928, and the outputs since then have consistently increased. With the alterations and economies which have been introduced it is believed that there will be a considerable reduction in working costs during 1929. The financial result for the year was a loss of £5,251, to which must be added £11,078 for depreciation and £407 for income tax.

Ex-Lands Nigeria.—During the year ended December 31, 1928, the company produced 650 tons of tin concentrates, a decrease of 55 tons as compared with the previous year, mainly due to shortage of water. Reserves of tin concentrates are estimated at 7,696 tons. The working profit for the year was £30,547 and £7,687 was distributed as dividend, equal to 5%. The balance of the profit has been credited to the appropriation account, as it has become necessary to equip the company's plant with electrical power, in order to work the lower grade ground. A contract has been entered into with the Nigerian Electricity Supply Corporation for this purpose and it is anticipated that the supply will be available by the beginning of 1930.

Ipoh Tin Dredging.—The report for the year ended March 31 last shows that the dredges treated 1,533,900 cu. yds. of ground for 533 tons of tin concentrates, which realized an average price of £136 19s. 3d., as compared with £166 3s. 9d. for the previous year. Of the total area of 524 acres of the company's property 225 acres have been worked out, 26·71 acres having been worked out last year. The year's working showed a net profit of £30,269 and £30,000 has been distributed as dividends, equal to 3s. per share.

Kent (F.M.S.) Tin Dredging.—Although the dredge only commenced work in June, the report for the year ended December 31, 1928, shows that 960,810 cubic yards of ground were treated, yielding 320¼ tons of tin concentrates, value £38,554. The working profit for this period was £26,440 and £13,125 was distributed as dividend, equal to 12½%.

Selayang Tin Dredging.—During the year ended December 31 last the dredge treated 1,175,000 cubic yards of ground, recovering 296 tons of tin concentrates, which realized £40,846, or an average of £138 per ton. The net profit for the year was £11,091, of which £8,000 preliminary expenses were written off, the balance being carried forward. The manager is endeavouring to obtain additional land and has commenced investigation of an area approximating 100 acres, to the north of the company's present property.

Tavoy Tin Dredging Corporation.—The report for 1928 states that during the year the three dredges and gravel pump treated 1,114,341 cubic yards, yielding 509 tons. The gravel pump only started late in the year and treated 20,162 yards for 13¼ tons, but the output from this source is expected to show an increase during the current year. The gross mining profit was £51,086 and £49,479 has been paid in dividends.

Berenguela Tin Mines.—The report for 1928 states that the production of tin concentrates was 382 tons, as compared with 363 tons in the previous year. The gross profit amounted to £4,877, but, after allowing depreciation and sundry expenses, there was a net loss of £665.

DIVIDENDS DECLARED

Ashanti Goldfields.—1s., less tax, payable July 31.

Changkat Tin Dredging.—1s., payable July 31.

Electrolytic Zinc.—6%, less tax, payable September 6.

Fanti Consolidated.—6d., less tax, payable July 26.

Fresnillo.—25c., payable August 21.

Ipoh Tin.—1s. 9d., less tax, payable July 27.

Kent (F.M.S.) Tin Dredging.—5%, less tax, payable August 27.

Kramat Pulai.—6d., less tax, payable Sept. 6.

Malayan Tin Dredging.—6d., less tax, payable September 7.

Northern Rhodesia.—4½d., less tax.

Petaling Tin.—15%, less tax, payable July 31.

South African Gold Trust.—1s., less tax, payable August 29.

Southern Malayan Tin Dredging.—4½d., less tax, payable September 5.

Southern Perak Dredging.—1s., less tax, payable September 6.

Sungei Kinta Tin Dredging.—1s., less tax, payable August 26.

Tanganyika Concessions.—1s. 6d., less tax, payable July 27.

Tavoy Tin.—5¼d., payable July 25.

Tehidy Minerals.—3d., tax free, payable August 14.

Tekka.—4½d., less tax, payable September 3.

Tekka-Taiping.—6d., less tax, payable July 31.

Zambesia Exploring.—3s., less tax, payable July 27.

NEW COMPANIES REGISTERED

Imperial Smelting Corporation, Ltd.—Registered August 3. Capital: £7,500,000 in £1 shares (500,000 Preference and 7,000,000 to be issued either as Preference or Ordinary shares). Objects: To acquire, hold or dispose of the whole or any portion of the shares or loan capital or the assets or undertaking of the National Smelting Company, or other companies, to carry on in any part of the world and more especially in any part of the British Empire all kinds of mining and quarrying operations, etc.

Kipushi Syndicate, Ltd.—Registered July 26. Capital: £60,000, in 5s. shares. Objects: To acquire mines and mineral properties and to adopt an agreement with the Rhodesian Congo Border Concession.

Pakaraima Diamond and Exploration, Ltd.—Registered August 3. Capital: £25,000 in 24,000 Eight per Cent. Preference shares of £1 and 20,000 Ordinary shares of 1s. Objects: To acquire and explore and turn to account any mines, metalliferous land and concessions, and in particular rights in and over land in the Pakaraima district of British Guiana, etc.

Shabani (Peak) Asbestos Mines, Ltd.—Registered July 6. Capital: £1,000, in 10s. shares. Objects: To acquire and turn to account the Peak Asbestos Mines at Shabani, Belingwe District, Rhodesia, and to adopt an agreement with the Moorgate Mercantile Trust, Ltd. Offices: 142-146, Finsbury Pavement House, Moorgate, E.C. 2.

Zumbo Company, Ltd.—Registered June 27. Objects: To enter into agreements (1) with Zambesia Mining Development, Ltd., (2) and (3) with International Properties, Ltd., etc. Capital: £150,000 in £1 shares.