The Mining Magazine

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EDITORIAL

THE forty-third annual issue of Skinner's "Mining Year Book" will be published on the 18th of this month. This well-known reference book contains particulars of all the mining companies registered in this country or known on the London market.

IN memory of the late Dr. Charles D. Walcott, the eminent American geologist, his widow has established a fund of $5,000 for the purpose of encouraging the study of Pre-Cambrian life in any part of the world. Every five years a medal and a presentation in money will be made for the most meritorious researches, explorations, and discoveries that have been brought to the notice of the board of adjudicators appointed by the National Academy of Sciences.

LAST month figures were given showing the great increase in the output of tin in the Federated Malay States during 1928. Since then it has been possible to estimate the world's production and the various computors agree fairly well. Messrs. Lewis Lazarus and Sons give the figures at 171,912 tons, as compared with 148,315 tons in 1927 and 139,182 tons in 1926, and the visible supplies at the end of 1928 at 23,508 tons as compared with 14,862 tons at the end of 1927.

LOW-TEMPERATURE carbonization is a subject much to the fore in industrial circles, but there is still some uncertainty among business men and others as to the nature and object of the process and the conditions under which it will gain financial success. Readers may therefore be recommended to study a new brochure written by Dr. Murray Stuart, just published by Mining Publications, Ltd. (proprietors of THE MINING MAGAZINE), at the price of 4s., which briefly and authoritatively states the case for this method of utilizing coal.

A COURSE of twelve lectures on Geophysical Prospecting will be delivered by Mr. E. Lancaster Jones and Captain H. Shaw in the geological department of the Imperial College of Science and Technology, South Kensington, at 12 noon, on February 18, 19, 21, 22, 25, 26, 28, and March 1, 4, 5, 7, and 8. The lectures will deal with the principles underlying geophysical prospecting, and will describe the apparatus and procedure employed in carrying out such work by gravitational, electrical, magnetic, seismic, and other methods. The course is primarily intended for present students, but former students and others interested in the subject may also attend, free of charge.

THE report of the Commission on the closer union of the dependencies in Eastern and Central Africa, of which Sir E. Hilton Young is chairman, was published last month. The points at issue are largely political and the mining interests occupy a back position at present, so that it is unnecessary to discuss the report in detail here. It may be said, however, that agreement among the members of the Commission was only reached with regard to Tanganyika, Uganda, and Kenya, and that Northern Rhodesia, Nyasaland, and Zanzibar do not come within the scope of the Commission's recommendations. With regard to the first three the Commissioners are of opinion that they must be governed in the same way as other tropical dependencies, that is to say, the interests of the native population must be considered paramount whenever there is a difference in the requirements of the white immigrant and the native. They recommend that the three should be under independent administrations, and that general co-ordination should be in the hands of a Governor-General and an advisory council.

British Metallurgy

The Institution of Mining and Metallurgy, at its January meeting, commenced a discussion on the present position and the future prospects of non-ferrous metallurgy in Great Britain. the subject being introduced by Dr. William Cullen. The paper and the discussion were somewhat analogous to those which centred two years ago on the mineral resources of the British Empire, when Sir Thomas Holland urged the necessity of taking stock of our resources and of securing for ourselves as great advantage as possible from them, both politically and from the point of view of trade. Sir Thomas was president of the Institution at the time and he was able to prepare members for the Empire propaganda brought forward at the subsequent Congress in Canada. Similarly Dr. Cullen is the president-elect, who will be in charge of Empire interests at the South African Congress which meets in March of next year. It is appropriate therefore that British mining engineers and metallurgists should hear something of the plentiful suggestions which may be made during the next year or so for improving the status of British non-ferrous metallurgy.

This question of restoring British non-ferrous metallurgy is a wide and complicated one, and before any answer or suggestion can be made there are other questions that receive precedence. In the first place it may be asked if the shrinkage of the volume of ore treated in this country is due to decadence in metallurgical ability, to the disinclination of British commercial men to embark on expansions and improvements and to provide funds for metallurgical operations, to vicious or blundering methods of doing business, or to labour and taxation troubles? Secondly, it is necessary to define the word metallurgy, which may mean (1) the extraction of metals from their ores, or (2) the treatment of such metals by alloying, heat treatment, or mechanical working for the purpose of rendering them more useful to the engineer. These two branches of the subject may be advantageously labelled Metallurgy I and Metallurgy II. It can be said at once that Metallurgy II is not in a state of decay in this country. Far from it! The fact that the Institute of Metals is one of the most active and prosperous technical societies in this country is evidence to the contrary. This goes to show that technical talent and capital are not absent when profitable business is in view, and that some other reason must be found for the absence of gigantic copper and lead smelters within the British Isles. Here a consideration of the recent history of Metallurgy I in this country will help to elucidate the present position. Early last century there was a home output of copper, lead, and zinc ores which was considerable compared with the world's total output. After the exhaustion of Cornish copper ores adequate supplies coming from Chile were imported to maintain Swansea's prosperity. When the century was two-thirds of its way through, the immense resources of copper and lead in the United States, the lead and zinc deposits of Australia, and the alluvial tin discoveries in the East came on the scene. Though much of the ore from these new districts was at first sent to Britain, local treatment of the new supplies gradually became the logical business method, for fuel and labour could be supplied locally and new consuming communities arose on which a big business could be founded. These new producers also became exporters, for their large-scale operations could be conducted at lower costs and shipping charges were also in their favour as against those of British exporters. The British smelters thus gradually lost their supplies of ore and on the other hand the American producers and metallurgists became skilled in large-scale treatment in lead and copper. It is no wonder, therefore, that when new metal mining ventures within the British Empire came to the front, American money and American metallurgy should be welcomed for the erection of plant on a large scale. In spite of this absence of opportunity for large-scale operations at home, the British metallurgists continue their researches, and some of the best work on lead refining and zinc and tin extraction is being done in this country.

We have said that domestic supplies of ore are essential for the foundation of a smelting industry. The fact that the United States metallurgists failed to establish tin smelters within their own boundaries for the purpose of treating imported ore is to some extent an example of the general principle. The argument put forward by Dr. Cullen that ores could be attracted to a non-producing country by the adoption of reagents such as ammonia or chlorine which cannot be easily manufactured at the mines and cannot be suitably transported from Britain is perhaps the only valid one in favour of the importation of ores by a non-producing country, but even in this case it cannot be certain that these reagents would be desirable or could withstand the opposition of others available locally and not so troublesome in operation.

The above-mentioned reasons appear to us to be the essential causes for the decline in British Metallurgy I. There are other reasons which may be brought forward, such as inefficient labour, high income tax and rates, and high freight charges and costs of handling the ore supplies, and the poor terms offered by British ore buyers. Then again the directional control of mining and metallurgical companies in this country is often in the hands of men who have not any profound knowledge of the technical questions involved. They may be the successors in the ownership of controlling shareholdings formerly the property of more able ancestors, or they may be trustees for those successors who are more obviously unsuited for control, and in that case are unable to recommend expenditure on new plant and processes. Or they may be City promoters whose last idea is to put the money they raise into the development of mines or processes. The discussion of many of these accessory causes for the present state of Metallurgy I in this country often arouses bitter recriminations. For instance, a metallurgist of standing has been known, when addressing a technical society, to indulge in what Gilbert called "profane ungentlemanly emphatics" when referring to the alleged unbusiness-like methods adopted by ore buyers in this country, but such an attitude does not help to improve the position. Nor did the mine owner do any better who threw a brick bat at the statue of the eminent metallurgist in Swansea because he did not get so much for his gold and silver contents as he expected. This style of argument does not help matters; it is too apt to act as a red herring to draw the investigation off the main track.

At the meeting useful contributions to the discussion were made by Professors S. J. Truscott and B. W. Holman, Mr. George C. Klug, Dr. Hutton, Dr. Sydney W. Smith, Mr. D. A. Bremner, Mr. W. Pellew-Harvey, and Mr. H. M. Ridge, but as a general account of the views of members will be given next month after the close of the adjourned discussion, nothing further need be said now.

Sir Hugh Clifford's Malayan Stories

Two months ago reference was made in these columns to a book by the Government Geologist of the Federated Malay States, which was not an official document but an entertaining account of conditions ruling in the tin-mining industry. Since then a book of the same character written by Sir Hugh Clifford, Governor of the Straits Settlements and High Commissioner of the Federated Malay States, has been published by Heinemann under the title of "Bush Whacking and other Asiatic Tales and Memories." This book consists to some extent of stories originally published nearly thirty years ago, but the entire contents will probably be quite new to most readers. Sir Hugh has contributed much other literature relating to the East and he is co-author with Sir Frank Swettenham of a dictionary of the Malay language. Furthermore he is a ruler of Empire who is in genuine sympathy with the races under his guidance. Thus his views and his local experience, coupled with his literary ability, give his writings a graphic interest that is both pleasing and touching. Over all, however, is exhibited his devotion to the Empire and to its modern duty of helping the natives of tropical countries to govern themselves. Sir Hugh went to Malaya as a cadet in the civil service in 1883, and for many years he was occupied in the administration of Pahang. Subsequently he became successively Governor of Ceylon, Trinidad, the Gold Coast, and Nigeria, and finally, in 1927, he returned to Malaya to take up the position he now occupies. His knowledge of the tropics is therefore probably unrivalled.

The first half of the present book is occupied with his account of the disturbances in Pahang in 1891, and of the jungle warfare undertaken with the object of repressing them, followed by the story of the further expeditions to the "benighted lands" of Kelantan and Trengganu. Among other attractive pictures indicating the gradual improvement of conditions in Malaya are his reminiscences of dealings with the local rulers, entitled "Piloting Princes." In his very early days he was attached to a native prince who was paying a state visit to Penang, a "typical son of the old regime, a barbarous person of unspeakable manners and morals," who persisted in bathing in the reservoir that supplied the settlement with drinking water. As a contrast he tells of his experience in later days when he acted as guide and friend to the Sultan of Perak on his visit to London at the time of King Edward's coronation. On this occasion the only incongruity was the ignorance of the visitors of the use of a bed, they not knowing that the coverings could be drawn back to provide them with a warm haven of rest. During twenty-five years of rule this Sultan had seen his country pass from a mere wilderness of forest into a land surprisingly wealthy and prosperous. He had seen lawlessness, brigandage, rapine, and internecine strife vanish and the spear and the kris, which once ruled his world, relegated to the museums. Blackest ignorance had been replaced by education, lack of sanitation by a wise respect of the laws of hygiene, and dire poverty by wealth and comfort.

It would be impossible to write about Malaya without introducing the mining engineer, and the sample which Sir Hugh serves up to his readers, while not flattering to the profession, is supremely amusing, and. let it be added in a whisper, not entirely unknown in real life. In short, he was a young man with a voluble tongue, who thought he knew everything and was not aware of the fact that friends and acquaintances laughed at him and voted him a hopeless and unforgivable bore. He could manage a steam launch better than a trained pilot and could manœuvre a native boat better than the native himself, both with disastrous results for which he blamed everybody but himself. He lectured Sir Hugh on the Malay language and local political problems a fortnight after his arrival in the country. For the purpose of testing the capabilities of the Government surveyors he took stellar observations and, after many futile attempts at calculation, declared that the point was only misplaced on the maps by three-quarters of a mile, "which was wonderfully accurate for an official chart." Our readers who may jib at this description will be glad to know that the engineer, after bringing six companies to ruin, was finally drowned in a sudden flood, while despising the advice of his companions.

We have not the space in which to refer to many other attractive stories such as "A Study in Despair," and the Home Coming of Vincent Brooke, which are of more tragic nature, or the "Past of the Schooner," which introduces pawang magic together with a gruesome portrait of the very unromantic pirates, and we may briefly conclude by recommending the book to those interested in Malayan conditions.

Sir W. Boyd Dawkins

The death of Sir William Boyd Dawkins on January 15 at the age of 90 removes the last of the great English geologists who won fame in the nineteenth century. He was a man of wide interests and, to quote Sir Walter Scott, had many "crowded hours" in his long life. Few men have held the Fellowship of the Royal Society for 61 years; still fewer could have directed the production of a film portraying prehistoric incidents at the age of ninety. Like Sir James Crighton Browne, the eminent medical man whom we still have with us, he was always as enthusiastic as a boy and was never aware that he was growing old. He was no dry-as-dust scientist who could not see the wood for the trees, but had a genius for popular exposition and was effective in interesting the general public in geology and anthropology. Altogether he was a personality of the best type.

Educated at Oxford, he was the first to take geology in the honours school of natural science and the first to hold the Burdett-Coutts scholarship in geology. Afterwards he joined the Geological Survey and remained there for seven years until his appointment in 1869 to the lecturership in geology at the Owens College, Manchester. Four years afterwards he became professor of geology and palæontology at that College, which was subsequently merged in the Victoria University of Manchester. He continued in that position until 1908, but he did not then sever his connection with teaching, with the University, or with Manchester, but continued to exercise a potent influence on academic and public life both in that centre and elsewhere. In his early days he took up researches in connection with the more recent stages in palæontology and became the leader of investigations with regard to prehistoric man. His books on "Cave Hunting" and "Early Man in Britain" became classics in a very short time and have continued to inspire two generations of philosophers. But the later ages of palæontology did not engross all his attention, for he was equally at home with the Jurassic reptiles, Carboniferous flora, and the Pre-Cambrian vestiges of early life on the earth.

It is not so much, however, the palæontological studies of Boyd Dawkins that interest the readers of the MAGAZINE as his work in connection with geology applied to engineering and mining problems. He was one of the first geologists to help the civil engineer in railway work and water supply problems. His share in laying the plans for a Channel Tunnel and in the development of the Kent coalfield is in itself sufficient to perpetuate his name. It may seem strange in these days, when commercial applications are widely found for such abstract sciences as botany and entomology, that the pure geologists strenuously opposed Boyd Dawkins' policy of placing his knowledge at the disposal of the engineers, but nevertheless it is a fact that he fell into disfavour with certain cliques devoid of sympathy with the scientist who gave of his best to his fellow men.

It is now over forty-five years since the present editor of the MAGAZINE became a student of geology at the feet of Boyd Dawkins. He will never forget the kindly and high-minded influence of the teaching and presence of his old master or the unaffected mien and character of his friend.

REVIEW OF MINING

Introduction.—The coal and iron industries of this country have substantially improved since the commencement of the year. The world's copper market is strong owing to increased demand and prices have advanced further. Tin prices have continued dull owing to over-production, but at the time of writing there has been a slight rise. The copper deposits of Northern Rhodesia have attracted renewed attention in financial circles, and competition for their control has become a strong feature of the position.

Transvaal.—The output of gold on the Rand during January was 840,344 oz., and in outside districts 36,108 oz., making a total of 876,452 oz. The number of natives employed at the gold mines at the end of January was 192,526 as compared with 187,970 at the end of December.

News from Luipaards Vlei has afforded more cheerful reading lately. A further cable announces that the Main Reef has been encountered on the 24th level in the central section to the east of the big fault, where it assays 8 dwt. gold per ton over a width of 68 in. The central section is the part between the east and west mines, and it was until recently regarded as a blank between the two sections now worked. The distance between the east and west shafts is 4,000 ft. and continuity of the Main Reef Series has already been proved for 2,600 ft. on the 22nd level. The striking of the reef on the 24th level is therefore of corroborative importance.

Southern Rhodesia.—The output of gold during December was 44,772 oz., as compared with 47,705 in November and 49,208 in December, 1927. The number of producers exporting was 123. The total output of gold during 1928 was 576,113 oz., a decline of 5,325 oz., as compared with the figures for 1927. Other outputs during December were: Silver, 7,215 oz.; coal, 99,762 tons; chrome ore, 18,041 tons; asbestos, 2,982 tons; mica, 18 tons; iron, 422 tons. The total output of asbestos during 1928 was 39,960 tons, valued at £970,327, an increase over 1927 of 6,784 tons and £176,112 over 1927. The output of chrome ore during 1928 was 219,428 tons, figures slightly in excess of those for the previous year, but the value was also slightly lower at £471,667. The output of coal continued to increase, the figures for 1928, 1¼ million tons, being 205,000 tons greater than those for 1927.

The following table gives particulars of dividends declared by Southern Rhodesian mining companies during the year 1928 :—

	Rate %	Total £
Cam and Motor	22½	168,750
Globe and Phœnix	75	150,000
Lonely Reef	25	72,325
Rezende	25	37,500
Rhodesian and General Asbestos	20	208,963
Shamva	7½	45,000
Sherwood Starr	5	5,000
Wankie Colliery	17½	163125,

The total of £850,663 compares with £909,360 in respect of 1927.

Northern Rhodesia.—Following on the recent discoveries of sulphide ore at various properties in Northern Rhodesia, negotiations have been in hand by the Bwana M'Kubwa and N'Changa companies to raise the necessary funds for development.

The Bwana M'Kubwa company has arranged with Rhodesian Anglo-American, Ltd., whereby the latter company exercises options on 935,530 shares of 5s. each at 10s. and on 1,249,953 shares at 15s., and also advances to the company sums up to £1,250,000 at 1% over bank rate, with a minimum of 6%, as and when required for the period ending December 31, 1936. The funds thus obtained will amount to £2,759,412. The Rhodesian Anglo-American has been given further options in 1,098,738 5s. shares at £1, and there are other parties who hold various options totalling £392,091, bringing the total probable resources to £4,250,241. The company is now in a position to complete the railway from N'Dola to N'Kana, and to bring the N'Kana property to the producing stage at the earliest possible date.

The N'Changa Copper Mines, Ltd., made a tentative deal with the American Smelting and Refining Co. whereby the latter undertook the finance. There was some dissatisfaction with regard to the terms on their publication, and another group announced publicly that they were prepared to offer terms more advantageous to the company. The American Smelting and Refining Co. thereupon withdrew their offer and negotiations have been started afresh. The other group consists of the Rhodesian Anglo-American, the British South Africa Co., the British Metal Corporation, the Johannesburg Consolidated, the Rio Tinto Co., and the Union Corporation. It is not unlikely that the American Smelting and Refining will join with this group in the new negotiations.

The North Charterland Exploration Co. (1910), Ltd., the control of which is with the London and Rhodesian Mining and Land Co., Ltd., has granted to Mr. Leslie Urquhart, in association with the Russo-Asiatic Consolidated, Ltd., the exclusive prospecting rights over the company's concession, which extends from the Loangwa Valley eastwards to the Nyasaland boundary. Mr. Urquhart has despatched Mr. Charles H. White and Mr. Donald Gill on a prospecting expedition. A campaign of geological investigation, aided by diamond-drilling and aerial survey, will be commenced forthwith.

Nigeria.—The Naraguta group has formed a subsidiary called the Naraguta Durumi Areas, Ltd., as indicated by the chairman of the Naraguta company at the recent meeting of shareholders, to acquire alluvial tin properties in the Durumi, Zurgum, and Kukuba districts. Before the acquisition of the properties they had been worked by other owners, and further development has been done by the Naraguta engineers. Mr. L. J. Cooper estimates the contents proved so far at 2,535 tons at the Durumi areas, 425 tons at Gwinni, and 300 tons at Zurgum. Mr. W. H. Trewartha-James has visited the Durumi property and reports favourably on it.

Australia.—It is commonly stated that there are no prospects for further world supplies of tin ore, but the Australian Development and Migration Commission, of which Mr. H. W. Gepp is head, is more optimistic, for a recommendation has been made for the development of immense bodies of granite averaging a recoverable 0·2% tin oxide in the Blue Tier tinfield, near Lottah, in north-eastern Tasmania. The House of Assembly of that State has voted £5,000 to assist a syndicate which is providing a similar amount for testing these bodies. Before this step was taken examination was made by a technical committee officially appointed, on which were such well-known engineers as Mr. A. McIntosh Reid, Mr. Lindesay Clark, and Mr. H. A. Curtis, the latter being chief engineer to the Tasmanian Hydro-Electric Department. This committee outlined a scheme whereby 34,000,000 tons of this low-grade ore could be worked by open-cut at the rate of 4,500 tons per day, with a prospect that the extraction might eventually reach 0·24%. Such a scheme would require a capital expenditure of £500,000, and the committee is able to predict costs that would make it possible to earn handsome profits. Tasmania has several examples of cheaply worked low-grade mines, where soft granite has been worked by open-cut, and, as the present scheme is backed by experienced men, there is no reason why large-scale operations of the same character should not be profitable, even when the price of tin is not particularly favourable.

The Lake View and Star has issued a summary of a report made by Dr. Malcolm Maclaren on the ground now being developed to the south of Golden Horse-Shoe in the Chaffers lease. He discusses the two series of lodes, the main vertical lodes, Nos. 1 and 3 in Chaffers, and the counter lodes, Nos. 2 and 4, which dip at 75° and cross the main lodes, and gives his interpretation of the history of the deposition of gold in them. He states that the ore in the counter lodes is not of sufficiently high grade to warrant working at the present level of costs at Kalgoorlie, but that the tin shoots on Nos. 1 and 3 main lodes are well worth following. The southern margin of the great shoot in No. 1 lode enters Chaffers ground from Golden Horse-Shoe at the 1,350 ft. level and pitches south at 55°, and the similar margin of the shoot on No. 3 lode enters Chaffers ground at the 1,850 ft. level and pitches south at 45°. At greater depths (2,780 ft. and 3,020 ft. respectively) the shoot in No. 1 lode is being followed southward into Chaffers from the corresponding levels in Golden Horse-Shoe. Dr. Maclaren recommends the continuance of certain development work now in progress and the sinking of the Chaffers shaft to a depth of 3,200 ft. in the first instance.

The Mount Isa Mines, Ltd., which is under the control of Mr. Leslie Urquhart, has issued an interim engineering report. It is announced that Mr. F. W. Draper, chief engineer to Russo-Asiatic Consolidated, is local representative of the advisory committee which has general supervision of construction and equipment. The design and construction of this mill and smelter is in the hands of Mr. J. M. Callow, and Mr. C. A. Mitke is inaugurating the system of mining best suited for this type of ore deposit. Mr. H. H. Knox has recently returned from Mount Isa to London, and gives an estimate of the reserves as follows: Carbonate ore, 3,500,000 tons averaging 9% lead and 3·6 oz. silver per ton; sulphide ore assured to 750 ft. depth, 12,200,000 tons, averaging 6·1% lead, 8·2% zinc, and 3·7 oz. silver;

there are also 5,000,000 tons of the same assay down to 750 ft. reckoned as further expected, and 500,000 tons of much higher assay. Since Mr. Knox's visit additional blocks of ore have become measurable and the total figures for reserves have been correspondingly increased.

Malaya.—The prospectus of Sungei Pari Hydraulic Tin, Ltd., was advertised at the end of January. The promoters are the Huntley-Williamson group and the properties acquired adjoin that of Meru Tin, Ltd., at Jelapang, four miles from Ipoh, which was floated by this group last year. Three of the properties, the Ban Grap, Cheong Moon, and Purloo, are already being worked and the Pari has only been tested by bore-holes. The total ground tested at the four properties is estimated to contain 35,000,000 cu. yd. with an average content of 1·06 lb. of tin-stone per yard. The ground is worked by monitors, gravel-pumps, and elevators, and the plant is now being extended. The report was made by Mr. W. F. McKenzie, of Ipoh.

India.—The Indian Copper Corporation announces that smelting commenced at the end of December, and that the production of refined copper started on January 29, the metal assaying 99·56%. The concentrator is working satisfactorily, the recovery being over 92%.

Burma.—At the meeting of shareholders in Burma Corporation held at Rangoon on the last day of December, Mr. P. E. Marmion gave a lengthy account of the contemplated development of low-grade ore in the mine and of the results of Dr. Malcolm Maclaren's recent examination. His remarks are quoted at length in the report of the meeting given elsewhere in this issue, and to this we must refer readers for details. Briefly, development is approaching the base of the rhyolite tuffs in which the rich ore is found and as the underlying sedimentary deposit 150 ft. thick is comparatively unfavourable to ore deposition a zone of lower-grade ore may be expected. Below this sedimentary bed there is another deposit of rhyolite tuffs and according to the nature of the fracturing so may richer ore be expected below. In the meantime owing to the nature of the dip of the beds the tuffs overlying the sedimentary bed will persist to a much greater depth in the Shan section than in the Chinaman section. During the past year the ore developed in the Shan section has been larger than that in the Chinaman section. It is notable that the ore in the Shan section is not of so high a grade as that in the Chinaman section. With regard to the treatment of low-grade ore a definite scheme will be published at a later date.

Panama.—Mr. H. F. Marriott was appointed to the board of the Panama Corporation last month. In his capacity as technical adviser he will greatly strengthen both the board and the executive. He has left with Mr. D. Elliott Alves, the chairman of the company, on a visit to Panama.

Tin Selection Trust.—This company belongs to the Anglo-Oriental group and its function is to invest money in tin companies in various parts of the world, under the control of the group or otherwise. The report for 1928 shows investments at cost of £1,261,977, loans to associated companies £212,500, market loans £100,000, and Government securities and cash £171,982. Dividends, profits on realizations, etc., brought an income of £189,926, and a net profit of £154,374, out of which £120,000 has been distributed as dividend, the rate being 15%, as compared with £130,000 or 16¼% the year before. The report contains a schedule of the various investments, from which it is seen that £626,786 represents holdings in 36 companies operating in Malaya, Burma, and elsewhere in the East, and £203,595 holdings in Nigerian companies. In addition three Cornish companies represent £51,699, five miscellaneous companies £30,961, and the London Tin Syndicate £338,936. The capital of the Trust has been increased to £2,000,000 by the creation of a million new shares.

Metallurgical Companies.—The capital of the N. C. Metal Co., Ltd., which operates the Coley zinc process, has been increased from £15,000 to £250,000, and Messrs. Stewarts and Lloyds, Ltd., the tube-makers, are interested in providing the additional capital. It will be remembered that some account of the process, which is essentially a continuous method of producing zinc, was given in the MAGAZINE for February last.

It is announced that the Murex Co. Ltd. is acquiring the business of Thermit, Ltd., the share capital of which is owned by the Imperial Chemical Industries, Ltd. The latter company will take shares in Murex in exchange, and will nominate a representative to the board. Murex is known among mining men as a buyer of tin-wolfram concentrates and Thermit for its process for reducing refractory ores.

THE GEOLOGY OF NORTHERN RHODESIA
AND OF THE
NORTHERN RHODESIAN COPPER FIELD

By TUDOR G. TREVOR, A.R.S.M.,
Late Secretary of Mines and Works, Northern Rhodesia

Physical Features

The territory of Northern Rhodesia lies on a plateau at an altitude rising from approximately 2,000 ft. on the Zambesi, which makes its southern boundary, to 4,000 ft. on the Zambesi-Congo Divide where it marches on the Belgian Congo. Though the territory lies wholly in the tropics this altitude ameliorates the climate and, except in the lowest valleys, neither the climate nor the vegetation is tropical in the colloquial sense. The plateau is divided by two deep "rift" valleys, those of the Loangwa and Luano,[1] which in practice cut the country into two distinct portions, North-Eastern and North-Western Rhodesia. As no minerals have yet been worked in North-Eastern Rhodesia this article deals specially with the north-western portion.

The whole area of the territory is 290,000 square miles and it may be said to be roughly rectangular, measuring about 400 miles from north to south and 700 miles from east to west.

The plateau—other than the escarpment of the valleys mentioned—is a peneplain of low relief, and is covered from end to end with bush or forest, the ordinary trees of which are about the size of small hedgerow timber in England and stand about as thickly as in an English wood. Trees which would cut into 20 cu. ft. of sawn timber are rare, and are usually absent, but good "poles" up to 15 ft. long and 12 in. thick are plentiful.

The rainfall varies from about 20 in. in the south to 50 in. in the north. The rain all falls between November and April.

Malaria is present in all parts, and in the early days was most virulent. To-day, however, it is well in hand and its effect on the European population is hardly noticeable.

Tsetse fly is present in small areas scattered all over the country.

General Geology

There has been no geological survey made of the country and the only published works on it are contained in papers by Studt and Molyneux, who were only visitors to the territory, but who nevertheless did some good pioneering work.

In the last three years the Concession companies, who have obtained from the Chartered Company the mineral rights over the greater part of the country, have organized a very complete geological survey staff of their own, consisting of some twenty-six qualified geologists, under the control of Dr. J. A. Bancroft, until recently of the McGill University, Montreal.

This survey is, however, being undertaken purely for commercial purposes and no results have been, or are for a long time likely to be, published. It must be understood therefore that the conclusions come to by the present writer are only the results of his own observations and those of others with whom he has discussed the geology of the country, and that the evidence obtained by this private survey may have already solved many of the points which he has left unsettled.

The surface of the country, except on the granitic escarpments of the two great valleys, is very largely covered with laterite and lateritic soil. This, coupled with the bush and rank grass and vegetation, makes outcrops rare and hard to follow, and there are none of the magnificent exposures of contacts and sequences which are such a marked feature in South Africa.

The sequence of the main geological formations appears to our present knowledge as follows :—

(*a*) *Fundamental Granites and Gneisses.*—These are similar to those in South Africa. As do those, these also include many sheared conglomerates and beds of obviously sedimentary origin, side by side with rocks which cannot be distinguished from true gneisses, but the author has seen nothing in them resembling the Swazie schists or the Jamestown series of South Africa.

(*b*) *Siliceous Schists.*—These outcrop over a large area. There is a good exposure of these in the hills at Kapiri M'Poshi on the road from Rhodesia Broken Hill to Bwana M'Kubwa and most of the hills from thence eastward to Serenje and to the south along the Luano Valley consist of them. Sometimes

[1] The Luano is the lower portion of the Lusemfwa River.

they have developed a very schistose structure, at other places they appear as very massively bedded quartzites. On the surface they look like friable sandstone and they disintegrate into a very fine white sand, but, when broken into for a few feet, they are shown to be a very hard quartzite translucent in thin edges and small fragments.

Though the author has travelled many miles over these rocks he has never seen any argillaceous beds in them, though ferruginous beds do appear.

The relationship of these to the older granite and gneisses is not yet clear, but it seems likely that they are enveloped in them as are the Swazie and Jamestown schists of South Africa in the basement rocks of that country.

(c) *The Congo Border Series.*—Totally unconformable with the above come what may be called for the present the Bwana M'Kubwa or Congo Border Series. These consist of sandstones, askoses, and shales. Their total thickness is not very great and a few thousand feet might cover it, but as they contain the copper deposits of the country which are now attracting so much attention, they are economically the most important formation in the land, and will be dealt with in detail later. When mineralized they are enfolded in a series of synclines in the underlying granitic rocks, and a more recent granite is intrusive in them.

(d) *The Dolomites.*—Closely connected with the above, though the actual relationship, if any, is not clear, come the limestones and the dolomites which cover so large an area of the country. These undoubtedly correspond to the dolomites of the Pretoria Series in the Transvaal and to those of Tsumeb in the South-West Protectorate, though there are some marked differences. In the first place, while in the Transvaal all these rocks are a true dolomite containing some 40% carbonate of magnesia, in Northern Rhodesia the proportion of magnesia is usually much less and there are large areas where the rocks are pure limestones.

The chert bands which make such a marked feature in the Transvaal dolomite are also usually absent. At the base of these dolomites near Lusaka-Kafue are also quartzites which resemble those of the Black Reef series in the Transvaal, but in other parts the author has not observed them.

These dolomites are the main country rock of the north-western plateau and form a belt, at least 70 miles wide, running near, and to the west of, the railway from Monze to Bwana M'Kubwa. The total thickness must be very great, for in the escarpment of the Zambesi Valley and to the east of Mazabuka at least 3,000 ft. are visible, but everywhere they have been so metamorphosed that the bedding planes have been almost obliterated, and it is difficult to obtain any consistent dips and strikes.

The actual dolomites are not consistent from top to bottom of the series, but include certain sandstones and shales comparable to the Blyde River quartzites of the Transvaal. The existence of these sandstones and shales very much confuses the reports received from prospectors and others, who generally regard them as a separate formation unconnected with the dolomites, for their outcrops are often obvious in places where the dolomite has decomposed and is not visible on the surface.

The Rhodesia Broken Hill mine lies in these dolomites and copper is of frequent occurrence in them though up to date none of the prospects are being worked.

(e) In the north of the territory near Fort Rosebery and again in the north-east corner near Minilunga there is said to be a formation comparable to the Waterberg formation of South Africa, but the author has not seen it, and so far no minerals have been reported from either area.

None of the above formations have yielded fossils and for the present they must be regarded as of unknown pre-Cambrian age.

(f) *Karroo Formation.*—Lying entirely unconformably with the forementioned formations and usually either horizontal or with a very slight dip, the Karroo formation occurs in the Zambesi, the Loangwa, and the Luano Valleys and possibly underlies much of the mid Zambesi and Kafue Valleys where the surface is covered with Kalahari sands. Coal has been discovered in these rocks but has not been developed, as the Wankie Colliery, just over the border in Southern Rhodesia, has amply supplied all the needs of the country.

(g) *Kalahari Formation.*—Nearly the whole of Barotseland and much of the north-western division of Rhodesia is covered with drift sand and detritus of desert origin which entirely obscures the underlying formations. In places these are obviously up to 200 ft. in thickness, but in others they may be only a few feet and the Karroo formation may, as remarked above, really be the country rock underlying the surface.

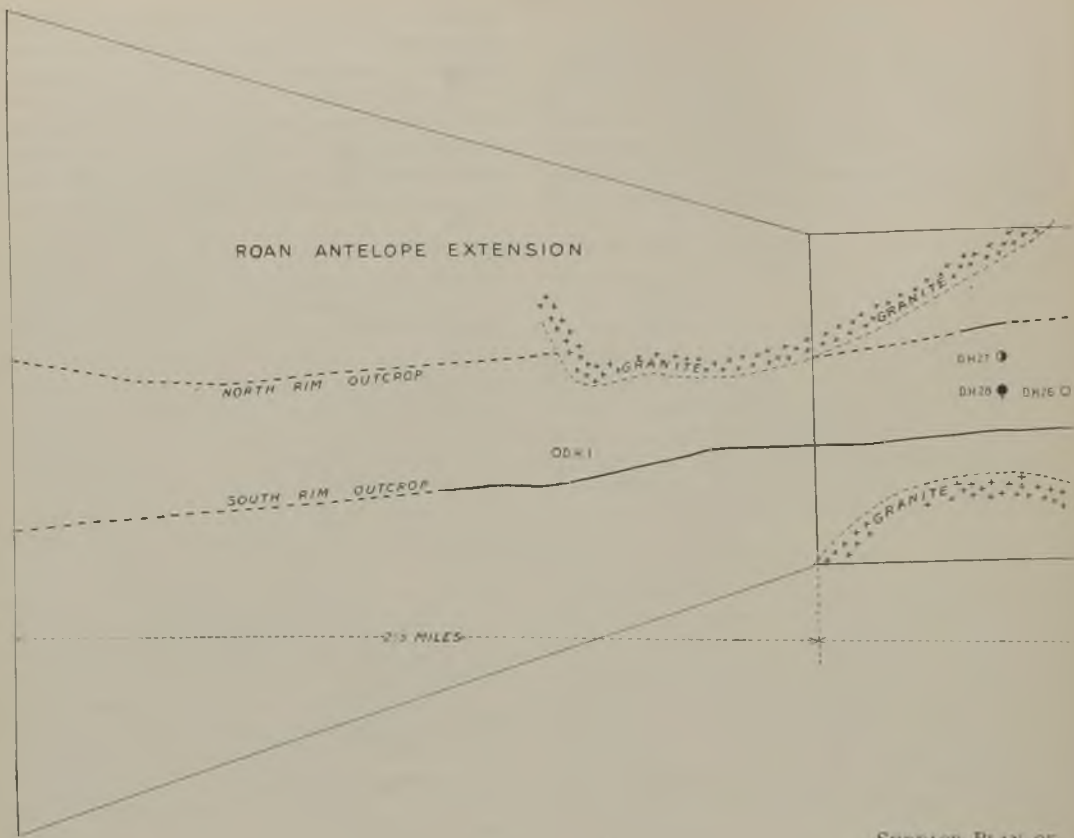
Mineralization

Gold.—The original search for gold in the country only led to the discovery of two small mines in the schistose rocks. As there is an entire absence of ancient workings for gold it seems improbable that any considerable goldfield will be found, though recently at Motali, a point some 70 miles west of Lusaka, payable values have been found in some of the beds of sedimentary origin included in the fundamental gneissic rocks, this enrichment extending for a considerable distance along the strike and continuing in depth to 200 ft. which is at present the deepest working. The possibility of some such deposits as those of the Witwatersrand which would not have attracted the ancients being discovered must not therefore be overlooked.

Zinc and Lead.—The well-known mines of the Rhodesia Broken Hill Company lie in the dolomites. On the surface the deposit outcrops in six stony hills rising abruptly to a height of some 70 ft. above the surrounding plain. One of these has now been entirely removed and its place taken by an open-cast 150 ft. deep, and the others have been explored by shafts. In each case the structure is the same.

To visualize it one must imagine huge caves, or " swallow holes " in the dolomite filled in with a mass of silicate of zinc, having

General Map of Northern Rhodesia.
(For map of the copper region see page 83.)



Surface Plan of

an irregular core of galena. As in depth blende begins to appear, it is possible that the silicate is a secondary product due in some way to surface action, and that the original mineral was the sulphide.

The deepest workings are down 250 ft. and none of the deposits show any signs of diminishing in depth. As they all occur within a radius of half a mile, it is interesting to consider if they have a common origin and represent in fact the ramifications of one huge deposit. The quantity of ore on the floors and in sight is said to be 1,218,000 tons averaging 30·0% zinc, 8·9% lead, and 0·9% V_2O_5.

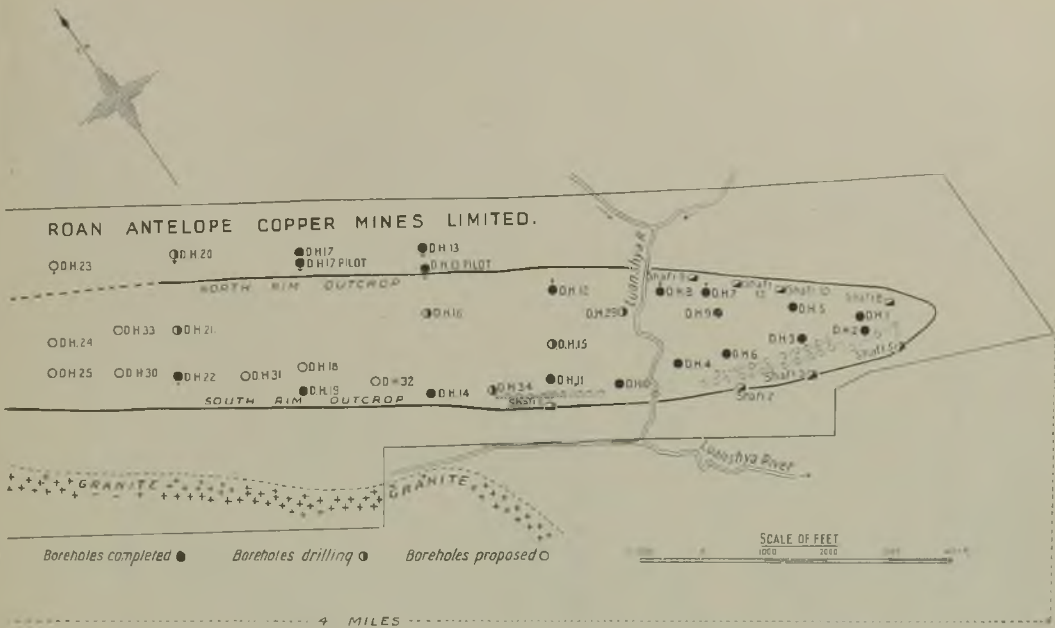
The vanadinite occurs in a concentrated form in veins and fissures in the ore-body and also finely disseminated throughout the whole mass. As its extraction is provided for in the process now in operation, it should be an asset of great importance to the company. So far no other mine similar to Rhodesia Broken Hill has been discovered, but there are many prospects yet to be developed and one—the Star mine near Lusaka—is already exporting zinc ores in some quantity.

Copper.—There are dozens of copper prospects in the dolomites and two mines, not without promise, were opened in the gneissic rock on the Lusemfwa River some seventy miles north-east of Broken Hill. These are, however, for the present shut down and all the energy of the country is turned to the Congo Border fields.

The Congo Border Copper Fields

It is at present believed these fields may prove to stretch from Bwana M'Kubwa on the east to near Minilunga on the west, a distance of three hundred miles. On the north they run into the Belgian Congo. Their southern limit is unknown, but extensions at least 100 miles to the south seem probable.

Like the rest of the north Rhodesian plateau this area, though it forms the divide between the Congo and Zambesi catchments, is one of low relief covered with thick bush, with few hills or obvious outcrops, and until mining work has exposed the underlying rocks

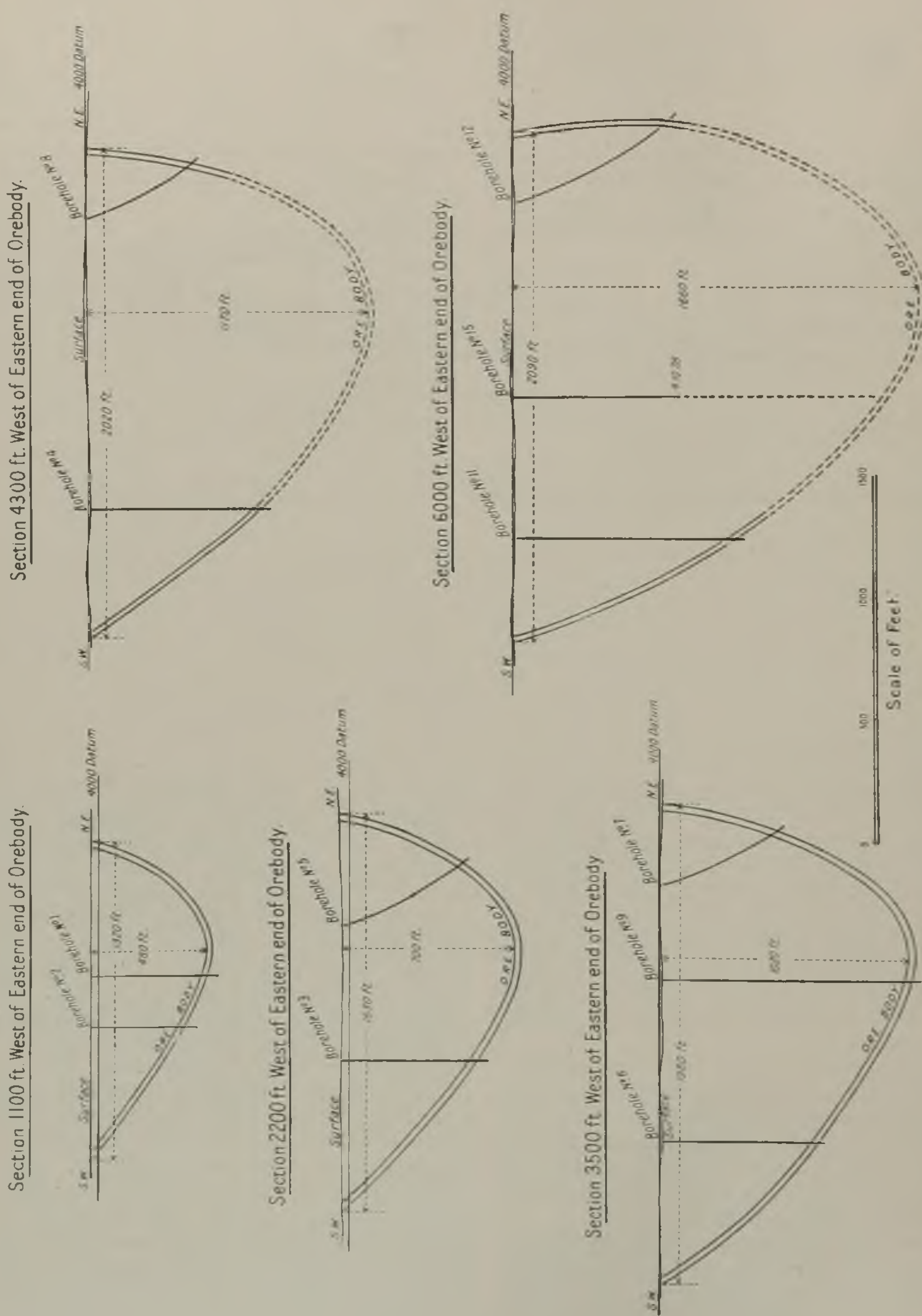


THE ROAN ANTELOPE COPPER MINES.

the geology is very obscure. Copper was first discovered owing to native workings at Bwana M'Kubwa, Kansanshi, and elsewhere. These workings were invariably on rich veins of malachite, mostly vertical and of limited extent. The search for these, however, disclosed many places where copper stains were visible, either in the outcrops of sedimentary rocks or in the grass roots and peat hags of the morasses or glades locally known as "dambos."

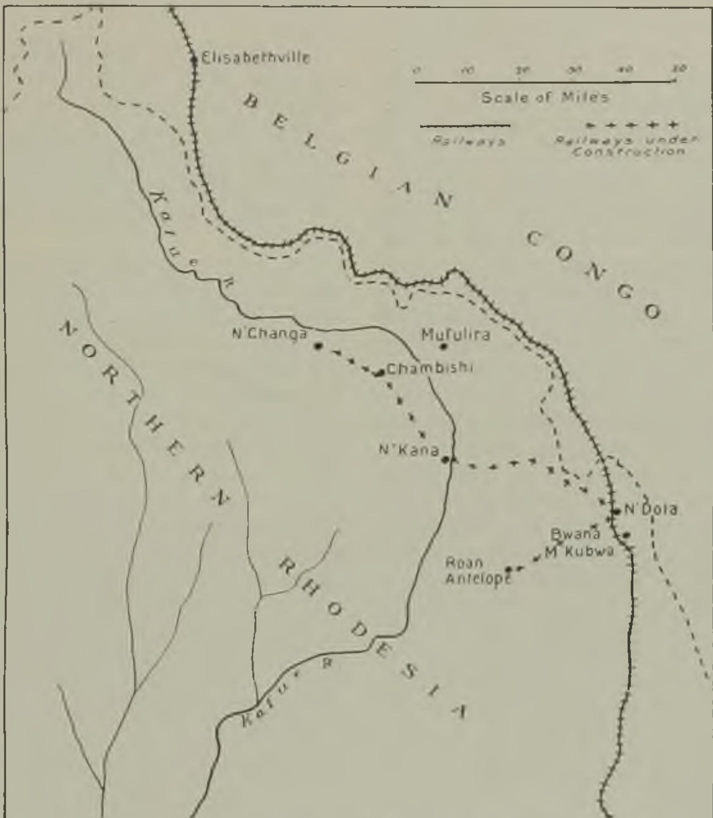
Most of these discoveries were made before 1910, but their value was quite unrecognized until some four years ago, for high-grade, 20% ores were being looked for, and no one realized that 3% ores in large quantities might be very much more valuable than 20% ores in small tonnages.

Apart from Kansanshi, which as known at present is a lode, not a sedimentary deposit, some six different discoveries, each many miles from its neighbour, have now been opened up sufficiently to be understood and at least twice that number are being prospected. These include the Roan Antelope, Bwana M'Kubwa, N'Kana, N'Changa, Chambishi, Mulufira, and others. In all cases the main geological features are the same. A section of sedimentary rocks has been caught up in an earth movement of the underlying granitic rocks and folded into a synclinal trough exactly as the blankets of a bed might be caught between the knees of a sleeper. No corresponding anticline has been discovered; in all cases these—for they must have been formed—have been denuded away by the process which produced the present peneplain. Apart from this folding there are in some, if not in all, cases intrusions of a later granite in the neighbourhood, which may prove to have to do with the mineralization of the beds. In the cases of the Roan Antelope and the N'Changa mines, both sides of the synclines are being developed and bore-holes have proved the continuity of the beds across the fold. At the Roan Antelope mine the width of the surface section of the syncline from granitic rock to granitic rock is not less than 1,000 yards. The average



VERTICAL SECTIONS OF ROAN ANTELOPE ORE-BODY.

distance between the outcrops of the copper-carrying bed on either side of the fold is about 600 yards, while the maximum depth to the bottom of the fold of the bed, as proved by bore-hole, is 1,660 ft. The depth is, however, increasing towards the west, and may become much greater in that direction. In horizontal length the extent of the fold is not known but it has been proved for 4,000 yards and there seems no reason yet known to set a limit to it, but the outcrop is covered with to have been chalcocite or bornite, but in every case there is considerable or total oxidation down to 100 ft. or so. The mineralization is extremely fine and evenly distributed. A dump of Roan ore from the 100 ft. level shows no mineralization to catch one's attention, and it is only when one examines a fragment closely with the aid of a glass that one detects the copper minerals. Iron pyrites and all other metallic minerals appear to be absent.



The Copper Region of Northern Rhodesia.

lateritic surface soil and it can only be followed by drilling.

The sedimentary beds included in these folds consist of sandstones, arkoses, and shales. At Bwana M'Kubwa the mineralization is in the sandstone or arkose, as is also the case at N'Kana. At N'Changa, when the writer was there the rock was so decomposed that it was difficult to describe, but was probably a very felspathic sandstone or arkose. At the Roan Antelope the copper occurs solely in a massive bed of shale. In all cases the original copper minerals appear

At the Roan the average true width of the ore-body is given as 26·4 ft. and the average copper content as 3·45%. In June last it was estimated that there were proved to be 30,000,000 tons of 3·25% ore in the drilled portion of the property, but as at that date probably less than half the known extent of the deposit had been drilled that figure has been very much increased by the present time, and eventually the total tonnage may be proved to be many times that amount. On the other properties the widths and richness of the beds are comparable to those at the Roan. At the Roan there are no mining difficulties. The ore-bed is sharply defined and the hanging and foot walls are excellent. At N'Changa and N'Kana the same is proving true in depth, but at the level of the water table great difficulty has been encountered as the sandstones or arkoses are almost completely decomposed or disintegrated for some 50 or 100 ft. and in that neighbourhood may probably prove unworkable.

In all deposits of this class that prove rich enough to be workable the greatest difficulty will probably arise from the fact that down to a certain level a portion of the copper content will be in the form of carbonate or a part as sulphides and that, whichever is worked, the other will not be recoverable by the same process. This difficulty has, it is understood, already been encountered at the Bwana M'Kubwa where the plant was designed for carbonates and sulphides have begun to appear. To indicate a limit of the possibilities of these copper fields is—in the present state of our knowledge—impossible and it will probably be many years before it can be attempted. No one can possibly guess how many of these mineralized synclinal folds there may be or what the extent of any may prove to be. There are certainly six of them, and indications of as many more have been found. In each case every new borehole indicates greater and greater tonnage.

As to the origin of the mineralization there is no evidence known to the writer on which to hazard a guess. Copper is certainly present in lenticular masses in the gneissic rocks of the country which underlie the syncline. It is also present in certain fissure veins as at Kansanshi, and throughout the whole of the dolomite formation it is of common occurrence, but in the immediate neighbourhood of these deposits no igneous rocks or pegmatites have been observed to which the mineralization might be attributed. Even the intrusive and later granites which are in evidence in the locality have not been traced into actual contact with the mineralized beds. It is also peculiar that, while at the Roan it is a shale that is mineralized, at the other known deposits it is an arkose, or felspathic sandstone.

Geographically the position of the Roan Antelope mine, which lies at the eastern end of these fields, has been fixed as follows :—Latitude, 13° south ; longitude, 28° 30′ east ; distance by rail to Beira, 1,472 miles, to Cape Town, 2,159 miles, to Lobito Bay, 1,569 miles. The railway to the last of these is not yet complete.

One is continually being asked how it is that, in the Congo, just over the border from the Rhodesian mines, only ore over 8% can be worked, while in Rhodesia 3% ore is estimated to be highly profitable. The reply is simple. In the Congo no sulphides have been discovered ; all the ores down to the greatest depth yet reached are carbonates. Carbonates of copper cannot economically be concentrated nor can carbonate ores containing less than 8% be economically smelted. In the Rhodesian mines now attracting attention the metal occurs as sulphide and in a form that is ideal for concentration, and as that sulphide is chalcocite a concentrate carrying 50% copper can be obtained by the flotation process, which is suitable for direct smelting.

The Institute of Metals will celebrate its coming of age at the twenty-first annual general meeting to be held on March 13 and 14, at the hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster. The annual dinner and dance will be held at the Trocadero Restaurant on the 13th, and a conversazione on the evening of the 14th at the new buildings of the Science Museum, South Kensington. Lord Melchett and Sir Samuel Hoare have promised to speak at the dinner. Another function in connection with the celebration will be an official visit to the British Industries Fair at Birmingham on February 21, when a party of 200 will be entertained by the management committee of the Fair. It is of interest to note that the membership of the Institute reached 2,000 in December. The autumn meeting of the Institute is to be held at Düsseldorf on September 9 to 12, at the invitation of the Verein Deutsche Ingenieure and the Deutsche Gesellschaft für Metallkunde. This will be the first meeting of the Institute to be held in Germany. At the forthcoming meeting next month fifteen papers are being presented, among which the following may be mentioned : Recent Developments in Electric Furnaces, by Donald F. Campbell ; An Improved Form of Electric Resistance Furnace, by Dr. W. Rosenhain and W. E. Prytherch ; Alloys of Zirconium, by C. Sykes ; Silver Contents of Specimens of Ancient and Mediæval Lead, by Dr. J. Newton Friend and W. E. Thorneycroft.

GREECE: ITS GEOLOGY AND MINERAL RESOURCES

By D. A. WRAY, Ph.D., M.Sc., F.G.S., F.R.G.S.

(*Continued from January issue, page 17*)

Lead and Zinc Ores.—By far the best known and most important mineral deposits in Greece are those of Laurion, or Laurium, in Southern Attica, twenty-five miles south of Athens. The modern town of Laurion is largely a mining colony of some 5,000 inhabitants, laid out in a regular manner around the smelting works, and pleasantly situated on the bay of Ergasteria. The metalliferous zone is confined to an anticlinal area at the southern end of the peninsula, the main axis trending from Daskalio Niki in the north-east across the Plaka Pass, and southwards through Kamaresa to the south coast. Quaternary, Tertiary, and Cretaceous rocks occur, underlain by crystalline schists. According to Lepsius the Cretaceous rocks include an upper grey limestone and a lower yellowish limestone with an intervening series of green slates and marls. These in turn rest on the crystalline schists, which consist of the following beds in descending order: (5) The Upper bluish grey fissile marble of Attica; (4) The Kasariani mica-schists; (3) Lower marble of Attica; (2) Dolomite and calcareous schists; (1) Calcareous mica-schists with quartz lenses.

In the crystalline schists and Cretaceous beds are intrusive masses of serpentinized gabbro, while at Plaka a granite boss with numerous apophyses is exposed along the anticlinal axis. These igneous masses have metamorphosed the surrounding rocks, and the ore-bodies occur in intimate association with them and along the so-called contacts of the several subdivisions of the crystalline schists and Cretaceous rocks. Many rich vein deposits occur, especially in the marbles and limestones close to the granite and its numerous apophyses. The principal ores include argentiferous galena, zinc blende, and calamine, cerussite, and limonite. Greenockite, the sulphide of cadmium, also occurs in small amounts. The iron ores are often rich in manganese. The iron and manganese ores are confined to the Cretaceous and higher beds and are absent from the lower thick beds of marble and massive limestone associated with the crystalline schists.

Lignite Mines at Oropos, north of Athens.

The mines of Laurion were probably first worked by the Phœnicians, the great Semitic race of traders who came from the East; and at least six centuries prior to the Christian Era the mines were in active operation. In the economic life of Ancient Greece they played a very important part. Slave labour was employed and the mines were leased out to enterprising citizens who paid an annual tribute to the State. About 500 B.C. the royalties from these mines first begin to appear in the Athenian Budget, while in the time of Themistocles they had so increased in importance as to furnish the whole revenue for the Greek fleet which routed the Persians under Xerxes at the famous battle of Salamis in 480 B.C. During the period that Athens held the ascendancy in Greece the mines of Laurion were extensively worked, and it was not until the Athenians lost their independence that their importance waned. In the first century of our era Strabo notes that the miners were then working over the old slags for the extraction of silver, while in the succeeding century Pausanias speaks of the mines as having been long disused. Many of the old shafts and galleries are still in the condition in which they were left two thousand years ago, and the former about 6 ft. square and up to 400 ft. deep, together with the galleries, reveal many interesting features.

For centuries the mines lay completely neglected, until in 1860 a French company obtained a lease to work over the extensive slag heaps. Within a very short time over 10,000 tons of lead, carrying as much as 22 oz. of silver per ton, were obtained. The potential wealth of these old dumps then began to be realized by the Greeks, and after legislation the French company purchased the area of their workings. At the present day there are two principal companies operating, a French and a Greek. The important French Laurion Mining Company, with a capital of some sixteen million francs, has mines at Kypriano, Kamaresa, and Plaka, in the Laurion district, and is also fully equipped with modern plant and smelting works. The same company has also diverse interests in Algeria, Asia Minor, and in many of the Grecian islands. At Laurion about one thousand men are employed, and in recent years about 50,000 tons of lead ore, 8,000

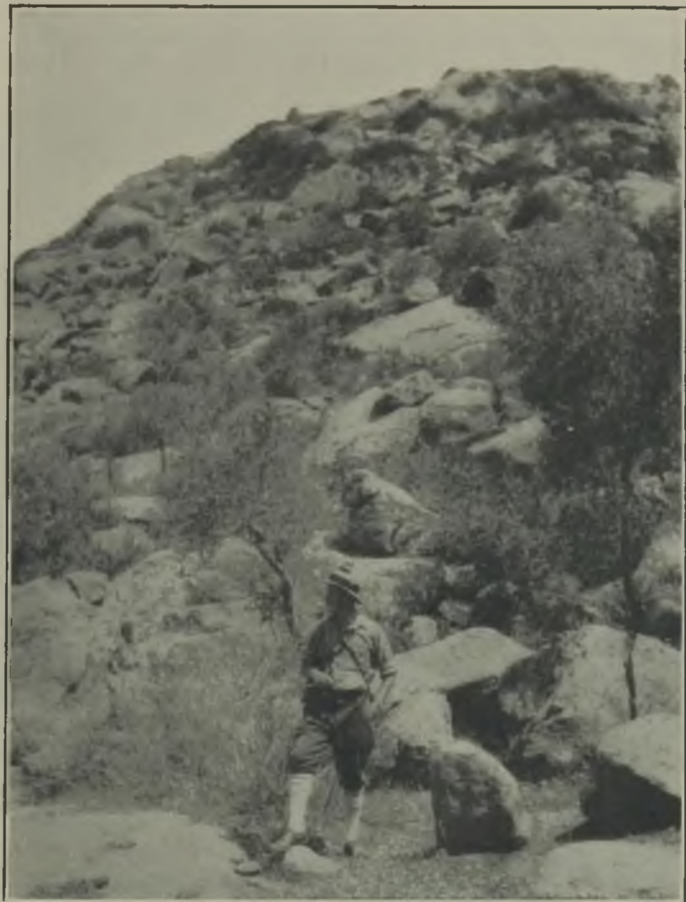
MARONIA, A PORT IN WESTERN THRACE,
at the foot of low hills consisting of gneissic and schistose rocks.

tons of zinc ore, and some 5,000 tons of arsenic ore are produced annually. The ancients only mined lead ore in the higher and more accessible workings, and these have since proved very productive of high-grade zinc ore. The Greek Laurion Company is mainly engaged in re-smelting old slags and scoriæ, but has mines at Dardeza and Kapsalo. About one hundred miners in all are employed and the output is comparatively small.

A smaller French company has mines at Vroumopousi and Sunium, at the extreme southern end of the Laurion peninsula.

The island of Thasos in the Northern Ægean has been recognized from the earliest times to be highly mineralized, and the enterprising Phœnicians are stated to have been attracted thither and worked its gold mines. At the present day no mines are actually in operation and it has not been possible to accurately locate many of the ancient mining sites. Prior to the European War, a German company was mining oxidized zinc ores somewhat extensively.

The island rises abruptly from the Ægean Sea to over 3,000 ft. and is largely covered by fir woods. It consists of highly crystalline and gneissose rocks with beds of marble and with intrusive granite masses. Along the west coast it is traversed by a series of complicated faults and all the more important mineral deposits appear to be closely related to these fault zones. Oxidized zinc ores predominate, but argentiferous blende also occurs associated with barytes and calcite. The minerals not only occur in a network of veins, but irregular metasomatic masses of ore are also met with.



Gneissic and Granite Rocks in the Rhodope Mountains.

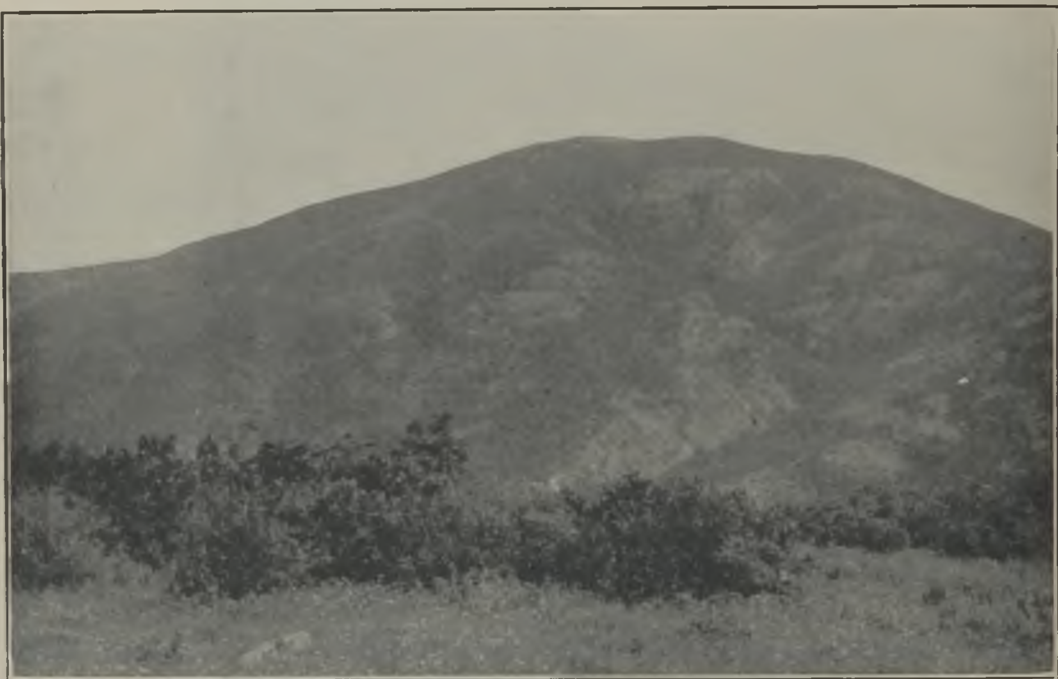
The principal mines are close to Vouves

in the south-western part of the island, but numerous disused mines occur around Corlou, Marlou, Sotiros, and Pachys, all along the west coast. In some years prior to the Great War, the annual output of zinc ore exceeded 30,000 tons.

Several of the Ægean islands have lead and zinc mines, but with the exception of Chios, where a French company is mining calamine, they are now in disuse. On the islands of Siphnos and Antiparos, lead and zinc ores occur under conditions exactly comparable to those at Laurion. These mines were of very great importance in ancient times, being in active operation in the sixth century before the Christian era. Large amounts of silver-bearing lead ore were obtained and the workings were only abandoned when the water-level was reached. In the latter half of the last century they were reopened by the French Laurion Company, and large quantities of zinc ore left in the old workings by the ancient miners were obtained. Fifty years ago silver-bearing lead ore was being mined on a small scale on the island of Melos, and also around Ano Meria on the small island of Mykonos. The ancient historians refer to the existence of silver mines on Kimolos in Roman times, but although they have been re-investigated no developments have as yet taken place.

Lead and zinc ores are also known to occur on the islands of Crete and Andros; what their economic value may be is at present unknown.

At the southern end of the island of Eubœa, and not far from the town of Karystos, there are several disused lead mines where silver-bearing lead and zinc ores occur as vein deposits in the Cretaceous limestones. Calamine was formerly worked at Halmyropotamos, twenty miles to the north of Karystos where it occurred under similar conditions.



A Peak in Thrace consisting of Gneissic and Metamorphic Rocks.

Lead and zinc ores are also recorded from the neighbourhood of Miliais and Zagora in the Pelion or Plessid mountain range which forms the eastern edge of the Gulf of Volo, but they are not at present worked.

Copper.—Small quantities of copper ore are obtained in some years at the smelting works of the French Laurion Company. This comes from the zinc-bearing lodes at Laurion which frequently carry small quantities of copper pyrites.

There are also several small copper mines in the Othyris Mountains, to the east of

Lamia, where copper pyrites and its alteration products, malachite and azurite, occur in small veins and stringers in gabbros and serpentines. Numerous ancient workings occur together with extensive masses of cupriferous scoriæ ; the copper content of the latter, however, seldom exceeds 3% and is usually much less. Around the villages of Gouro, Gardiki, and Dereli, twenty to thirty miles east and north-east of Lamia, these old workings have been reopened on a small scale, and at Port Ptelio, at the entrance of the Gulf of

Copper ores have also been recorded from a large number of widely separated localities in Greece, but whether they are of economic importance is not known. Thus in the neighbourhood of Karystos in Southern Eubœa chalcopyrite and iron pyrites associated with galena occur in veins in the massive Cretaceous limestones. Copper ores have also been recorded from the islands of Crete, Thasos, Paros, Skyros and Andros, and from the neighbourhood of Sparta and Alagonia in the Taygetus Mountains on the Peloponnesus.

Present-day Transport in Rural Greece.

Volo, two stone piers have been erected for the transhipment of the ore.

Similar small workings occur further south in the province of Locris, around Chani, eight miles east of Atalanti. The copper ore here occurs in veins in Cretaceous limestones. In Western Thrace, there are several disused copper-ore workings in the hills around Comotini (or Gumuldjina). In an official German report on this area published immediately after the War, it is recorded that from the district of Yardimli, eight miles south of Comotini, 600 tons of copper ore were being produced annually some 25 years ago. The copper-bearing veins here occur in intimate association with Tertiary trachytes and volcanic tuffs.

Gold.—If it were possible to place any great reliance on the frequent references and often glowing accounts given by ancient writers on early mining, it would appear that Greece might possibly become in time a gold-producing country of some importance. More especially is this the case with the newly acquired territories in Thrace and Macedonia. Herodotus and Strabo in particular make frequent references to the mining wealth of the North Ægean area, while the historian Gibbon records that the wealth of the Thracian gold mines was on so large a scale as "to corrupt the orators of Greece"! Speaking of the island of Siphnos, Herodotus informs us that "the Siphnians were the richest of all the islanders, having in the island gold and silver mines so great that from one-tenth of the money accruing from thence a treasure is laid up at Delphi equal to the richest " (Thalia, iii, 57). His information about Thasos is, however, more precise. Thus we are told that " he himself has seen these mines ; and by far the most wonderful of them are those which the Phœnicians discovered. These Phœnician mines are in that part of Thasus between a place called Ænyra and Cœnyra, opposite Samothrace ; a large mountain has been turned upside down in the search " (Erato, vi, 47).

Gold has been found in very small amounts in the alluvial sands of the islands of Siphnos and Skyros, but extensive researches made by German engineers have so far failed to locate the ancient gold mines on the island of Thasos, despite the fact that Herodotus specially mentions the east coast, and the neighbourhood of Kinara in particular. Similar investigations in Thrace and Macedonia have not been attended with any great success. The mountainous tract between the Struma and Mesta rivers, more particularly the vicinity of Mount Pangæum, was referred to by both Herodotus and Strabo, and the owners of a concession are at present engaged in investigating the alluvials of this district. Small quantities of gold have been obtained in the silver extracted at Laurion, while it has also recently been found associated with iron pyrites at Poliani in the Taygetus Mountains in Arcadia.

Antimony and Arsenic.—Stibnite is of frequent occurrence on the islands of Chios, Lesbos, and Thasos. Considerable amounts have been exported in some years by a French concession which has mines in the vicinity of Keram on Chios. Stibnite also occurs in the Othyris Mountains and in the high ground to the north of Volo, but it has never been worked in these districts.

Arsenical ores are only known from the Laurion district. In some years as much as 1,000 tons are exported by the French Laurion Company.

Nickel.—The iron mines of Larimma, in the province or nome of Lokris, have within the past few years been worked with marked success for the production of nickel ores, 10,000 to 20,000 tons being mined annually. It here occurs associated with iron and chrome oxides in large dykes or lens-shaped masses in Cretaceous limestone.

Chromite.—Among the mineral products of Greece, chrome iron ores are relatively of considerable importance. The principal deposits are in Thessaly and on the Khalkidike peninsula, and in some years as much as 15,000 tons of ore have been mined. The ore invariably occurs in irregular masses or impregnations in basic rocks or serpentines. In the majority of the localities the irregular nature of the deposits has resulted in the actual mining and preparation of the ore being left to the local peasantry, the mining agent confining himself to making the contracts for delivery and ensuring the relative purity of the material.

The principal mine in Thessaly is close to Pharsala, thirty miles west of Volo. Within recent years it has produced upwards of 10,000 tons annually with an average chromic oxide content of 38 to 40%. In the same district is another mine at Alchani Domokos with an annual production about half that of Pharsala. Another smaller working is at Nezero on the south side of Lake Daoukli or Nezero, and close to the main railway line from Larissa to Lamia. Other smaller deposits occur in several places around Neochori in the serpentines which cover a wide area on the western slopes of the Othyris Mountains. Ten miles north of Trikkala there is a small mine working chrome ore at Voivoda, close to the narrow-gauge railway from Kalabaka to Volo. The ore from all the above-mentioned mines in Thessaly is forwarded to the port of Volo, and from thence transshipped mainly to Belgium and Philadelphia.

Around Katerini, twenty miles west of Salonika, and on the northern slopes of Mount Olympus, there are several comparatively small chrome ore workings. The material here occurs as a basic segregation in serpentinized peridodites. Ore-bodies of similar nature have been worked at several places on the Khalkidike peninsula. One of these mines is at Vavdos close to Galatista and has an annual output of about 300 tons. At the head of the Gulf of Cassandra is another small mine at Mandra, close to Ormilia. There are also several small workings on the steep and thickly wooded peninsula of Longos.

Chrome ore has also been recorded from several parts of Eubœa, Bœotia, and from the island of Skyros.

(*To be concluded.*)

ASBESTOS MILLING AT THE ETHEL MINE, SOUTHERN RHODESIA

By F. E. KEEP, M.Sc., Assoc.Inst.M.M.,
Mining Geologist, Geological Survey of Southern Rhodesia

Published by permission of the Director, Geological Survey of Southern Rhodesia.

In view of the fact that descriptions of the milling practices of asbestos mining companies are but rarely divulged to the public it is considered that the following summary of the methods in use at the Ethel mine, the property of the Rhodesia Chrome and Asbestos Co.. Ltd., may be of interest.

The Ethel mine is situated in the Lomagundi District, Southern Rhodesia, the asbestos deposit occurring in the completely serpentinized enstatite rock of the Great Dyke, a complex igneous intrusion represented by rocks varying from the most acid to ultra-basic, the latter forming the greater portion.

The chrysotile asbestos of the Ethel mine is unique among the asbestos deposits of Southern Rhodesia insomuch as many seams consist of both brittle and non-brittle fibre, adjacent fibres often being found to be of different types. This intimate admixture has been the cause of much difficulty in the endeavour to discover a system of milling whereby the brittle, useless fibre could be eliminated without injury to the commercial-quality chrysotile asbestos.

In the early days of the asbestos industry in Southern Rhodesia, great trouble was experienced in obtaining asbestos in a condition acceptable to the consumers, the flow-sheet shown in Fig. 1 being one of the first in use. The worst point in a plant embodying such a flow-sheet was that the long fibre was not separated at an early stage in the operations, but was allowed to travel through the plant with the remainder of the mill feed. The result was that in passing through the rotary drier and trommel the various lengths of fibre became entangled and rolled into balls. When passed through the rolls the balls were pressed into discs, rendering subsequent endeavours to produce a graded product almost hopeless. In addition it was found that the dirt in the rotary drier had the effect of staining the fibre, this being a serious drawback in the eyes of the consumers of the longer grades.

When Mr. S. R. Tonkin, the manager of the Ethel mine and one of the foremost authorities on the mining and milling of asbestos in Southern Rhodesia, became associated with the property he found it necessary to make extensive alterations in the milling practice in use. In his efforts in this direction he has been obliged to consider primarily the capital cost of such

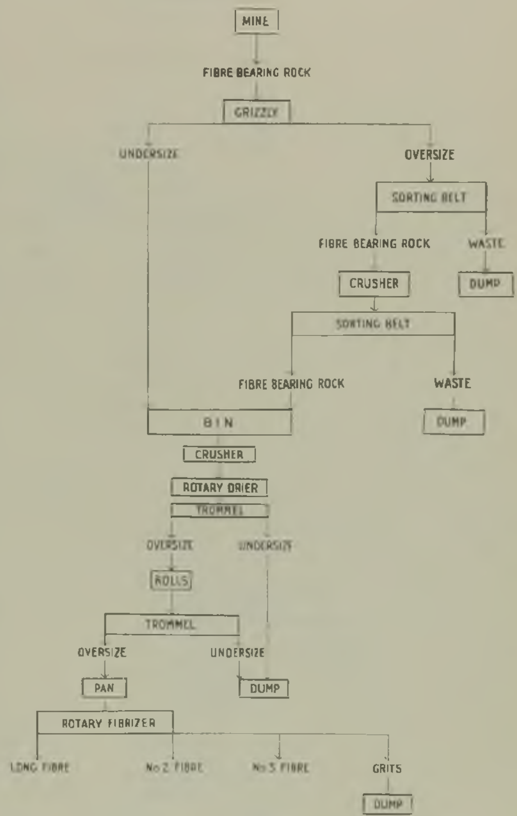


FIG. 1.—EARLY FLOW-SHEET.

alterations, the result being that he does not pretend that the present plant is by any means ideal. He has, however, been able to embody the general principles which he considers correct in the mill as running at the present time.

The grades of fibre produced to-day are equal to any on the market in spite of the unfavourable manner in which, as stated, the brittle and commercial quality fibres occur intermixed.

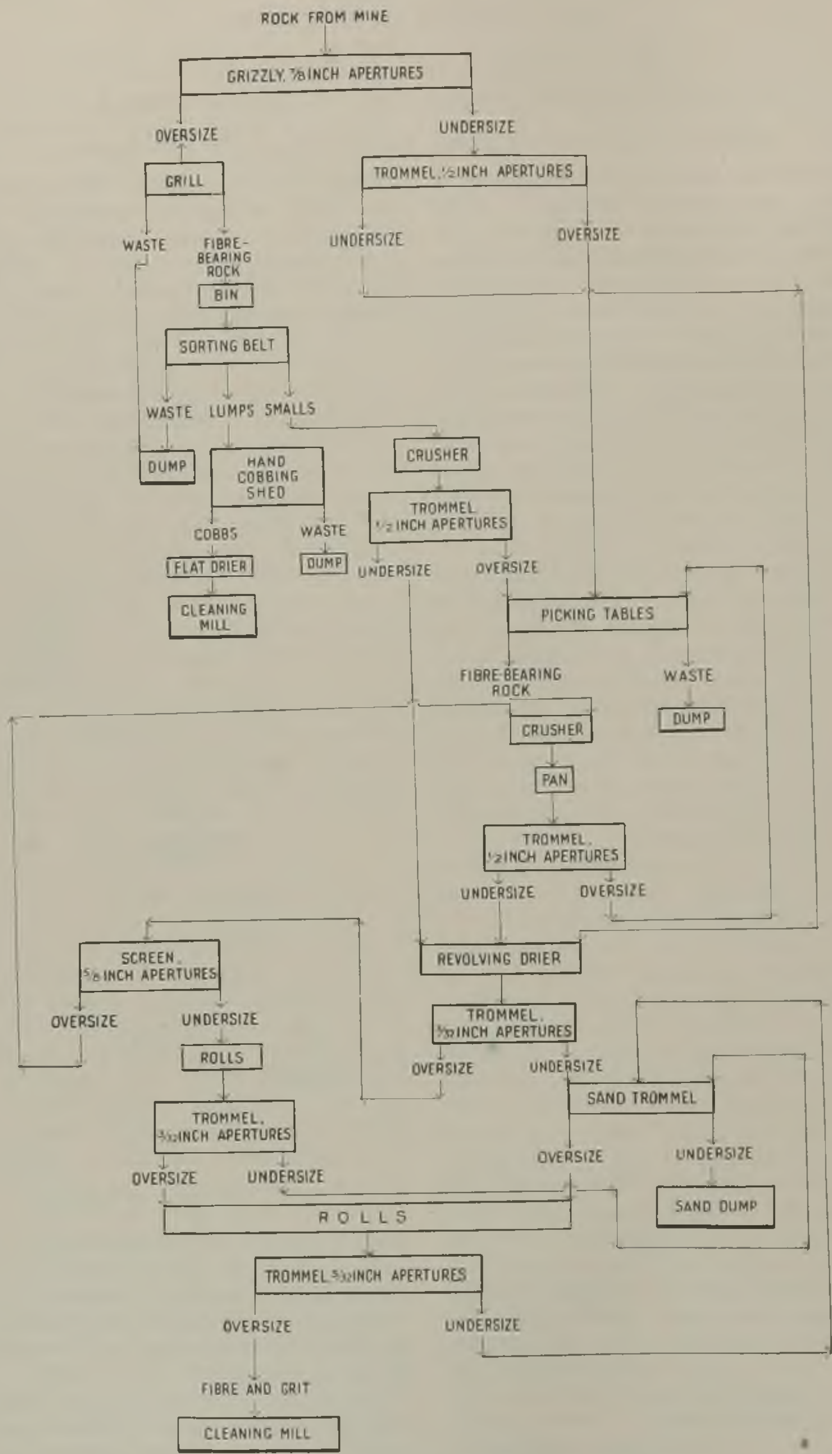


FIG. 2.—PRESENT FLOW-SHEET OF SORTING MILL.

To a great extent the flow-sheets of the Ethel mine milling plant are self-explanatory. The grill embodied in the sorting mill (Fig. 2) has apertures 1 in. less in diameter than the largest rock with which the crusher (10 in. by 6 in.) can deal. It will be noted that no hand-cobbing of the asbestos seams is carried out in the open quarries, as is usual in Rhodesia, a good point insomuch as no reliance is thereby placed on the judgment of the native miner in throwing out lumps of asbestos-bearing rock which present difficulty in cobbing. The cobbs withdrawn from the mill-feed at an early stage are accumulated until sufficient are on hand for a separate run through the cleaning mill to be made. As shown in Fig. 3 the longer grades of fibre (Nos. 1 and 2) do not receive excessive treatment.

When dealing with fibre from the oxidized zone of the mine, which fibre is invariably milled separately owing to the fact that it is stained, the No. 1 fibre does not receive any further treatment after leaving the grading trommel, the No. 2 fibre similarly passing through curtailed treatment and being bagged straight from the settler. White fibre No. 1 and No. 2, that is, from below the oxidized zone, pass through the grading trommel and pan three times in order to get rid of the friable brittle fibre.

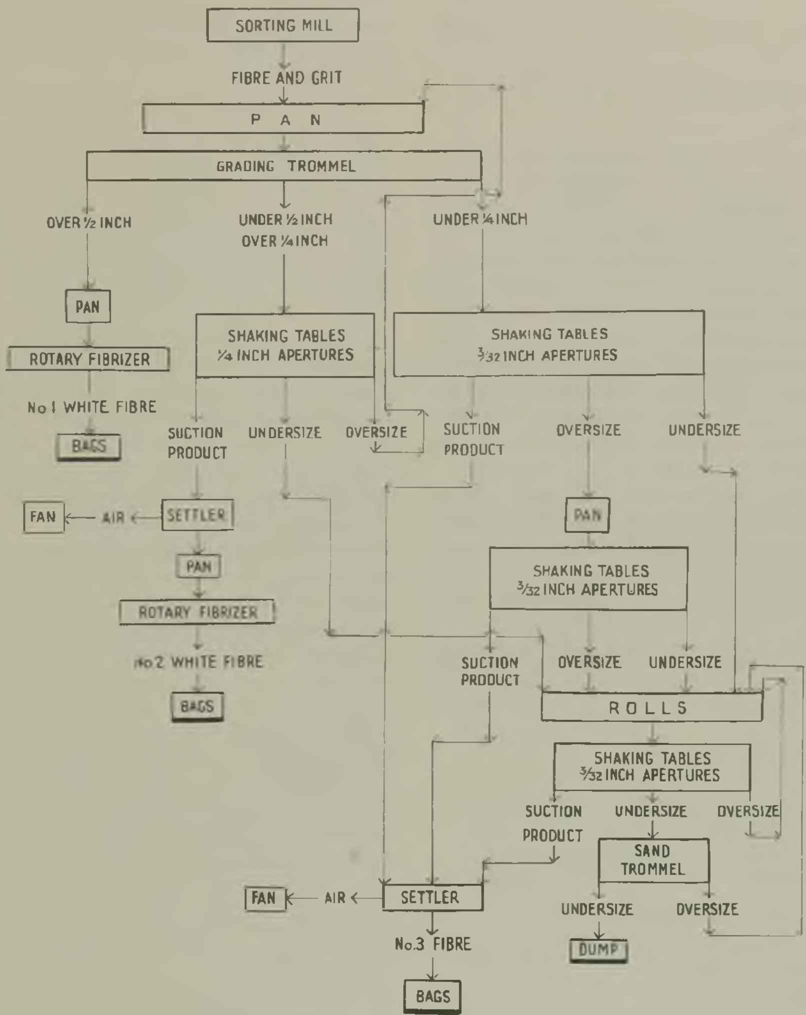


Fig. 3.—Present Flow-Sheet of Cleaning Mill.

The capacity of the sorting mill is greater for unoxidized than for oxidized rock owing to the increased percentage of fines in the latter, the ultimate capacity of the whole plant per 24 hours, expressed in terms of tons of rock, naturally varying with the percentage of fines in the rock treated.

For permission to obtain the facts given herewith, as also for his cordial and willing assistance in the preparation of the flow-sheets, the writer is indebted to Mr. S. R. Tonkin, to whom he wishes to express his sincere thanks.

LETTER TO THE EDITOR

Hydrogen Assay for Tin Ore

THE EDITOR :

SIR,—Mr. Allen in his valuable paper on the hydrogen reduction method states that potassium iodide in sufficient quantity prevents the interference of $TiCl_3$ in the iodine titration of stannous chloride. Although he prefers to add it incorporated in the iodine solution, it follows logically, and is at the same time good chemistry, that the addition of x grams of potassium iodide to the assay liquor of a Beringer, Pearce, or hydrogen method, and preferably prior to reduction to stannous, should answer the same purpose.

But does it in either case ? Frankly, I am sceptical but not inimical, and on behalf of all tin assayers equally interested, I appeal to him through your columns to give such evidence in support of his contention as will bring conviction.

I note also that the hydrogen reduction method does not ensure freedom from Ti in the assay solution.

H. W. HUTCHIN.

Tuckingmill, Camborne.

January 25.

BOOK REVIEWS

Elements of Geophysics. By Dr. R. AMBRONN. Translated by MARGARET C. COBB. Cloth, octavo, 294 pages, illustrated. Price 25s. New York and London : McGraw Hill Book Company.

The original German edition of Dr. Ambronn's book was reviewed in the May, 1927, issue of this magazine, when the general scope of the work and its method of treatment were indicated. The volume is not intended as an exhaustive text-book on applied geophysics, but rather as a comprehensive guide for both the mining engineer and the geologist. "Elements of Applied Geophysics" would have been a more fitting title, as there are several branches of pure geophysics with which the book does not presume to deal.

With the rapid progress that is continually being made in the development and application of these methods of prospecting the mining engineer finds himself more and more in a state of quandary and indecision as to the reliability and usefulness of any one of them, and this renders it the more difficult for him to differentiate between the more obscure methods of the diviner and the highly developed and strictly scientific procedure of the modern geophysicist. This book enables him to become conversant with the general principles of the subject, and thus places him in a position to collaborate usefully with the practical geophysicist, so that the methods may be applied to the best advantage.

In facilitating the translation of this book, Mr. De Golyer and his associates have rendered a great service to English-speaking engineers and geologists, and have made available to them what is perhaps the best exposition of the subject that has yet appeared.

The translation as a whole is commendable, although there are occasional signs that the translator is not thoroughly conversant with all branches of the subject, while in places a somewhat freer translation would have been preferable. Useful matter has been added in several chapters by the translator, bringing the book more nearly up to date. Additions have been made in Chapter IV on the radioactive method, and in Chapter VI, where information on the electrical methods and a discussion on electromagnetic vibration ellipses have been introduced. In Chapter VII, dealing with the seismic method, useful information has been incorporated on the analysis of time-distance curves, and a number of actual records are now given.

It cannot be emphasized too strongly that applied geophysics is and will always remain a most useful auxiliary to the practical geologist, increasing the range of his knowledge by providing a means of elucidating subterranean anomalies which would otherwise remain unknown. An intimate and continuous collaboration between the geologist and the geophysicist is essential for the success of these methods in locating and delimiting the mineral wealth still awaiting discovery and exploitation, and this book contains all the information that the geologist will require in this connection.

H. SHAW.

Methods in Non-Ferrous Metallurgical Analysis. By ROBERT KEFFER, late Chemist to the Anaconda Copper Mining Co., and C. L. MCNEIL. Cloth, octavo, 336 pages, illustrated. Price 20s. New York and London: McGraw-Hill Book Company.

The number of text-books on assaying and metallurgical analysis is becoming so great that a new volume needs to be of a very attractive character before it can claim a place on the bookshelf. The late Mr. Robert Keffer has not deviated greatly from the procedure of his predecessors in the compilation of this work, but he has certainly succeeded in compressing an enormous amount of information into 335 pages. A new and valuable feature is a chapter on the analysis of xanthates, which gives the book a claim to the consideration of those engaged in flotation work.

The book is intended for the use of metallurgical chemists and for students taking advanced analytical courses. So far as the latter purpose is concerned, it suffers from the omission of the theoretical considerations underlying the methods given, and of many of the possible causes of error due to the presence of associated metals. In the "Low" tin assay, for example, the only interfering metal mentioned is copper. To include one metal by name in this way is misleading, as it suggests that no other interferences are to be anticipated.

The subject matter is arranged, for the most part, in alphabetical order, each metal being treated in a separate chapter. Each chapter gives, firstly, a summary of the methods mentioned; secondly, a description of the general methods and of methods suitable for particular cases; thirdly, the method for the determination of traces; and finally the estimation of impurities usually present in the metal or in substances of which the metal forms a major constituent. Such an arrangement as this is excellent in principle as it facilitates rapid reference. It is, however, somewhat difficult to carry out satisfactorily in practice. Thus the determinations of cadmium in zinc and of zinc in cadmium materials both appear in the chapter on cadmium. Determinations in copper leaching solutions, however, with few exceptions, are scattered through the whole book under various headings.

A book which attempts to cover so large a subject as non-ferrous metallurgical analysis in such a small space is bound to omit a considerable amount of material. This is unavoidable, but it is surprising to find no mention of the determination of gold and silver in lead bullion. Various well proved methods for other determinations might have been included with advantage, such as the permanganate and iodometric titrations for antimony, and the ferric chloride titration for tin. On the other hand, the inclusion of methods for the determination of chromium, cobalt, phosphorus, tungsten, and iron in steel seems unnecessary.

The appendix contains the usual reference tables, including conversion factors, weights and measures, etc., and is followed by a very complete index. An excellent feature of the book is the frequent references to technical papers and other text-books where further information may be obtained. If this cannot be considered to be the perfect text-book, it is certainly a laudable attempt to cover an enormous subject in a very small space.

C. W. DANNATT.

An Introduction to the Study of Minerals and Crystals. By E. H. KRAUS and W. F. HUNT. Second edition. Cloth, octavo, 600 pages. New York: The McGraw-Hill Book Co.

This is the second edition of a work which first appeared in 1920. Many changes in the text have been made and chapters on crystal structure and X-ray analysis have been added. The book has made its reputation as an excellent introduction to the study of minerals, and the student will find it a good book with which to commence, but he must not expect to find particulars of the rarer minerals. A large number of illustrations have been added. Some of these, notably the illustrations of actual mineral deposits, are decidedly instructive, while others, such as portraits of eminent mineralogists and small photographs of polished rocks, are of doubtful value. The chapter on blowpipe reactions is good and thoroughly up to date. Though the use of the microscope for the determination of minerals is dealt with, the microscopical characters of the various minerals are not included in the mineral descriptions.

The general subject order of the book is as follows :—Crystallography, various crystal systems treated in detail, physical properties, the polarizing microscope, crystal structure and X-ray analysis, chemical properties, formation and occurrence of minerals, qualitative blowpipe analysis, descriptive mineralogy, gems and precious stones, classification of minerals according to elements with their occurrence and economic uses, glossary, and tables for determination of minerals. The book can be strongly recommended to students beginning the study of mineralogy.

E. H. Davison.

The Geology of Petroleum and Natural Gas. By Dr. E. R. Lilley, Associate Professor of Geology at New York University. Cloth, octavo, 502 pages, illustrated. Price 30s. New York : D. Van Nostrand Co. ; London : Chapman and Hall, Ltd.

The cover and title page of this book have the name Chapman and Hall, Ltd., in the positions where the publishers of books usually print their names, but on the reverse of the title page we find that the book is printed in America by the Lancaster Press, Inc., Lancaster, Pennsylvania, and that the copyright is owned by the D. Van Nostrand Company, Inc., of New York. It is an example of the habit, which is growing, of firms in this country having their names printed on books as if they were the publishers, when actually the books are published and printed abroad. The habit is misleading, as prospective buyers in a bookshop, seeing a book with a well-known English publisher's name on the cover, are apt to infer that the book is an English publication produced by the particular firm of publishers whose name catches their eye.

In the preface the author states: " Additions to our knowledge are being made every day. Yet it is necessary from time to time that we stop and summarize the data that have become available. It is now almost impossible for even the individual who is actively practising the profession of petroleum geology to keep up with its literature. This book has been written to supply to such individuals and to others, whose work brings them into contact with geologic problems in the field of oil and gas, a single volume in which they may find brief statements of principles of the science and examples illustrative of the application of those principles."

The demand for the book in this country will not be as great as it deserves, because, for some reason never yet explained, the academic leaders of the science of geology in Great Britain as a rule look upon oil geology as a thing entirely apart from the science which they profess. Also, the comparative few in this country whose work brings them into contact with geological problems connected with the occurrence of oil and gas prefer as a rule to remain firmly seated on the fence when any question regarding the origin of oil arises, and to view with distinct disapproval any attempt to shake them off it.

The book deserves careful reading because of the vast amount of information which the author has attempted to condense into it, and although it is impossible to bring into one volume all the information which the author has attempted to assemble, nevertheless the brief references serve as a link between the seeker for information and the publications where that information may be studied at length. With so much information to be studied, it was only to be expected that occasionally the author would draw erroneous conclusions from too hurried reading. For instance, on page 69 he attributes to me an explanation of the phenomenon of the sedimentary deposition of oil which is exactly what I have been at pains to explain is what does not happen. Also he occasionally makes dogmatic statements which it would have been wiser to quote as someone else's opinion, such as that (page 156) in Persia the oil, while of Miocene origin, is obtained from the underlying porous limestones (Oligocene) instead of sands.

The book is based on the theory, largely accepted in America, that kerogen is an intermediate substance in the alteration of organic matter to petroleum, and, to quote the author : " Considerable modification would be necessary if new evidence were discovered, which would make it necessary to revise the views of the nature of kerogen which have been accepted."

Murray Stuart.

The Economics of Coal Mining. By ROBERT W. DRON, Professor of Mining in the University of Glasgow. Cloth, octavo, 168 pages, illustrated. Price 10s. 6d. London: Edward Arnold and Co.

Attention has often been drawn to the modern tendency in the authorship of works on mining to specialize in one small branch rather than to attempt a comprehensive treatise on the whole as was formerly a fashion. Nowadays a joint effort would be necessary if it would carry the weight of authority to the critical circle of readers for whom such works are written. When a book on a highly specialized subject appears from the pen of a professor of mining, there is a feeling that several birds have been killed with one stone, and that with an indoor subject of the nature of the "Economics of Coal Mining" there will be a sound exposition of the subject probably based on a series of repeatedly revised lectures. The finished work then may become a guide to the students of the present generation as well as trustworthy support to the already formed ideas of coal mining engineers at large. Professor Dron's book satisfies the expectations, and if some readers think that it does not go far enough, the answer is that the publishers and author wished to limit the size and cost of the book. If in the following remarks reference is made to omissions, this restriction must be given weight.

The recent and present conditions of coal mining are given in Chapter I by way of introduction. Mineral Leases are dealt with from an up-to-date point of view in Chapter II, and in the section which treats the method of ascertaining the quantity of mineral worked, those readers engaged in surveying will wish that this section had been considerably expanded. To aid the novice, Table V, p. 21, might have had a little further explanatory matter added at the head of columns 3, 4, and 5. Next there is an account of the Valuation of Minerals, with an appendix giving rules for the relevant calculations. It is rather surprising that examples of the use of each rule as evolved have not been included, as it would have made the book more useful to the student. Valuable tables are given at the end of this chapter.

The next three chapters will repay a most careful study by all concerned, as they contain useful original matter on the Valuation of a Going Colliery, on the Development of a New Colliery, and on Power Production. On page 88 appears an argument in favour of the reduction of the size of the upcast shaft. General readers will need to read this carefully, as it applies only to those cases where all the hoisting of mineral is done in the downcast shaft, the upcast being kept as a second outlet and for ventilation only, and hence the flow of air in the upcast is not interrupted by the frequent passing of cages, and the consequent increase in the turbulence factor is absent. Where both shafts are used for the hoisting of men and minerals it would appear that the shafts would need to be of equal size at least. A further examination of the ventilation question would show that the upcast shaft needs to be made larger wherever two shafts only are available by reason of the increase in temperature in the upcast as compared with the downcast, bringing as it does increase in the volume which is further augmented by the gases given off from the strata. The increased volume in the upcast shaft, where both shafts are of the same area, is dealt with by an increase in the velocity in the upcast, and the increased velocity causes a rise in the power required *which increases as the velocity cubed*. Where two shafts only are available for the ventilation, necessarily and naturally they form the bottle necks of the whole system. The truth of the above is easily proved by taking a simple numerical example in which two shafts of equal cross-sectional area are used, and in which the temperature of the downcast is 60° F. and the temperature of the upcast is 70° F., a difference of only ten degrees. With a quantity of 100,000 cu. ft. of air per minute and a velocity of 1,000 ft. per minute, the increase in velocity due to the difference of temperature is nearly 2%, and the increased power is nearly 8%. The values of all the quantities used are lower than is commonly found in practice, but sufficient has been given to show that much more space would be required adequately to discuss all sides of the question of the most economical sizes for shafts. The chapter contains much food for thought on capital expenditure and the author has been bold enough to give ideas of costs at a time when many may consider that financial stability in coal mining in this country has not yet been reached, but in spite of this the figures will be found useful for some years to come.

Chapter VIII, on Organization, recalls the storm of criticism and advice given by the daily press, which held up the coal-mining industry of the United States as a shining example to the engineers in charge of the coal mining of Great Britain, completely ignoring the vast difference in the conditions existing in the two countries. Grouping of collieries was an idea spoken of as if it was something new, but no attempt was made to give the evidence for and against its adoption. This porton of the book presents one or two useful accounts of this and other important matters, in a form more easily accessible than previously, but even so this matter was never adequately discussed and impartially decided by the public. This is followed by a short chapter on the Economics of Coal Cleaning based on the latest information available, and then by the concluding chapter which is on the law of Britain concerning the right of support. This subject is so vast that any attempt to discuss it in such a book can only be regarded as an introduction to the matter and as a reminder of the relation of the law to economics.

Students of coal mining will find the book very useful. There are copious references which will assist the tracing of each subject through its various phases. As already mentioned, the size of the book does not permit of the pursuit of each subject to exhaustion so it can merely give the salient points as a foundation on which the reader may build. Senior engineers will find many of their ideas co-ordinated in this book, and there are others who could read it with profit.

C. Habberjam.

Stratigraphical Palæontology : A Manual for Students and Field Geologists. By E. Neaverson, D.Sc., F.G.S. Cloth, octavo, 540 pages, illustrated. Price 18s. London : Macmillan and Co., Ltd.

The dictum "Palæontology is the handmaiden of stratigraphy" probably requires revision in the light of progress in this science. Indeed, to continue the metaphor, one might almost say that the handmaiden has now become the mistress. At all events, few will disagree with Professor H. L. Hawkins that stratigraphy to-day "is a kind of applied palæontology," for the former subject is now so largely interpreted in terms of biological reasoning that, devoid of this reference, its stimulus to geological progress would be sadly diminished.

Critics of the existing order of things are not wanting, particularly those whose student days seem far away and whose geology has been turned to economic account in the remoter places of the world. Some view with misgiving the sway of intensive biological research in the domain of palæontology, with its compelling attention to detail of structure and organization of plant or animal, from which is forged an unceasing chain of varieties and new species. Knowledge from the lecture-room of bygone days has, they complain, to be partly unlearnt ; the old familiar formation with its common fossils is now rent with zones and non-sequences ; a perplexing nomenclature hides the identity of once well-recognized forms ; and new dividing lines have been drawn wherein lithology no longer seems to count. In the circumstances, it is argued, nothing remains but to hand over the finer points of correlation to the specialist, with the fervent hope that his findings will not upset too much deductions based on *a priori* argument. Such is the gist of the grumble.

This attitude is to some extent understandable, but it is a mistaken one. It arises from a blurred perspective in which the demands of progress are obscured. Palæontology, to be a vital force in geology, must itself evolve, both in method of study of fossils as indices of organic evolution, and in its relations with stratigraphy. This it has done, and in no uncertain manner. If in the flood of recent discoveries the biological aspect has been unduly stressed, the stratigraphical standpoint has never really been lost sight of ; rather has it been a case of modifying stratigraphy in accordance with more philosophical and exact data thus determined. The convenient term "biostratigraphy" emphasizes this conception ; it is fully recognized on the Continent, to the extent of possessing appropriate text-books. In our own country stratigraphical palæontology finds a conspicuous place in the curriculum of most geological schools, but, as the author of this book indicates, it lacks a modern English treatise. This is the omission, now corrected by the appearance of this volume. The author aims at teaching the student to use his palæontology, according to current precept and practice, to best advantage in geology. In this he is more than successful, for, apart from fulfilment of purpose, no one can read his opening chapters and yet remain dissentient.

Mining men, oil geologists, engineers, and others concerned with economic geology —from whose standpoint this review is expressly written—will gain just that re-introduction to modern palæontology they need after a long spell in the field, out of contact with current thought and progress. Short of attending refresher courses at home, to many an impracticable proposition on the score of time and other circumstances, they have here the means of assimilating knowledge which is bound to prove valuable in future work. A brief survey of the text gives point to this observation.

The first seven chapters discuss, *inter alia*, principles of correlation, evolution, and stratigraphy, means of identifying fossils. morphological features of the chief groups, preservation and occurrence of fossils, their relation to habitat, their geographical distribution and migration, and their functions as indices of horizon. These chapters cover the ground in a general, but none the less comprehensive way. The reader grips a clear idea of the matters dealt with and is never fogged by hosts of unexplained technical terms, the bugbear, for the uninitiated, of many palæontological writings. A restrained use of bold type for such technical terms as appear in the text facilitates reference and, incidentally, contributes much to render the text clear and readable.

In the second part of the book, the "biostratigraphy" of Britain is described, thirteen chapters being devoted to the faunas of the various geological systems involved. This section may at first glance appear of less immediate value to the geologist abroad, save for comparative purposes; but he should not neglect its perusal, especially the chapters dealing with similar systems to those with which he is himself concerned; he will at least learn something of what has been accomplished by recent research at home. On the other hand, if he be immersed in problems of Miocene history, the imperfection of our geological record, and not the author, must be blamed for the paucity of data presented. He may, or may not, agree with the author in the unequivocal dismissal of "Quaternary System" on the grounds that there is no palæontological justification for its recognition as such; it depends how far inclinations are concerned with flint implements and "Newer Tertiary" man.

Of all geological literature, books on palæontology should be profusely illustrated, since we are as far off as ever from the student ideal that fossils should bear their generic and specific label *in situ* when found! A generous measure of some five hundred drawings, diagrams, and photographs is included in this volume, many of them well executed; these should satisfy the most exacting reader.

Bibliographical references are appended to each chapter. These have been selected from the foremost publications on each relevant subject. They are never allowed to degenerate into lengthy, forbidding lists, and therefore gain in usefulness by this fact; still more by the short epitome of the substance of the work cited, which follows in the majority of instances.

H. B. MILNER.

NEWS LETTERS

BRISBANE

December 17.

MOUNT ELLIOTT AND CLONCURRY.—The lately announced intention of the Mount Elliott company to resume operations on a comprehensive scale in the Cloncurry district, in this State, means a great deal to the copper-mining industry of Queensland, if not to the whole of Australia. This vast mineral field, after the Mount Elliott, Hampden Cloncurry, and Mount Cuthbert companies closed down, lay practically dormant for several years, mainly owing to the low ruling price of copper. Mount Cuthbert was the first to cease operations, and the Hampden Cloncurry company has lately gone into liquidation. The directors of the Mount Elliott, however, despite the set-back occasioned by the failure to discover new cupriferous deposits on the company's leases and the fact that the newly installed Mackay electrolytic plant at Cloncurry was never put into commission, were fortunately so impressed with the possibilities of its existing mines that they have, on the recommendation of their advising expert, Mr. C. Q. Schlereth, decided to deal with the known quantities of ore, estimated at 1,750,000 tons, by established methods of treatment. Their estimate of profits is based on a price for electrolytic copper of £63 per ton, and seeing that the metal is now over £74, they have the advantage of a greatly improved margin.

Under the new scheme of operations, the electrolytic plant, the erection of which was completed over eighteen months ago, is to be altered so that it will refine blister copper. The company's old works, which have been idle since 1917, are at Selwyn, the terminus of the Mount Elliott railway, 71 miles south of Cloncurry. Here the Mount Elliott mine is situated; and, as showing the vastness of the area over which the company's leases extend, its Mount Oxide mine, the "best of the bunch," is north-westerly from Cloncurry 141 miles—69 miles by rail and 72 by road. The Premier of Queensland (Mr. M'Cormack) has intimated that his Government is agreeable to provide facilities for the company to carry out its Cloncurry proposals, which Mr. M'Cormack regards as of national importance and as leading to a complete revival of copper mining in the Cloncurry district. This no doubt means that the Queensland Government will, for one thing, grant substantial concessions in railage freights, as it has already promised to do for the Mount Isa company, in the same district. The Premier also mentioned that Mr. Schlereth estimated that if the work of equipping the Mount Oxide mine for the production of its high-grade oxidized ores could be commenced by the beginning of 1929 production should start by April 1, 1930.

Mount Isa.—Prospecting work at the Mount Isa mines is still chiefly in the shape of diamond-drilling, the only other mining being the sinking of Davidson's shaft, the starting of a winze at the 300 ft. level in the Doherty shaft on the Black Rock lode, and the opening out of the experimental stope over the 80 ft. level on the Black Star lode. In the four weeks ended October 19 the total amount of drilling carried out was 186 ft. on the Rio Grande lode, 822 ft. on the Black Star, and 251 ft. at the Deep Levels. A section in the Rio Grande, when the bore-hole had been deepened to 882 ft., showed values: 834 ft. to 836 ft., 9·8% lead, 9·7% zinc, and 4·6 oz. of silver per ton. Diamond-drill bore-hole No. 4B, on the Black Star lode, was completed at a depth of 1,208 ft., and the plant was shifted to another site. The average value of the churn-drill bore-hole No. 11 on the Black Star, from 5 ft. to 253 ft., was 8·5% lead and 6·6 oz. of silver a ton. The concreting of the Rifle Creek dam has been proceeding satisfactorily, and the erection of workmen's cottages is being carried on with two gangs, totalling 120 men. On the railway under construction the rails have been laid to 42 miles from Duchess, or within twelve miles of Mount Isa.

Industrial Troubles.—Just now there is a respite from the industrial troubles which are so frequently with us in Australia, and which have so seriously interfered with mining in all the States. The latest strike, and one of the worst, was caused by the water-side workers, who refused to abide by an award of the Federal Arbitration Court. This strike, stopping shipping, hung up supplies for Mount Isa and other mining centres, and seriously interfered with the coal trade as well as the sugar industry of Queensland. It also affected the zinc markets of Great Britain through the uncertainty of the date of arrival of Australian supplies, mainly those from Broken Hill. The ship-owners took a firm stand, holding that the men must abide by the law; they engaged volunteer labour which was forthcoming in large numbers notwithstanding physical hostility, and in the end the unionists were hopelessly beaten, leaving thousands of them stranded without work. Fortunately there are now indications of a desire on the part of the industrialists to bring about more amicable relations between employers and employed, and the former appear to be ready to assist in such a move. Preliminary sittings have been held of what is called the Peace-in-Industry Conference, in which both parties are represented; and a step towards a much-desired peace on the waterfront has been foreshadowed in an invitation which the Prime Minister (Mr. Bruce) has stated his intention of issuing for a conference of those directly interested in the waterside work.

Mount Morgan.—Yet another move—and one that seems to be assuming a concrete form—has just been announced for the resuscitation of the Mount Morgan mine. This has taken the form of the New Mount Morgan Gold Mining Co., Ltd., of which a prospectus has been issued. The capital of the company is £250,000. Its object is to purchase the Queensland assets of the old company for £120,000, to dispose of certain of the plant and equipment not required in future operations, to recover copper by precipitation, treat a quantity of tailings, recover accessible ore, and to consider the working of the remaining ore in the mine.

Yampi Sound Iron Ore.—Mr. John Thomson, the lessee of the iron ore deposits of Yampi Sound, Western Australia, has entered into negotiations with the United States for supplying foundries in that country with ore from those deposits, and has left for England on his way to America to continue negotiations in person. Some American financiers wished to buy out Mr. Thomson's rights, but he prefers to continue control of the deposits. He states that at no time had he entertained any idea of selling Koolan Island, in Yampi Sound, to the Japanese, as had been reported.

New Guinea.—The Commonwealth Administrator of New Guinea (General Wisdom), when lately in Australia, expressed the opinion that there is great promise in the New Guinea goldfield. During the year ended June 30 last, he stated, there was exported a total of 113,000 oz. of gold, of the value of £256,216, which, as a result of the exhaustion of some rich alluvial patches, was slightly less than that for the previous year. With the discovery of reefs and lodes, however, the fields, the Administrator says, are reaching a permanent and valuable stage. Following on the interest taken by those connected with Mount Isa and the Russo-Asiatic Consolidated, and the formation of a group in London that is taking options over leases at Edie Creek and elsewhere, big developments are expected.

Mr. Henry W. Clark, a mining engineer, who was the first to prospect for lodes on the Bulolo goldfield, and who returned to Australia recently, has declared that this is the richest field discovered for many years, and believes that many other rich discoveries will be made. He considers it has many advantages, including native labour, ample water power, and an abundance of timber. The opening up of the quartz lode on Golden Peaks No. 4, the property of New Guinea Gold Fields Exploration, Ltd., of London, declared Mr. Clark, revealed that the new lode was more than 40 ft. wide. It was impregnated with veins of quartz up to 5 ft. wide on the foot-wall side, and nine bulk samples taken in 5 ft. sections from the foot-wall proved the lode to be the richest discovery made on the field.

JOHANNESBURG

January 4.

The New Diamond Fields.—It is reported from Namaqualand that the marine terrace recently discovered by the Consolidated Diamond Mines of South-West Africa on the north bank of the Orange River has already been proved to be some 800 yards long, and indications show that it may extend another 800 yards. Some large diamonds have been found in the terrace, including one of over 260 carats. According to the Precious Stones Act, no prospecting on farms can be done without a prospecting permit from the Minister, and although a large number of applications for such permits have been made, only about six have hitherto been granted.

Dr. H. Merensky, the well-known geologist, one of the discoverers of the diamondiferous deposits at Alexander Bay, states that the diamonds recovered there are realizing an average price of £12 per carat. He considers that the fine stones recovered on the northern bank of the Orange River should prove of the greatest value to the Consolidated company, inasmuch as they can be used to lend variety in size and value to the parcels of stones from the South-West. A well-assorted parcel of large and small stones is naturally of the greatest commercial value. For this reason the significance of the finds on the north bank of the Orange River is very considerable.

A Dying Gold Mine.—Operations at the Ferreira Deep will continue for only a few more months. The mine is 30 years old. At September 30 last the company had crushed over ten million tons of ore and won 4,373,05 oz. of gold (8·225 dwt. per ton milled) for a working revenue of £18,803,794 (35s. 4d. per ton). Working expenditure amounted to £10,938,682 (20s. 7d. per ton) and working profit £7,865,111. Dividends have been paid totalling 702½%, and absorbing £6,637,207. The tonnage milled during the year ended September 30 last compared with that for the preceding twelve months was greater by 7,200 tons, but the working revenue was lower by 1s. 9d. per ton milled owing to a further decline in the yield. Working costs were reduced by 2s. per ton milled, and the net result was an increase of £6,688 in the profit. The working profit for the year amounted to £50,080.

Transvaal Phosphates.—The South African Phosphates Exploration Syndicate is developing a large occurrence of phosphate of lime near Bandolier Kop, Northern Transvaal, with the object of supplying farmers in the Union and Rhodesia with a very necessary fertilizer. The Syndicate's property lies within seven miles of the main line of railway, and extends for six or seven miles along the outcrop. The lodes vary in width from 1 ft. to 22½ ft. and contain quantities of phosphoric acid running up to 30%. The deepest point to which the lodes have been followed is 180 ft. on the incline, and some 46,000 tons of phosphate rock are now in sight. The deposit is the only valuable one known in the country, and it may reasonably be expected that when the production stage is reached the syndicate's product will find a ready sale.

Postmasburg Manganese Fields.—It is hoped that the negotiations proceeding between the Union Manganese Mines and Minerals, Ltd., and a British firm of high financial standing will result shortly in the formation of an enlarged company to acquire the whole of the Union Manganese company's property in the Postmasburg district and provision of the funds required for the construction of a railway to the fields. One of the British firm's representatives is now inspecting the company's properties. The company has recently acquired options over three copper propositions in the district of Hay on very favourable terms.

Platinum.—At the end of November last Potgietersrust Platinums, Ltd., had on hand and in transit 1,172 tons of concentrates, the estimated metallic contents of which are platinum 4,850 oz., palladium 5,019 oz., other platinum group metals 203 oz., gold 314 oz., nickel 46 tons, and copper 24 tons. These concentrates have been obtained from Potgietersrust ore, and their total value, estimated at prices much lower than those ruling at the present time, is £110,000. The company has cash on deposit, quite apart from the £110,000 locked up in concentrates, amounting to £308,652, which is ample to meet the capital expenditure necessary to bring the Rustenburg properties to the producing stage. The concentrates were produced by the pilot plant and probably represent a profit of £25,000 per annum. It is unofficially estimated that if the proposed larger plant can be kept going on, say, 10 dwt. platinoids ore and treats 70,000 tons per annum, the company's profit for the first twelve months should be something like £350,000. The New Consolidated Gold Fields, Ltd., has secured an interest in the Rustenburg platinum field. It holds options over a number of shares in the Waterval (Rustenburg) Platinum Mining Company, and if the options are exercised the New Consolidated Gold Fields will have a predominating interest in the platinum company, which is an offshoot of Lydenburg Platinum, Ltd. The property is being rapidly developed under the technical management of the New Consolidated Gold Fields with a view to reaching the producing stage as soon as possible.

Nickel Discovery in Rhodesia.—A promising discovery of nickel has been made in the Gwanda district of Southern Rhodesia. A block of claims pegged by a farm-owner and a prospector, acting in concert, has been optioned to the Bechuanaland Exploration Co., and an early start is to be made in prospecting and developing the occurrence. A large number of claims has been pegged in this new nickel area, and three blocks adjacent to the original discovery have been secured for the Gorge Company. According to the *South African Mining and Engineering Journal*, the nickel minerals observed so far include garnierite, a hydrated silicate of nickel and magnesium; niccolite or kupfernickel, a nickel arsenide; and chloanthite, an alteration product from the arsenides, which is likely to be superficial. Various arsenide samples, some high-grade and others of less obvious merit, have been analysed, and have given nickel values of from 13 to over 31%. These were only surface samples, and no more can be said of the results than that they are highly encouraging. The average Sudbury ores contain about 3% of nickel and 2% of copper, together with very small quantities of platinoids, and on these values the present prosperity of the great nickel combine, lately achieved, is founded.

In Southern Rhodesia the nickel is found over a considerable area in circumstances which suggest large lenses if not vein formation. It does not seem as though the metal is confined to a few small patches. Analyses of the kupfernickel and chloanthite specimens have given over 30% of nickel and also of arsenic, from which it appears that there are no other metals such as cobalt or iron present, the rest of the sample being gangue. In other words, the discovery seems to be unique, relating to a straight nickel-arsenic ore. The economic possibilities are therefore of some importance.

Diamonds in Tanganyika.—Very satisfactory results were reported at the annual meeting of Tanganyika Diamonds, Ltd., held in Johannesburg. The profit earned by the company during the year to June 30 last was £51,517, equal to a little over one-third of the company's capital. The profit and the balance of £30,562 brought forward from the previous year make a total of £82,080. Since the end of the financial year the shareholders have received a dividend of 25%, which absorbed £37,500. Although there is sufficient cash in hand to enable the directors to declare another substantial dividend, they have very wisely decided to conserve the company's cash resources. It was pointed out at the meeting that the new Shinyanga diamondiferous field, in which the company is largely interested, extends over an area 60 miles long, with kimberlite occurrences spread over a large area, and requires a good deal of development. The prospects there look very promising, and the company may at any time be called upon to provide plant and machinery which will run into large sums. Moreover, the company is holding over 9,000 carats of diamonds worth over £50,000, for an improvement in market prices, and it is therefore necessary that it should retain a large amount of cash.

CAMBORNE

February 5.

COMPENSATION IN CASES OF SILICOSIS.—New regulations dealing with compensation in cases of silicosis have come into operation, and Cornish tin and other miners who have become disabled through this disease are now entitled to compensation. Although the regulations imposed on the Cornish mines are less stringent than those enforced on the South African mines, they nevertheless throw increased responsibility on the mines as employers of labour.

ADVANCE IN THE PRICE OF WOLFRAM.—During the past year the price of wolfram has risen from about 14 shillings per unit to its present price of 21 shillings per unit for good class concentrates. If this upward tendency in price is maintained, the production of wolfram by the leading Cornish mines will, without doubt, be given serious consideration. For some time past several of the mines experienced great difficulty in marketing their wolfram concentrates, with the result that the production was considerably curtailed and the sections of the lodes rich in wolfram were not exploited to their full extent.

DOLCOATH.—It is satisfactory to note that the Roskear shaft is being kept unwatered, and surely one is entitled to gather from this that all hope of obtaining fresh capital has not been abandoned.

NEW VENTURES.—Preliminary operations are being carried out at Wheal Merth, a tin mine near St. Erth, at Georgia mine, situated in the parish of Towednack near St. Ives, and on a promising tin lode on Castle-an-Dinas hill about halfway between Penzance and St. Ives. This Castle-an Dinas should not be confused with the hill and mine of similar name situated near Roche in mid-Cornwall.

It is understood that arrangements are being made for the erection of a plant to treat the dumps at Clitters mine, near Gunnislake in East Cornwall.

There are persistent rumours afloat to the effect that a company is being formed to dredge the river Tamar for tin.

LAMBRIGGAN.—Referring to the notes on Lambriggan and Wheal Hermon in the January issue, it is now stated that these two mines are separate propositions. The fact that Messrs. R. C. N. Robinson and Co. are consulting engineers to both ventures gave rise to the error.

VANCOUVER

January 11.

MINING AND INDUSTRIAL OUTLOOK.—The last few days of the old year and the first few of the new were made the occasion for some exceedingly important announcements. Mr. J. J. Warren, president of the Consolidated Mining and Smelting Co. of Canada, made the announcement at Nelson that he considered the time was ripe for the erection of a copper refinery on the coast of British Columbia and, if the present producers would combine and agree to support the plant, there is no reason why the construction of a refinery should not be started immediately. In round figures, 100 million pounds of copper was produced in British Columbia last year, of which less than 40 million pounds was smelted and less than 20 million pounds was refined in the Province. The production came almost entirely from the Granby Consolidated Mining Smelting and Power Co.'s and the Britannia Mining and Smelting Company's mines. Mr. Warren's announcement evidently was directed to these two companies. The Consolidated Co. has developed a large reserve of copper ore at the Old Sport and the Sunloch mines on Vancouver Island. To have spent as much money as it has spent and is spending on the George group, in the Portland Canal division, seems to indicate that it is meeting with a considerable amount of encouragement there.

Mr. E. W. Beatty, president of the Canadian Pacific Railway Company, announced that his company has entered into an arrangement to develop the Peace River region, which he thinks will be to the advantage of all Canada. The company has purchased the Province of Alberta's railways, which includes the Edmonton Dunvegan and British Columbia railway, the western terminus of which is at Spirit River, some 25 miles from the British Columbia boundary. The Canadian Pacific Railway's chief object probably is a settlement scheme, but, incidentally, 10 miles from Hudson Hope and some 120 from Spirit River, a deposit of one of the best free-burning coals in Canada has been developed. Mr. F. H. McLearn, of the Canadian Geological Survey, estimated the actual tonnage in workable seams at 84 million tons and the possible tonnage at the least double that amount. Farther north, along the Ingineka River, a large deposit of silver-lead-zinc ore is being developed, which may offer a sufficiently large tonnage to induce the railway company to extend a branch to it.

Dr. F. A. Kerr, of the Canadian Geological Survey, returned from a season's field work along the valleys of the Stikine and Iskut Rivers, has declared that he and his associates are convinced that the territory from Telegraph Creek south to the Iskut River and along the Iskut River to its junction with the Stikine is the most promising mineral district in western Canada. He stated that large ore-bodies are indicated and some of his samples run high in gold, silver, copper, and zinc. In order that prospectors may have the advantage of his knowledge for next season's work, he will prepare a preliminary statement during this winter, for publication early in the spring.

Mr. W. G. Murrin, president of British Columbia Electric Railway Company, announced that his company will immediately call for tenders for the erection for the first 43,000 h.p. unit of a 172,000 h.p. hydro-electric station at Ruskin, on the Stave River, three and a half miles below its existing plant, at a cost of $7,250,000, and that it will immediately double the size of the tunnel from Bridge River to Seaton Lake and provide for a transmission line at 220,000 volts, instead of 165,000 volts, to Vancouver, at an additional cost of $1,000,000.

The Hon. F. P. Buren, Minister of Lands, has announced that the new hydro-electric installations before his department at the present time aggregate 300,000 h.p.

Grand Trunk Pacific Mineral Belt.—Duthie Mines is to be reorganized and its capital increased to $2,000,000, by the creation of 1,000,000 new shares at $1 par. After examination by three independent engineers, the Atlas Exploration Company and the Mines Issues Corporation of Toronto have agreed to take the new issue, supplying funds as needed for the contemplated expansion and taking in exchange shares at par value as the money is provided. Mr. J. F. Duthie, who owns 70% of the stock of the old company, will retain his interest and remain president. Mr. Charles A. Banks has been appointed managing director and the Atlas and Mines Issues companies will each be represented on the board. Recent development at Duthie Mines' Henderson mine are reported by the engineers who made the examination to warrant operation on a much larger scale than has been attempted in the past. The ore in the mill or bottom level is of a higher grade and of greater extent than in any part of the mine.

Alice Arm.—Toric Mines, 90% of the stock of which is said to be owned in Great Britain, subject to ratification by the shareholders, has bonded a controlling interest in the company to the Britannia Mining and Smelting Company, and the Britannia company's engineers are now sampling the property and making a geological study of the formation. The terms of the bond have not been announced. The Toric ore deposit has puzzled engineers. A four to five foot vein at the surface has swelled to 70 ft. at a depth of 200 ft., and is said to average $12 per ton, chiefly in silver. The property is situated at the head of Kitsault valley, north of the Dolly Varden mine.

Portland Canal.—At the annual general meeting of B.C. Silver Mines, on December 10, the shareholders passed a resolution approving the expenditure of $1,000,000—to include the $627,000 already spent—on the development of the company's property. Funds for development have been advanced by the British Canadian Silver Corporation which is the holding company for B.C. Silver Mines and a subsidiary of Selukwe Mining and Finance Company, of London.

The Premier Gold Mining Company has disbursed a dividend of 6% covering operations for the last quarter of 1928, and amounting to $300,000. The company was unable to complete the six-mile aerial tramway to the Prosperity and Porter-Idaho properties before a heavy fall of snow stopped work until next season, but it was able to get supplies to the properties and consequently to continue development during the winter.

DIVIDENDS.—The dividends disbursed by mining metallurgical and allied companies covering operations in British Columbia during 1928 amounted to more than 12½ million dollars, which is a new high record for the Province.

TORONTO

January 19.

SUDBURY DISTRICT.—The outstanding feature of the mining industry during the past year has been the great activity in this field, due to the expansion of the operations of the nickel-copper companies and the opening up of other large deposits of base metals, some of which promise to become important mines. Recent lateral work on the Mond company's section of the Frood ore deposit has greatly increased the ore reserves, proving the continuity of high-grade ore on both the 2,800 and 3,100 ft. levels. Similar results have attended development on the International Nickel Company's section of the deposit, where driving on the 1,600, 2,400, and 2,800 ft. levels is advancing in ore of good grade, the ore-body having apparently widened at the lower horizons. Diamond-drilling at the property of the Sudbury Basin at Vermillion Lake has indicated a section of copper-zinc-lead ore 800 ft. long by 500 ft. deep, and ore has also been encountered 1,600 ft. to the west. Drilling is being carried on to ascertain whether the deposit is continuous. The Falconbridge, which has a large property on the nickel range, is carrying on an active diamond-drilling campaign, the results of which so far are understood to be encouraging. The Canam Metals, Ltd., has taken an option on a property in Genoa township which carries good showings of lead, zinc, and copper, and will carry on active exploration during the winter. The Sudbury Contact Mines has decided to suspend work for the present, and await the result of operations on the adjacent property of the Sudbury Basin.

PORCUPINE.—The mines of this field during November produced bullion to the value of $1,923,228, as compared with $1,698,122 in October. Hollinger Consolidated appears to be gradually recovering from the severe setback that it experienced last year. The mill is now treating approximately 6,000 tons of ore daily of a grade in excess of $6, and it is anticipated that the aggressive development now in progress at the lower levels will produce a better grade of ore. The McIntyre-Porcupine has made a discovery of major importance at depth. A drive from No. 11 central shaft at the 3,875 ft. level has intersected a high-grade section, believed to be the downward continuation of No. 7 vein, showing an average grade of $25 per ton across a width of about 20 ft. For the nine months ended December 31 the gross recovery from the mill was $3,122,758, and the net earnings before depreciation amounted to $1,412,552. The production at Dome Mines, Ltd., for December amounted to $350,294, as compared with $418,540 for November and $400,527 for December, 1927. The output for the twelve months of 1928 was $3,914,473, as compared with $4,031,838 for the previous year. The West Dome Lake has resumed milling operations. The mill has been overhauled and improved, adding 25% to its capacity. Underground work is yielding satisfactory results, a vein carrying good ore on the upper horizons having been cut on the 1,325 ft. level. The mill of the Vipond is operating at the rate of about 6,800 to 7,000 tons per month. Development is proceeding on six levels and is opening up much good ore.

KIRKLAND LAKE.—During November bullion was produced by the gold mines of the Kirkland Lake area to the value of $1,016,467, as compared with $1,100,305 for the preceding month. At the Lake Shore, installation of new machinery is proceeding rapidly, and in a few weeks the rate of production will be increased to 1,250 tons daily. At present mill heads are running at about $18 per ton. The sinking of a new shaft is being continued, and a depth of 1,450 ft. has been reached. When it is completed a cross-cut will be driven to the section underlying No. 1 shaft and a rise driven so as to establish a connection at that depth. The Wright-Hargreaves, which has been paying dividends steadily for some years, has passed its quarterly dividend, the reason given by the directors being the decrease in earnings on account of the quantities of low-grade ore encountered in development.

A good grade of ore is being opened up on the 2,000 ft. level and mill heads which at present run about $9 to the ton are expected to improve. The Department of the Provincial Attorney-General is making an investigation into the affairs of the Tough-Oakes-Burnside at the request of the Canadian shareholders, who are dissatisfied with the closing down of the mine. It was ascertained that operations had for some time been financed by the British shareholders, who were disappointed with the results and refused to make further advances. The inquiry is still in progress. The Teck-Hughes is steadily proceeding with its programme of expansion, involving the sinking of two deep shafts, the objective being the 25th level. When this horizon is reached it will be possible to open six new levels which are expected to add substantially to the ore reserves. Good headway is being made in shaft-sinking on the Cambro Kirkland Mines, Ltd., in the eastern section of the field; a depth of 828 ft. has been attained and tongues of porphyry are present in the workings. The immediate objective is 1,000 ft., when lateral work will be started. It is hoped to pick up an extension of the adjacent Bidgood vein. Amity Copper, in the Boston Creek section, is driving work as quickly as possible to a depth of 600 ft. Work completed to a depth of 500 ft. has indicated a widening of the vein. The erection of a concentrator is being considered. The Barry-Hollinger will adopt a policy of selective mining in order to secure an operating profit. The winze will be put down from the 1,375 ft. to the 1,500 ft. level.

Rouyn.—The Noranda smelter is producing about 70 tons of blister copper daily, with a recovery of about $4 a ton in gold. Good progress is being made with the sinking of the new shaft, the completion of which will enable production to be increased by at least 50%. Underground exploration to ascertain the downward continuity of rich ore is understood to have met with encouraging results, but no official details are as yet obtainable. The first milling unit of the 100 ton cyanide plant of the Siscoe is now in operation, with ore reserves sufficient for a two years' supply. High-grade gold ore is being taken from four levels. Diamond-drilling on the 500 ft. level down to 700 ft. has revealed substantial widths of commercial ore. At the Granada 15 ft. of ore has been intersected on the 375 ft. level. The shaft is down 625 ft. and lateral work is being actively undertaken. The Gilbec has installed a complete mining plant which is working satisfactorily. The sinking of a shaft on a vein of good copper ore has been started. A shipment of ore is being prepared for the Noranda smelter to check up sampling results. The Evangeline Calumet has begun a campaign of diamond-drilling to prove up at depth a vein encountered at the surface carrying high gold content. The Quebec Malartic has made what appears to be a further important discovery by stripping and trenching and is arranging for a diamond-drilling campaign.

Patricia District.—Access to the mining areas of this field has been rendered much easier than in previous seasons by the establishment of regular aircraft and traction services from points on the railroad to the leading mining centres. Much machinery and equipment for the mines is being shipped in, and many prospectors and representatives of mining companies are going to the new camps of Shinioah Lake and Crow River, where much staking is being done. The Northern Aerial Mineral Exploration is conducting systematic sampling of its property at Crow River where a vein 22½ ft. wide gives assays of $16 per ton. The vein has been stripped for a length of 1,500 ft. The Nipissing, of Cobalt, has taken over on option a group of 22 claims adjacent to this property. Active operations are being carried on in other parts of the district by the Howey, Dunkin, Bathurst, Consolidated Smelters, and others.

Mineral Production in Canada in 1928.—The steady expansion of the Canadian mining industry is shown by the estimates of the mineral output for 1928, issued by the Dominion Bureau of Statistics. The total value of production was $271,000,000, as compared with $247,356,695 for the previous year, an increase of $23,644,000, or nearly 10%. Advances were general in all metals, non-metals, and structural materials. The most noteworthy increase was that of the metallic products, the value of which advanced from $113,561,030 in 1927 to $128,500,000 in 1928. The greatest increase in the metal group was in the output of nickel and copper, the former of which was valued at $21,394,000, as compared with $15.262,171, while the yield of copper advanced in value from $17,195,487, to $26,913,000. The great activity now displayed in the opening up of new fields renders it altogether probable that the present year will see the establishment of a new high record.

The following table gives details of the outputs and values for 1928:—

	Quantity.	Value $.
METALLICS—		
Gold............fine oz.	1,869,548	38,647,000
Silver .... ,,	21,345,537	12,420,000
Nickel ....lb.	93,788,500	21,394,000
Copper .... lb.	191,944,079	26,913,000
Lead ....lb.	336,391,021	15,484,000
Zinc ....lb.	183,823,520	10,089,000
Cobalt and platinum metals	—	3,174,000
Other metals	—	379,000
Total	—	128,500,000
FUELS—		
Coal ....tons	17,785,265	63,000,000
Natural gas ....M.cu.ft.	21,986,200	8,377,000
Petroleum, crude barrels	617,600	2,043,000
Total	—	73,420,000
OTHER NON-METALLICS—		
Asbestos...........tons	280,096	10,586,000
Felspar .... ,,	29,800	260,000
Gypsum........... ,,	1,100,000	3,350,000
Mica .... ,,	4,525	95,000
Quartz .... ,,	240,000	505,000
Salt .... ,,	275,000	1,500,000
Talc and soapstone ,,	16,800	240,000
Other non-metallics.....	—	914,000
Total	—	17,450,000
CLAY PRODUCTS AND OTHER STRUCTURAL MATERIALS—		
Total	—	51,630,000
Grand total........	—	271,000,000

PERSONAL

D. ELLIOTT ALVES has left for Panama on his annual visit.

R. A. ARCHBOLD has left for Ecuador.

CHARLES A. BANKS, president of B.C. Silver Mines, has been appointed managing director of Duthie Mines.

BERNARD BERINGER has left for the south of Spain.

S. G. BLAYLOCK, general manager of the Consolidated Mining and Smelting Co. of Canada, is visiting England and Europe.

G. W. CAMPION is home from West Africa.

F. C. CANN, manager of the Geevor tin mine, is taking a holiday in Madeira.

GEORGE P. CHAPLIN has left for the Carmen Valley gold mines, Colombia.

H. CHAPMAN has left for Northern Rhodesia.

WILLIAM COCK is here from the Federated Malay States.

A. H. COLLIER has left for West Australia.

NIGEL COOKE has left for Nigeria

A. BROUGHTON EDGE is here on a short visit from Australia.

Dr. J. D. FALCONER has left for South America.

R. M. GEPPERT is leaving for Northern Rhodesia.

DONALD GILL has left for Northern Rhodesia.

G. W. GRAY has been appointed a director of the Rio Tinto Company.

F. R. H. GREEN has left for Venezuela.

T. C. F. HALL is expected from Korea.

L. R. J. HAWKEY has left for the Gold Coast.

JOHN HOWESON, chairman of the Anglo-Oriental Mining Corporation, left for New York on January 30.

W. P. LEAL has left for Burma.

F. W. LEIGHTON has left for Colombia.

E. A. LORING has returned from the United States.

H. F. MARRIOTT has been appointed a director of the Panama Corporation, and has left for Panama.

W. R. MURRAY is home from New Zealand.

W. MURRAY is home from Burma.

R. D. NEVETT, formerly metallurgist with the Mount Morgan Co., has joined the staff of the Zinc Corporation.

A. V. PAULL is leaving for Venezuela.

JAMES H. PIERCE, of the firm of Stuart, James, and Cooke, is here from New York.

D. RENOUF is expected from Nigeria.

REGINALD S. H. RICHARDS has left for Portugal.

R. SHAW has left for Nigeria.

J. SIM, N. L. SMITH, and A. L. AUSTEN are leaving for the Belgian Congo.

J. H. SOUTHWOOD has returned from Nigeria.

OLIVER SOSKICE has left for Northern Rhodesia.

D. A. THOMPSON has left for Insuta, Gold Coast Colony.

E. G. THOMPSON has left for Tanganyika.

JAMES B. THOMSON, late with Cutten Brothers, has commenced business as a consulting dredging engineer at 65, London Wall, E.C. 2, and the registered office of the South Andes Development Co., Ltd., has been transferred to this address.

G. H. TIPPER has retired from the Geological Survey of India after 25 years' service and has been appointed Minerals Adviser to the High Commissioner for India, being attached to the office of the Indian Trade Commissioner at 42, Grosvenor Gardens, S.W. 1.

CHARLES H. WHITE has left for Northern Rhodesia.

J. H. G. WILSON is home on leave from the Gold Coast.

R. WINTER has left for Mount Elliott, Queensland.

WRIGHT AND BOYDELL, of Toronto, have taken VICTOR A. JAMES into partnership and the firm is now known as Wright, Boydell, James and Associates.

A. E. PENGILLY died in Portugal on January 5 at the age of 66. For 34 years he had been at the Pintor arsenic mine of the Anglo-Peninsula Mining and Chemical Co., Ltd.

R. H. CAMBAGE, for some time Under Secretary of Mines in New South Wales, died on November 28. At the time of his death he was President of the Australasian Association for the Advancement of Science.

GUY C. REVELEY died on January 18 at Plymouth of blackwater fever, aged 28. He was a brilliant student at Camborne School of Mines and afterwards was engaged in mining on the Gold Coast, where he contracted the fatal illness. His death is rendered additionally tragic owing to his having been married on December 15 at Perranporth.

John Dixon Kendall, a leading English authority on iron ores, died at his home in London on Christmas Eve at the age of 80. He was born at Windermere, and in his early days he was associated with an engineering and mining firm at Barrow in Furness. He started as a mining engineer on his own account at Whitehaven in 1872, subsequently continuing his practice from 1896 onwards in London. During this time he reported on or managed mines in almost every part of the world. His book "The Iron Ores of Great Britain and Ireland" is a classic. Mining engineers will remember him as the originator of the discussion on "Ore in Sight," held under the auspices of the Institution of Mining and Metallurgy. He contributed many papers to the North of England Institute of Mining and Mechanical Engineers. The Magazine has also published several important communications from him dealing with Cumberland ore deposits. He was a keen controversalist, and an excellent expounder of his views and presenter of his geological and mining records. The accompanying photograph shows him in the heyday of his career.

The late J. D. Kendall.

Ernest H. L. Schwarz, professor of geology in the Rhodes University College, Grahamstown, South Africa, since 1905, died on December 15 in Senegal, at the age of 55. Professor Schwarz was an able exponent of South African geology and his suggestions for counteracting the supposed dessication of the country have formed the basis of much discussion. He was born in London and took the A.R.C.S. in 1894. He went to South Africa in 1895, and joined the Cape Geological Survey the next year.

TRADE PARAGRAPHS

Caldwell and Co., of 130, Elliot Street, Glasgow send particulars of their Paracyclic pump which operates on a novel principle and is especially suitable for dealing with fuel oil.

The Bureau of Information on Nickel, Ltd., of 2, Metal Exchange Buildings, London, E.C. 3, have published a further bulletin, in this case devoted to Nickel Cast Iron.

Henry Bath and Son, Ltd., of 53, New Broad Street, London, E.C. 2, have issued their annual chart showing variation in prices of copper, tin, spelter, and lead during the past eleven years.

Allen West and Co., Ltd., of Brighton, have published a folder giving particulars of liquid starters and regulators for use with slip-ring induction motors.

The Sullivan Machinery Co., of Salisbury House, London, E.C. 2, furnish us with some details regarding "Sulamite" which is described as a substitute for black diamonds in diamond core drill bits suitable for use in certain cases. Sulamite is a metallic alloy which, although not as hard as a diamond, is yet harder than emery, corundum, and similar substances. Pieces of Sulamite and a bit set with them are shown in the accompanying photograph. They have also sent us some further particulars about their new 12 in. coal cutter.

Sullivan Alloy "Sulamite."

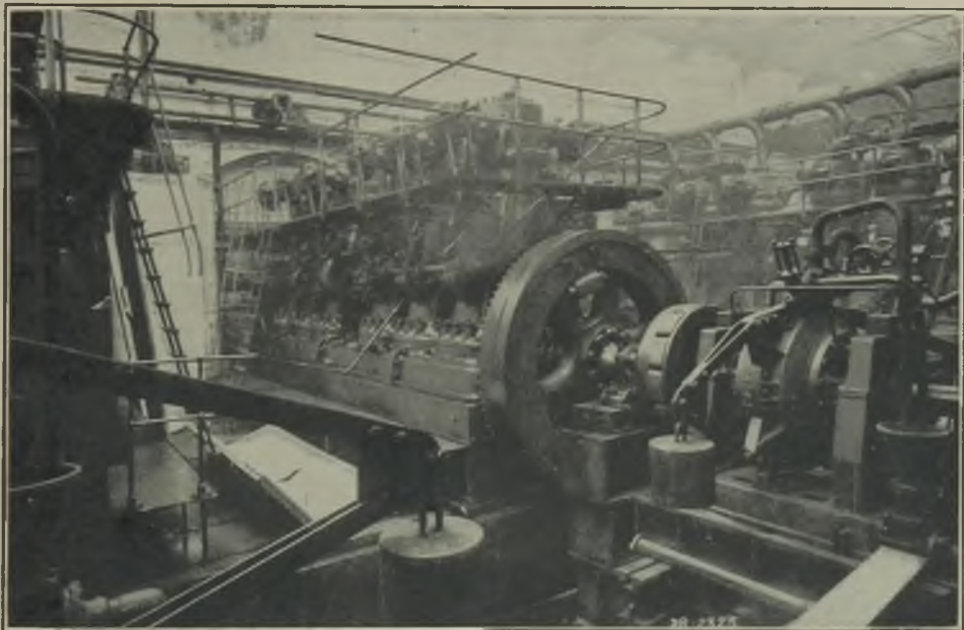
The Buda Company England, Cecil Chambers, Strand, London, W.C. 2, issue particulars of "Conneaut" metallic packing, the base of which is formed of bearing metal in granulated form with which is incorporated a lubricant.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E. 7, will be exhibiting at the forthcoming British Industries Fair, Birmingham section. Others who have notified us of their intention to exhibit are: **Hadfields, Ltd.,** of Sheffield, and **Ruston and Hornsby, Ltd.,** of Lincoln. Details of these and other exhibits will be given in our next issue.

British Ropeway Engineering Co., Ltd., of 14 to 18, Holborn, London, E.C. 1, send us their latest catalogue of aerial ropeways, which include monocable and bicable systems, suspension railways, telphers, cableways, and modern mechanical transport plant for all purposes. It is well illustrated with photographs of a great variety of typical installations.

Ruths Steam Storage, Ltd., of Africa House, Kingsway, London, W.C. 2, have published booklets giving particulars of their steam accumulator for use in plants where the load is a fluctuating one. We hope to describe the principle of this plant in some detail in a later issue.

Askania-Werke A.G., of Kaiserallee 87 to 88, Berlin-Friedenau, have issued through their London agent (**O. G. Karlowa**, 19, Grosvenor Gardens, S.W. 1) a pamphlet (Geo 92E) describing magnetic field balances for measurements of both vertical and horizontal intensities, together with auxiliary apparatus for the determination of constants. A special feature of these instruments is the recording apparatus that has been designed for use with them and in place of observation telescopes.



RUSTON AND HORNSBY 600 H.P. OIL ENGINE FOR CYPRUS ASBESTOS CO., LTD., UNDER TEST.

Combustion Steam Generator, Ltd., of 1, Southampton Row, London, W.C. 1, report that their American associates have received an order for extra high pressure boiler plant, at 1,800 lb. per sq. in. Each boiler will have an actual evaporation of 150,000 lb. per hour and the final steam temperature will be 815° F.

Richard Klinger, Ltd., of 120, Southwark Street, London, S.E. 1.—Reference was made in these columns recently to the specialties manufactured by this firm for steam and compressed-air users. Valves, which are an essential part of such equipment, are made in a variety of designs and of different metals according to the temperatures and pressures to be encountered. Seatless piston valves are made in bronze for pressures up to 250 lb. per sq. in. A smooth cylindrical plunger moves with a sliding motion through two jointing rings of flexible material separated by a metal bush, in which are ports for the passage of steam, air, etc. The valve opens as the plunger is withdrawn (by hand wheel) from the lower ring and only the lower end of the plunger is exposed to high velocity effects and thus the wearing away of even half an inch does not affect the tightness of the valve when closed. Valves of similar design for high pressures and temperatures are made of forged steel and the plungers of nickel.

Ransomes and Rapier, Ltd., of Ipswich, have published an illustrated booklet giving the case for direct current as against alternating current for electrically-operated shovels. The booklet also contains a brief review of the development of the modern excavator from about 1880, the real impetus to its intensive development being furnished (it is pointed out) by the American railroad expansion in 1870-1900.

Ruston and Hornsby, Ltd., of Lincoln, recently afforded us an opportunity of visiting their works on which occasion we were particularly impressed with the great number of oil engines of all sizes erected (on test) and in course of manufacture. We reproduce here a photograph of a 600 b.h.p. vertical engine which is destined for the Cyprus Asbestos Co. This is the fifth engine of this size built to the order of Henry Simon, Ltd., who are contractors to the company named. An interesting feature is that the bedplate of this engine has been constructed in four pieces to facilitate transport, since it is to be erected in the mountains.

International Combustion, Ltd., Grinding and Pulverizing Offices, of 11, Southampton Row, London, W.C. 1, report that orders have been received for the following equipment: For England: one 6 ft. by 36 in. Hardinge ball-mill for wet coal grinding; one No. 00 Raymond pulverizer for grinding colours; one No. 0000 Raymond pulverizer for copper oxide; one 3-roller "Baby" Raymond mill for ochre. For India: one 3-roller "Baby"

Raymond mill for unnamed oxide. For Germany: one 4 ft. by 5 ft. 2-surface, type 39, Hum-mer electric screen for slag. For Holland: one 5-roller Raymond mill for Gafsa phosphate. For Italy: one B. 4 cage mill, and one 3-roller Raymond mill for phosphate. For France: one 3-roller Raymond mill for Gafsa phosphate; one Hardinge ball-mill with one Rayco separator and one Raymond separator for graphite.

METAL MARKETS

Copper.—The copper market was very firm during January, when electrolytic in New York rose from 16·60 cents to 17 cents per lb. and standard values in London underwent quite an appreciable further advance. The situation remained very much in favour of producers, as although world production has latterly increased, stocks are very short. Doubtless, but for the fear that excessively high prices would drive consumers to the use of alternative metals, producers would advance quotations still further. There is no doubt that such action lies within their ability, and as a matter of fact there was a considerable amount of bull activity on the standard market at the close of January, which carried up standard values in anticipation of such an eventual advance in refined metal prices.

Average price of cash standard copper: January, 1929, £75 11s. 11d.; December, 1928, £69 7s. 7d.; January, 1928, £61 18s. 11d.; December, 1927, £60 2s. 3d.

Tin.—Prices receded gradually on this market last month, despite the continued presence of the powerful bull group. It is not believed that the latter have yet abandoned their endeavour to get prices up higher, but their task seems to grow more formidable week by week, as not only their own surplus accumulation of metal but also the stocks in warehouses continue to expand. Frankly, the statistical position of the metal is not brilliant. It is too early yet to discern whether consumption during the current year is likely to make a very good showing, but obviously if the market is to be merely maintained it will have to do so, as world production is steadily broadening, despite the declarations of the bulls that sooner or later supplies will commence to fail.

Average price of cash standard tin: January, 1929, £222 16s. 3d.; December, 1928, £227 13s. 11d.; January, 1928, £253 6s. 5d.; December, 1927, £267 4s. 10d.

Lead.—The London lead market was steady and colourless during January. Demand was dull, but on the other hand arrivals of fresh metal were not excessive, so that the position was more or less one of equilibrium. A certain amount of confidence was engendered by the pending meeting of producers in March, when possibly stronger action will be taken to support the market. It is interesting to note that according to estimates world production of lead last year was reduced by about 3 per cent.

Average mean price of soft foreign lead: January, 1929, £22 4s. 6d.; December, 1928, £21 10s. 8d.; January, 1928, £21 19s. 10d.; December, 1927, £22 6s.

Spelter.—The market fluctuated moderately during January. After losing fully 20s. by the 23rd, values recovered somewhat towards the close of the month. Generally speaking, everybody concerned was waiting to see the result of the output curtailment measures initiated by producers. Latterly, a hopeful feeling has manifested itself, the view being taken that makers are likely to meet with success in their endeavours to strengthen the market.

Average mean price of spelter: January, 1929, £26 4s. 3d.; December, 1928, £26 12s. 2d.; January, 1928, £26 1s. 9d.; December, 1927, £26 4s. 8d.

Iron and Steel.—The Cleveland pig iron market presented a fairly cheerful aspect during January. The industry, of course, was working on a restricted scale and stocks continued to diminish, some buyers experiencing difficulty in obtaining supplies. It would not be surprising if foundry pig iron makers in the Middlesbrough district decided eventually to blow in more furnaces, as the hematite producers have already done recently, but they are not eager to take the risk until they are assured that the present improvement is going to last. Quotations remained as follows: No. 1 Cleveland foundry 68s. 6d., No. 3 G.M.B. 66s., No. 4 foundry 65s., and No. 4 forge 64s. 6d. per ton. Hematite was a good market, with East Coast Mixed Nos. priced at 71s. per ton. As regards finished iron and steel in this country, there was a decided revival, due to a considerable extent to the recovery in the shipbuilding industry. Continental steel was firm at the close of January, with works on the other side of the Channel heavily booked in most cases.

Iron Ore.—There is very little fresh business passing as most works have covered the bulk of their requirements for months ahead. Prices are rather nominal in the absence of business, but the undertone is firm and best Bilbao rubio is worth 22s. 6d. per ton c.i.f. or even a little more.

Antimony.—At the close of January English regulus was priced at £54 to £55 per ton. There was a fair demand at times. Chinese was firm at about £38 per ton ex warehouse, with shipment material around £34 c.i.f.

Arsenic.—This remains a quiet market, but prices are steady with 99% Cornish white unchanged at £16 5s. per ton f.o.r. mines.

Bismuth.—A steady business continues to be done at the official price of 7s. 6d. per lb. for 5 cwt. lots and over.

Cadmium.—There has been rather less inquiry for cadmium recently, and the spot position has eased somewhat. Sellers are still pretty firm in their ideas, however, and supplies generally are not superabundant. Current quotations are about 4s. 1d. per lb. for forward shipment and around 4s. 2d. to 4s. 3d. for spot.

Cobalt Metal.—A very fair business is reported in this commodity recently, but the official price of 10s. per lb. is still shaded for good contracts.

Cobalt Oxides.—A steady demand continues in evidence with prices unaltered at 8s. per lb. for black and 8s. 10d. for grey.

Platinum.—This remains a poor market, and further price recessions have taken place. Refined metal is now priced officially at £13 17s. 6d. per oz. with merchants' ideas, as usual, rather below this figure.

Palladium.—There is no apparent change in this market, business remaining rather quiet with prices ranging from £9 10s. to £10 10s. per oz.

Iridium.—A quiet but steady demand continues, with sponge and powder priced at about £57 to £60 per oz.

LONDON DAILY METAL PRICES

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

	COPPER.							TIN.		ZINC (Spelter).	
	STANDARD.		ELECTROLYTIC		WIRE BARS	BEST SELECTED.					
	Cash.	3 Months.	Near.	Forward.		Near.	Forward.	Cash.	3 Months.	Near.	Forward.
Jan.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
10	75 5 0	73 11 3	78 5 0	78 15 0	78 15 0	—	—	223 5 0	223 5 0	26 7 6	26 11 3
11	75 10 0	73 12 6	78 5 0	78 15 0	78 15 0	76 15 0	78 0 0	224 0 0	223 17 6	26 6 3	26 10 0
14	75 2 6	73 1 3	78 5 0	78 15 0	78 15 0	—	—	222 10 0	222 10 0	26 5 0	26 7 6
15	74 15 0	72 17 6	78 5 0	78 15 0	78 15 0	76 15 0	78 0 0	222 15 0	222 2 6	25 17 6	26 0 0
16	74 15 0	72 18 9	78 5 0	78 15 0	78 15 0	—	—	223 0 0	222 2 6	26 0 0	26 1 3
17	74 17 6	73 0 0	78 5 0	78 15 0	78 15 0	—	—	223 0 0	222 7 6	26 1 3	26 1 3
18	75 2 6	73 8 9	78 5 0	78 15 0	78 15 0	76 15 0	78 0 0	224 5 0	223 7 6	26 3 9	26 2 6
21	75 7 6	73 13 9	78 5 0	78 15 0	78 15 0	—	—	222 5 0	221 15 0	26 1 3	26 1 3
22	75 15 0	73 18 9	78 5 0	78 15 0	78 15 0	77 0 0	78 5 0	223 0 0	222 7 6	25 17 6	25 16 3
23	76 2 6	74 6 3	79 10 0	80 0 0	80 0 0	—	—	223 0 0	222 7 6	25 15 0	25 13 9
24	76 7 6	74 8 9	79 10 0	80 0 0	80 0 0	—	—	222 0 0	222 0 0	26 5 0	26 3 9
25	76 15 0	74 5 0	79 10 0	80 0 0	80 0 0	78 5 0	79 10 0	222 10 0	222 10 0	26 3 9	26 2 6
28	77 2 6	74 10 0	79 10 0	80 0 0	80 0 0	—	—	221 10 0	222 0 0	26 7 6	26 7 6
29	77 5 0	74 13 9	79 10 0	80 0 0	80 0 0	78 10 0	79 15 0	220 5 0	221 2 6	26 0 0	26 0 0
30	77 7 6	74 16 3	79 10 0	80 0 0	80 0 0	—	—	220 5 0	221 7 6	26 2 6	26 2 6
31	78 0 0	75 7 6	79 10 0	80 0 0	80 0 0	—	—	220 0 0	221 2 6	26 5 0	26 5 0
Feb.											
1	78 10 0	76 2 6	79 15 0	80 15 0	80 15 0	79 0 0	80 5 0	220 10 0	221 10 0	26 5 0	26 8 9
4	80 10 0	77 12 6	80 15 0	81 5 0	81 5 0	—	—	223 0 0	224 2 6	26 8 9	26 12 6
5	80 10 0	78 7 6	81 0 0	81 10 0	81 10 0	80 10 0	81 15 0	228 0 0	228 5 0	26 7 6	26 11 3
6	80 5 0	77 17 6	81 15 0	82 5 0	82 5 0	—	—	229 15 0	229 15 0	26 7 6	26 11 3
7	78 5 0	77 15 0	83 0 0	83 10 0	83 10 0	—	—	225 15 0	226 10 0	26 6 3	26 10 0
8	78 5 0	78 0 0	84 0 0	84 10 0	84 10 0	82 0 0	83 5 0	224 0 0	224 10 0	26 6 3	26 10 0

SELENIUM.—High-grade black powder is still held for about 7s. 8d. to 7s. 9d. per lb. ex warehouse.

TELLURIUM.—Very little interest is shown in this metal and it is difficult to arrive at a definite price. About 12s. 6d. to 15s. per lb. seems to be about the current value.

MANGANESE ORE.—It is now apparent that the Russian interests intend to try and get business by cutting prices, and washed Caucasian ore has sold recently at 1s. 2d. per unit c.i.f. Best Indian is easier in consequence, holders asking about 1s. 2¾d. per unit c.i.f., although actual business might be possible at 1s. 2½d. Ordinary grades of ore stand at about 1s.

ALUMINIUM.—A fairly steady demand is reported and prices are quite unchanged at £95, less 2%, delivered.

SULPHATE OF COPPER.—The sharp rise in copper quotations has not been without its effect on the price of copper sulphate, which is now quoted at about £28 to £28 10s. per ton, less 5%.

NICKEL.—Demand is well maintained and prices seem quite firm at £170 to £175 per ton, according to quantity.

CHROME ORE.—With most of the better-grade ore closely controlled it is difficult to obtain definite prices, but current quotations range from about £4 to £4 15s. per ton c.i.f., according to quality for both Indian and Rhodesian.

QUICKSILVER.—Demand has been anything but brisk, and although the cartel is still firm in its price ideas, the current level of quotations here is about £22 2s. 6d. to £22 5s. per bottle for spot material.

TUNGSTEN ORE.—The cessation of American purchases has been followed by a very dull period, which has in turn been followed by easier prices. Current quotations for forward shipment from China are around 19s. 3d. to 19s. 6d. per unit c.i.f., although nearby shipment remains rather scarce.

MOLYBDENUM ORE.—A quiet business is passing in 85% Australian concentrates at about 34s. to 34s. 6d. per unit c.i.f.

GRAPHITE.—Very little change is noticeable in

LEAD.			SILVER.		GOLD.	
SOFT FOREIGN.		ENGLISH.				
Near.	Forward.		Forward.	Cash.		
£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.	Jan.
22 2 6	22 10 0	23 10 0	26$\frac{7}{16}$	26½	84 11½	10
22 1 3	22 8 9	23 10 0	26⅜	26$\frac{7}{16}$	84 11½	11
21 18 9	22 6 3	23 5 0	26$\frac{7}{16}$	26½	84 11¼	14
21 15 0	22 0 0	23 5 0	26$\frac{5}{16}$	26⅜	84 11½	15
22 0 0	22 3 9	23 5 0	26¼	26⅜	84 11¼	16
22 1 3	22 3 9	23 10 0	26⅛	26¼	84 11½	17
22 0 0	22 3 9	23 5 0	26$\frac{3}{16}$	26$\frac{5}{16}$	84 11½	18
22 5 0	22 7 6	23 10 0	26$\frac{3}{16}$	26$\frac{5}{16}$	84 11½	21
22 3 9	22 5 0	23 10 0	26⅛	26¼	84 11⅜	22
22 1 3	22 2 6	23 10 0	26$\frac{1}{16}$	26$\frac{3}{16}$	84 11½	23
22 3 9	22 6 3	23 10 0	26	26$\frac{1}{16}$	84 11½	24
22 1 3	22 3 9	23 10 0	26⅛	26⅜	84 11½	25
22 5 0	22 6 3	23 10 0	26⅛	26$\frac{3}{16}$	84 11½	28
22 2 6	22 3 9	23 10 0	26$\frac{3}{16}$	26$\frac{3}{16}$	84 11⅜	29
22 2 6	22 3 9	23 10 0	26¼	26$\frac{5}{16}$	84 11½	30
22 3 9	22 5 0	23 10 0	26$\frac{3}{16}$	26¼	84 11½	31
						Feb.
22 5 0	22 10 0	23 15 0	26$\frac{5}{16}$	26¼	84 11½	1
22 7 6	22 11 3	23 15 0	26$\frac{3}{16}$	26$\frac{3}{16}$	84 11¼	4
22 8 9	22 12 6	23 15 0	25$\frac{15}{16}$	25$\frac{15}{16}$	84 11⅜	5
22 16 3	22 15 0	24 0 0	26	26$\frac{1}{16}$	84 11½	6
23 0 0	22 18 9	24 5 0	25$\frac{15}{16}$	26	84 11½	7
23 2 6	23 1 3	24 10 0	25⅞	25$\frac{15}{16}$	84 11½	8

the position of graphite, and 85 to 90% raw Madagascar flake remains at about £25 to £27 per ton c.i.f., with high-grade Ceylon lumps around £22 to £24 c.i.f.

SILVER.—Generally speaking, the market ruled dull during January with hardly any movements of importance. On January 1 spot bars stood at 26⅜d., and, with sellers rather hesitant and buyers showing no keenness to operate, prices moved very little during the first half of the month and on January 15 spot bars were 26$\frac{5}{16}$d. Subsequently China sold a little and with an absence of support prices eased to 26d. for spot bars on the 24th but improved later on a little Indian buying, although at the close of the month the market had an uncertain tone. The price closed on January 31 at 26$\frac{3}{16}$d. and subsequently another fall took place.

STATISTICS

OUTPUTS UNION OF SOUTH AFRICA.
(OTHER THAN GOLD.)

	October.	November.	December.
Coal............ Tons	1,448,465	1,422,320	1,327,900
Copper, metallic . Tons	985	991	874
Tin concentrate.. Tons	194	181	166

PRODUCTION OF GOLD IN THE TRANSVAAL.

	RAND.	ELSEWHERE.	TOTAL.
	Oz.	Oz.	Oz.
March, 1928...........	840,837	36,543	877,380
April	789,823	36,084	825,907
May..................	849,155	37,031	886,186
June	825,143	37,220	862,363
July	828,482	38,729	867,211
August	854,172	37,691	891,863
September	819,341	38,390	857,731
October	858,945	38,775	897,720
November	832,461	40,023	872,484
December.............	821,582	38,179	859,761
Total, 1928	9,908,188	451,408	10,359,596
January, 1929	840,344	36,108	876,452

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	GOLD MINES.	COAL MINES.	DIAMOND MINES.	TOTAL.
January 31, 1928 ...	193,063	16,686	4,329	209,894
February 29	197,340	16,599	4,668	209,774
March 31	199,487	16,720	5,167	214,950
April 30	199,820	16,696	5,664	219,700
May 31	198,461	16,943	5,742	222,172
June 30	197,186	16,870	5,650	222,340
July 31	194,584	16,695	5,189	220,345
August 31	194,788	16,553	4,839	218,578
September 20	194,936	16,724	4,535	215,843
October 31	193,147	16,767	4,807	216,362
November 30	190,870	16,803	4,889	216,628
December 31	187,970	16,059	4,444	208,473
January 31, 1929 ...	192,526	15,845	5,056	213,427

COST AND PROFIT ON THE RAND.
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.	£
January, 1928	2,428,600	28 2	19 9	8 5	1,021,891
February	2,357,900	28 1	19 11	8 2	959,824
March	2,552,100	27 11	19 9	8 2	1,039,078
April	2,381,800	28 2	20 0	8 2	971,128
May	2,571,900	28 0	19 7	8 5	1,084,465
June	2,500,100	28 2	19 10	8 4	1,038,851
July.........	2,528,600	27 11	19 8	8 3	1,048,432
August	2,580,700	27 11	19 7	8 4	1,079,152
September ...	2,485,700	27 11	19 7	8 4	1,040,368
October	2,612,500	27 9	19 5	8 4	1,092,162
November ...	2,539,700	27 9	19 7	8 2	1,041,713

PRODUCTION OF GOLD IN RHODESIA.

	1925	1926	1927	1928
	oz.	oz.	oz.	oz.
January.........	48,159	48,967	48,731	51,356
February	48,284	46,026	46,461	46,286
March	45,858	46,902	50,407	48,017
April	47,386	51,928	48,290	48,549
May	48,686	49,392	48,992	47,323
June............	47,647	52,381	52,910	51,762
July	49,453	50,460	49,116	48,960
August..........	49,245	49,735	47,288	50,611
September.......	48,319	48,350	45,838	47,716
October	48,896	50,132	46,752	43,056
November	50,364	51,090	47,435	47,705
December	49,307	48,063	49,208	44,772
Total	581,604	593,426	581,428	575,913

TRANSVAAL GOLD OUTPUTS.

	DECEMBER.		JANUARY.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	81,500	£134,934	84,500	£134,547
City Deep	89,000	23,986	91,500	23,875
Cons. Main Reef	58,200	22,389	60,500	22,199
Crown Mines..........	207,000	69,362	208,000	68,105
D'rb'n Roodepoort Deep	40,300	13,997	40,300	14,037
East Rand P.M........	141,000	38,050	140,500	37,715
Ferreira Deep	29,100	5,206	32,000	5,358
Geduld...............	85,000	26,262	85,500	26,755
Geldenhuis Deep	65,000	14,313	63,000	14,483
Glynn's Lydenburg ...	6,300	2,078	6,200	1,960
Government G.M. Areas	192,000	£378,389	208,000	£400,810
Kleinfontein	50,600	11,175	53,100	11,387
Langlaagte Estate	76,000	£105,420	83,000	£110,095
Luipaard's Vlei	22,300	5,854	24,000	5,933
Meyer and Charlton ...	17,200	£18,805	17,200	£18,946
Modderfontein New ..	142,000	72,911	147,000	73,714
Modderfontein B	69,500	25,728	71,500	26,761
Modderfontein Deep ..	43,000	22,643	45,700	24,056
Modderfontein East ...	62,000	19,018	65,000	20,020
New State Areas	73,000	£134,502	78,000	£138,490
Nourse	54,200	16,897	61,000	16,752
Randfontein	209,000	£200,703	207,000	£207,098
Robinson Deep	77,000	21,673	77,000	21,924
Rose Deep	55,700	11,179	55,800	11,622
Sabie	3,400	£3,688	—	—
Simmer and Jack	79,100	18,463	74,300	21,924
Springs	66,300	£135,706	72,000	£147,605
Sub Nigel	25,000	23,247	23,700	22,515
Transvaal G.M. Estates	14,540	4,691	14,620	4,531
Van Ryn	39,000	£40,123	39,000	£40,555
Van Ryn Deep	61,000	£101,251	66,000	£107,053
Village Deep	58,000	15,653	59,000	15,535
West Rand Consolidated	81,200	£87,289	86,000	£90,766
West Springs	59,000	£76,712	63,000	£80,785
Witw'tersr'nd (Knights)	54,000	£46,347	53,000	£45,137
Witwatersrand Deep ..	43,000	9,236	43,000	9,828
Wolhuter.............	25,300	6,298	27,700	6,384

RHODESIAN GOLD OUTPUTS.

	DECEMBER.		JANUARY.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,000	11,041	25,000	11,205
Globe and Phœnix ...	6,030	5,437	—	—
Lonely Reef	5,300	2,924	—	—
Rezende	6,400	2,943	6,400	2,980
Shamva	44,500	£19,348	—	—
Sherwood Starr	4,700	£8,319	4,800	£7,874

WEST AFRICAN GOLD OUTPUTS.

	DECEMBER.		JANUARY.	
	Tons.	Oz.	Tons.	Oz.
Ashanti Goldfields	8,710	9,305	9,129	9,537
Taquah and Abosso ...	9,730	£13,257	10,010	£13,771

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	DECEMBER.		JANUARY.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	4,050	2,735	4,000	2,434
Champion Reef	9,770	5,729	9,670	5,263
Mysore...............	18,254	9,991	18,150	9,111
Nundydroog	10,675	6,367	11,000	6,652
Ooregum	14,000	8,401	14,000	7,381

WEST AUSTRALIAN GOLD STATISTICS.

	Reported for Export Oz.	Delivered to Mint Oz.	Total Oz.	Value £
January, 1928	248	28,313	28,561	121,319
February	99	32,021	32,120	136,436
March	614	22,989	23,603	100,259
April	213	36,274	36,487	154,986
May	72	29,192	29,264	124,305
June	348	39,101	39,449	167,568
July	184	29,215	29,399	124,877
August	120	37,871	37,991	161,374
September	426	31,871	32,397	137,613
October	75	36,490	36,565	155,317
November	390	31,076	31,466	133,658
December	547	35,550	36,097	153,329
January, 1929	237	27,147	27,384	116,319

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Victoria.	Queensland.	New South Wales.
	Oz.	Oz.	Oz.
January, 1928	891	3,906	1,336
February	2,276	886	1,108
March	2,098	1,339	4,176
April	2,811	846	318
May	2,990	321	397
June	3,932	498	487
July	3,208	772	154
August	2,637	690	3,447
September	3,366	644	364
October	2,632	820	256
November	—	—	—
December	—	—	—
Total	27,841	10,722	12,043

AUSTRALASIAN GOLD OUTPUTS.

	December.		January.	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.) .	3,957	6,314	3,962	6,527
Blackwater (N.Z.)	2,782	5,044	3,153	5,836
Boulder Persev'ce (W.A.)	4,128	12,083	4,932	14,461
Grt. Boulder Pro. (W.A.)	6,638	20,003	6,633	20,945
Lake View & Star (W.A.)	—	—	—	—
Sons of Gwalia (W.A.) ..	7,100	7,724	—	—
South Kalgurli (W.A.) ..	6,095	12,617	8,303	15,600
Waihi (N.Z.)	22,864*a*	6,810*g* / 70,851*s*	—	— / —

a Four weeks to December 31. *g* Oz. gold. *s* Oz. silver.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	December.		January.	
	Tons	Value £	Tons	Value £
Chosen Synd. (Korea) ..	7,655	10,532	—	—
Frontino& Bolivia (C'lbia)	1,740	6,008	1,950	5,494
Gabait (Sudan).........	410	1,455	440	1,447
La Noria (Mexico)	12,903	124,364*d*	—	—
Lampa (Bolivia).........	—	45,000*s*	40,000	—
Lena (Siberia)	—	—	—	32,616
Lydenburg Plat. (Trans.)	3,330	671*p*	3,620	755*p*
Marmajito (Colombia) ..	720	3,765	710	2,832
Mexican Corp. Fresnillo .	89,033	126,527*e*	—	—
Mexico El Oro (Mexico) .	—	—	—	—
Nus River (Colombia) ..	—	—	—	—
Onverwacht Platinum...	2,260	495*p*	2,422	476*p*
Oriental Cons. (Korea) ..	—	90,500*d*	—	81,000*d*
St. John del Rey (Brazil)	11,800	33,500	10,980	29,800
Santa Gertrudis (Mexico)	53,021	124,098*e*	—	—

d dollars. *p* Oz. platinoids. *e* Profit in dollars. *s* Oz. silver.

Pato Mines (Colombia): No. 1 dredge, 38 days to January 28, $31,081 from 241,591 cu. yd.; No. 2 dredge, 20 days to January 11, $8,521 from 72,060 cu. yd.

COPPER, LEAD, AND ZINC OUTPUTS.

		Dec.	Jan.
Broken Hill Prop.	Tons lead conc. ..	—	—
	Tons zinc conc. ..	—	—
Broken Hill South	Tons lead conc. ..	3,895*a*	—
	Tons zinc conc. ..	3,918*a*	—
Burma Corporation ...	Tons refined lead	6,546	6,502
	Oz. refined silver	604,784	592,042
Bwana M'Kubwa......	Tons copper oxide	725	907
Electrolytic Zinc	Tons zinc	7,626*f*	—
Messina	Tons copper conc.	1,211	1,223
Mount Lyell	Tons copper	1,204*t*	—
	Oz. silver	19,825*t*	—
	Oz. gold	370*t*	—
Namaqua	Tons copper	176	—
North Broken Hill.....	Tons lead conc. ..	5,270	—
	Tons zinc conc. ..	4,170	—
Poderosa	Tons copper ore..	862	823
Rhodesia Broken Hill..	Tons lead	414	345
	Tons slab zinc ...	932	821
San Francisco Mexico .	Tons lead conc. ..	3,538	3,445
	Tons zinc conc. ..	3,680	4,072
South American Copper	Tons Matte......	—	—
Sulphide Corporation ..	Tons lead conc. ..	2,572*d*	—
	Tons zinc conc. ..	3,900*d*	—
Tetiuhe	Tons lead conc. ..	—	724
	Tons zinc conc. ..	—	1,213
Union Minière	Tons copper	8,600	—
Villemagne (Russo-Asiatic)....	Tons lead conc. ..	—	—
	Tons zinc conc. ..	—	—
Zinc Corporation	Tons lead conc. ..	5,124	—
	Tons zinc conc. ..	4,653	—

a Four weeks to December 29. *t* Three months.
d Six weeks to December 29. *f* Eight weeks to January 9.

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

		December.	Year 1928.
Iron Ore	Tons ..	284,460	4,435,075
Manganese Ore................	Tons ..	24,409	205,967
Iron and Steel	Tons ..	183,668	2,895,923
Copper and Iron Pyrites	Tons ..	20,498	302,923
Copper Ore, Matte, and Prec. , ..	Tons ..	3,385	46,313
Copper Metal	Tons ..	11,020	150,460
Tin Concentrate	Tons ..	8,653	81,432
Tin Metal	Tons ..	3,236	16,948
Lead Pig and Sheet............	Tons ..	23,625	262,127
Zinc (Spelter)	Tons ..	10,731	136,204
Zinc Sheets, etc.	Tons ..	1,823	22,835
Aluminium	Tons ..	376	13,486
Quicksilver	Lb.....	20,955	2,509,747
Zinc Oxide	Tons ..	878	11,561
White Lead	Cwt....	12,821	165,968
Red and Orange Lead	Cwt....	3,443	40,271
Barytes, ground	Cwt....	65,414	737,298
Asbestos	Tons ..	2,606	32,106
Boron Minerals	Tons ..	623	16,573
Borax	Cwt....	21,266	149,710
Basic Slag	Tons ..	3,574	67,710
Superphosphates	Tons ..	5,874	127,216
Phosphate of Lime	Tons ..	34,391	274,623
Mica	Tons ..	205	2,970
Sulphur	Tons ..	13,830	93,042
Nitrate of Soda	Cwt....	195,740	1,552,589
Potash Salts	Cwt....	323,034	3,452,364
Petroleum: Crude	Gallons	46,865,656	503,140,284
Lamp Oil	Gallons	14,742,806	190,604,204
Motor Spirit	Gallons	57,975,652	730,959,481
Lubricating Oil	Gallons	7,455,850	104,954,831
Gas Oil	Gallons	2,927,914	117,900,608
Fuel Oil	Gallons	28,802,704	451,402,376
Asphalt and Bitumen	Tons ..	7,381	187,453
Paraffin Wax	Cwt....	113,669	1,575,300
Turpentine	Cwt....	45,944	384,582

IMPORTS AND EXPORTS OF GOLD AND SILVER.

	December.		Year 1928.	
	Imports.	Exports.	Imports.	Exports.
Gold:				
Unrefined Bullion £	319,445	—	2,983,549	—
Refined Bars.... ,,	2,847,523	4,925,922	32,747,020	56,195,644
Coin .... ,,	489,087	314,355	12,077,486	4,328,057
Silver:				
Unrefined Bullion oz.	1,699,049	—	9,640,360	—
Refined .... ,,	7,512,470	5,675,037	32,885,058	69,160,782
Coin .... £	78,588	104,657	1,995,990	891,520

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	November.	December.	January.
	Tons.	Tons.	Tons.
Amari	10	7	—
Anglo-Nigerian	65	65	60
Associated Tin Mines	252	274	—
Baba River	7½	5½	—
Batura Monguna	6	4½	—
Bisichi	60	50	53
Daffo	7	6	6
Ex-Lands	65	65	50
Filani	4	2½	2
Jantar	40	35	—
Jos	26	25½	19
Juga Valley	4½	14	—
Junction	21	20	—
Kaduna	52½	40¾	—
Kaduna Prospectors	30½	23¾	—
Kassa	17	16	17
Lower Bisichi	6½	6½	5½
Madubi	—	—	—
Mongu	50	60	—
Naraguta	43½	33	—
Naraguta Acquisitions	—	—	—
Naraguta Extended	25	26	10
Naraguta Karama	31	25	30¼
Naraguta Korot	15	15	—
Nigerian Base Metals	36½	44½	—
Nigerian Consolidated	20	20	20
N.N. Bauchi	150	150	—
Offin River	3½	9½	12½
Ribon Valley	18¾	17	18½
Ropp	84	80	80
Rukuba	4½	4	4
South Bukeru	7½	6	10
Tin Fields	4¾	6½	7
Tin Properties	19	22	—
United Tin Areas	10½	6½	—
Yarde Kerri	10	10	10

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Nov.	Dec.	Jan.
	Tons.	Tons.	Tons.
Ampang	25	14	14
Chenderiang	26	24	24
Gopeng	74½	77½	80½
Idris Hydraulic	47¾	38¾	35¼
Ipoh	46¾	42	49½
Kamunting	110	97	71
Kent (F.M.S.)	58	59½	54
Kepong	34½	24	25⅝
Kinta	34½	34½	30½
Kinta Kellas	34¾	32	23¾
Kramat Pulai	24½	24½	25½
Kuala Kampar	145	147	—
Lahat	20¾	21¾	21
Malaya Consolidated	75	79	70⅓
Malayan Tin	148¾	160¾	179½
Meru	30	20¾	20
Pahang	203½	209½	206
Pari	—	—	—
Pattani	5½	5	3½
Pengkalen	71½	65½	51
Petaling	192	178½	190
Rahman	53½	59½	59½
Rambutan	14	15	15
Rantau	40	52	69
Renong	57	60½	60¾
Selayang	26	25¾	18
Southern Malayan	92¼	104¼	104¼
Southern Perak	107¾	80¼	50½
Sungei Besi	44	46	46
Sungei Kinta	35¾	29¾	38¾
Sungei Way	32¾	35¾	44½
Taiping	34	35	41
Tanjong	46	41¾	22½
Teja Malaya	—	8	13½
Tekka	48	48	50½
Tekka-Taiping	49	51	51
Temoh	—	—	17
Tronoh	89	108	96

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

	Tons.		Tons.
July, 1928	5,488	January, 1929	5,840
August	5,499	February	—
September	5,071	March	—
October	5,161	April	—
November	5,483	May	—
December	5,249	June	—
Total 1928	61,898	Total 1928	5,840

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Nov.	Dec.	Jan.
	Tons.	Tons.	Tons.
Anglo-Burma (Burma)	28	19½	—
Aramayo Mines (Bolivia)	327	—	—
Bangrin (Siam)	32½	33¾	14¾
Berenguela (Bolivia)	32	33	—
Briseis (Tasmania)	28	30	—
C'nsolidated Tin Mines (Burma)	84*	107*	94*
Dolcoath (Cornwall)	—	—	—
Eastern Siam (Siam)	9	11	—
East Pool (Cornwall)	81	86¾	—
Fabulosa (Bolivia)	125	158	165
Geevor (Cornwall)	64	70	68
Jantar (Cornwall)	11	—	—
Kagera (Uganda)	23	23	23
Leeuwpoort (Transvaal)	—	—	—
Levant (Cornwall)	—	117¾t	—
McCreedy (Swaziland)	—	—	—
Rooiberg (Transvaal)	—	115t	—
San Finx (Spain)	38	40*	—
Siamese Tin (Siam)	103	117¼	120½
South Crofty (Cornwall)	69	73¾	66½
Tavoy Tin (Burma)	40	60	—
Theindaw (Burma)	6	6	—
Tongkah Harbour (Siam)	81	87	87
Toyo (Japan)	25	35	—
Wheal Kitty (Cornwall)	27	29	—

* Tin and Wolfram. t Three months.

STOCKS OF TIN.

Reported by A. Strauss & Co., Ltd., Long Tons.

	Jan. 31.
United Kingdom Stocks :	
Straits	686
Australian	88
Banka	186
Other Standard	7,183
Banka Straits and Australian Landing	315
United Kingdom Afloat :	
Straits	1,483
Australian	55
Banka	—
Continent :	
Banka in Holland	—
Do. Afloat	1,052
Straits do.	925
Other Countries :	
Straits and Banka Afloat	572
United States Straits and Standard :	
Afloat	7,973
Landing	2,146
Stock	465
Total	23,129

SHIPMENTS, SUPPLY, AND CONSUMPTION OF TIN.

Reported by A. Strauss and Co., Ltd., Long Tons.

	Jan.
Imports of Bolivian Tin into U.K.	2,915
Total Shipments of Bolivian Tin	3,568*
Imports of Nigerian Tin	868
Shipments of China Tin	335
Shipments of Straits Tin	8,094
Shipments of Banka Tin	853
Supply :	
Straits United Kingdom	1,508
,, Continent	915
,, United States	5,165
,, Other Countries	506
Banka	853
Australian	125
Standard U.K. and U.S.A.	3,345
Total	12,417
Consumption :	
United Kingdom deliveries	1,246
Dutch ,,	1,413
United States ,,	8,795
Continent ,,	777
Other Countries ,,	565
Total	12,796

* December.

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	Nov.	Dec.	Jan.
Anglo-Ecuadorian	13,378	13,679	13,106
Anglo-Egyptian	20,342	25,442	19,560
Apex Trinidad	33,530	31,950	32,640
Attock	5,150	6,760	9,430
British Burmah	5,520	5,760	—
British Controlled	28,880	37,559	30,426
Dacia Romano	3,110	—	—
Kern Mex	1,541	1,436	—
Kern River (Cal.)	5,359	5,390	—
Kern Romana	3,732	4,296	—
Kern Trinidad	3,646	3,807	—
Lobitos	23,604	25,722	26,901
Mexican Eagle	78,286	100,714	78,001
Phœnix	29,502	29,236	34,484
St. Helen's Petroleum	4,626	5,654	—
Steaua Romana	63,420	64,430	60,670
Trinidad Leaseholds	35,350	35,150	34,200
United of Trinidad	4,570	4,883	5,872
Venezuela Oil Concessions	445,295	575,666	514,181

QUOTATIONS OF OIL COMPANIES SHARES.

Denomination of Shares £1 unless otherwise noted.

	Jan. 7, 1929			Feb. 6, 1929		
	£	s.	d.	£	s.	d.
Anglo-American	3	2	6	3	6	3
Anglo-Ecuadorian	1	5	0	1	3	9
Anglo-Egyptian B	3	0	0	2	13	9
Anglo-Persian 1st Pref.	1	8	3	1	8	0
,, ,, Ord.	4	13	9	4	6	3
Apex Trinidad (5s.)	1	5	0	1	6	3
Attock	1	7	6	3	0	0
British Burmah (8s.)		7	6		7	3
British Controlled ($5)		6	0		5	3
Burmah Oil	4	13	9	4	7	6
Kern River, Cal. (10s.)		8	6		8	0
Lobitos, Peru	2	7	6	2	2	6
Mexican Eagle, Ord. (4 pesos)		15	6		13	6
,, ,, 8% Pref. (4 pesos)		15	0		13	0
Phœnix, Roumania		15	6		14	0
Royal Dutch (1,000 fl.)	33	15	0	32	0	0
Shell Transport, Ord.	5	16	3	4	16	3
,, ,, 5% Pref. (£10)	9	17	6	9	17	6
Steaua Romana		12	3		12	0
Trinidad Leaseholds	4	0	0	4	6	3
United British of Trinidad (6s. 8d.)		8	6		8	9
V.O.C. Holding	4	8	9	4	8	9

PETROLEUM PRODUCTS PRICES. London, February 7.

Refined Petroleum: Water white 8½d. per gallon; standard white, 7¼d. per gallon; in barrels 3d. per gallon extra.
Motor Spirit: Inner London Zone: Aviation spirit 1s. 6¾d. per gallon; No. 1, 1s. 2¾d. per gallon; No. 3, 1s. 0¾d. per gallon.
Fuel Oil: Furnace fuel oil, £3 7s. 6d.; Diesel oil, £4 per ton.
American Oils: Best Pennsylvania crude at wells, $4·10 per barrel. Refined standard white for export: in barrels 14·25 cents. Refined water white: in barrels 15·25 cents.

DIVIDENDS DECLARED BY MINING COMPANIES.

During month ended February 9.

Figures in brackets represent par value of shares and the dates are the days on which the dividends are payable.

Aramayo Mines (25fr.), interim 5%, February 1.

British South Africa, (15s.), 1s. 6d. less tax, March 7.

Consolidated African Selection Trust (5s.), interim 1s. 3d. less tax, February 4.

Kent (F.M.S.) Tin Dredging (2s.), 5% less tax, February 27.

Rambutan (£1), 6d. less tax, February 7.

Rantan Tin Dredging (2s. 4d.), 9% on preference covering period from August 1, 1926, to January 31, 1928, payable January 31, 1929.

Tin Selection Trust (£1), final for 1928, 1s. 6d., less tax.

Zaaiplaats Tin (5s.), 10%.

PRICES OF CHEMICALS. February 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	19	0	0
,, Carbonate	,,	27	0	0
,, Nitrate	,,	24	0	0
,, Phosphate	,,	41	0	0
,, Sulphate, 20·6% N.	,,	10	10	0
Antimony, Tartar Emetic	per lb.		1	1
,, Sulphide, Golden	,,			7
Arsenic, White	per ton	16	10	0
Barium Carbonate, 92%	,,	5	5	0
,, Chlorate	per lb.			5
,, Chloride	per ton	11	10	0
,, Sulphate, 94%	,,	6	0	0
Benzol, standard motor	per gal.		1	6
Bleaching Powder, 35% Cl.	per ton	7	0	0
,, Liquor, 7%	,,	3	5	0
Borax	,,	20	0	0
Boric Acid	,,	30	0	0
Calcium Chloride	,,	4	15	0
Carbolic Acid, crude 60%	per gal		2	0
,, ,, crystallized, 40°	per lb.			6½
Carbon Disulphide	per ton	24	0	0
Citric Acid	per lb.		2	3
Copper Sulphate	per ton	27	0	0
Cyanide of Sodium, 100% KCN	per lb.			7
Hydrofluoric Acid	,,			6
Iodine	per oz.		1	0
Iron, Nitrate	per ton	7	0	0
,, Sulphate	,,	2	0	0
Lead, Acetate, white	,,	40	0	0
,, Nitrate	,,	34	0	0
,, Oxide, Litharge	,,	28	0	0
,, White	,,	38	0	0
Lime, Acetate, brown	,,	9	0	0
,, ,, grey, 80%	,,	17	0	0
Magnesite, Calcined	,,	8	0	0
Magnesium, Chloride	,,	6	10	0
,, Sulphate	,,	4	5	0
Methylated Spirit 64° Industrial	per gal.		1	5
Nitric Acid, 80° Tw.	per ton	21	0	0
Oxalic Acid	per lb.			3
Phosphoric Acid	per ton	30	0	0
Potassium Bichromate	per lb.			4
,, Carbonate	per ton	26	0	0
,, Chlorate	per lb.			3
,, Chloride 80%	per ton	9	0	0
,, Hydrate (Caustic) 90%	,,	33	0	0
,, Nitrate, refined	,,	21	0	0
,, Permanganate	per lb.			5
,, Prussiate, Yellow	,,			7
,, ,, Red	,,		1	9
,, Sulphate, 90%	per ton	10	0	0
Sodium Acetate	per ton	21	10	0
,, Arsenate, 45%	,,	26	0	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3¼
,, Carbonate (Soda Ash)	per ton	6	5	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	per lb.			3
,, Hydrate, 76%	per ton	15	0	0
,, Hyposulphite	,,	9	0	0
,, Nitrate, 96%	,,	10	10	0
,, Phosphate	,,	12	0	0
,, Prussiate	per lb.			4¼
,, Silicate	per ton	10	0	0
,, Sulphate (Salt-cake)	,,	2	10	0
,, ,, (Glauber's Salt)	,,	2	5	0
,, Sulphide	,,	9	10	0
Sulphur, Roll	,,	11	0	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	4
Turpentine	per cwt.	2	7	3
Tin Crystals	per lb.		1	7
Titanous Chloride	,,			10
Zinc Chloride	per ton	12	0	0
Zinc Dust	,,	35	0	0
Zinc Oxide	,,	£40 to £42		
Zinc Sulphate	,,	10	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

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

DIAMONDS:	Jan. 7, 1929. £ s. d.	Feb. 6, 1929 £ s. d.
Consol. African Selection Trust (5s.)	1 7 6	1 10 0
Consolidated of S.W.A.	1 1 3	1 6 3
De Beers Deferred (£2 10s.)	11 17 6	12 12 6
Jagersfontein	2 7 6	2 11 3
Premier Preferred (5s.)	5 12 6	5 15 0
COPPER:		
Arizona Copper (5s.) Arizona	19 3	1 6 6
Bwana M'Kubwa (5s.) Rhodesia	14 6	1 2 3
Esperanza Copper, Spain	18 6	1 0 0
Messina (5s.), Transvaal	18 0	19 6
Mount Lyell, Tasmania	2 0 0	2 2 0
Namaqua (£2), Cape Province	1 2 6	1 2 6
N'Changa, Rhodesia	1 15 0	3 10 0
Rio Tinto (£5), Spain	63 5 0	65 7 6
Roan Antelope (5s.), Rhodesia	2 3 9	2 10 0
Tanganyika, Congo and Rhodesia	3 5 0	3 12 6
LEAD-ZINC:		
Broken Hill Proprietary N.S.W.	1 5 6	1 7 0
Broken Hill North, N.S.W.	5 2 6	5 1 3
Broken Hill South, N.S.W.	2 15 0	2 12 6
Burma Corporation (10 rupees)	19 6	18 0
Electrolytic Zinc Pref., Tasmania	1 15 0	1 15 0
Mount Isa, Queensland	1 13 9	2 2 6
Rhodesia Broken Hill (5s.)	4 9	5 6
Russo-Asiatic Consd. (2s. 6d.)	3 6	4 6
San Francisco (10s.), Mexico	1 13 9	1 15 0
Sulphide Corporation (15s.), N.S.W	17 9	18 0
Tetiuhe (5s.), Siberia	4 0	4 0
Zinc Corporation (10s.), N.S.W.	2 8 9	2 5 0
TIN:		
Aramayo Mines (25 fr.), Bolivia	3 8 9	3 5 0
Associated Tin (5s.), Nigeria	12 3	13 6
Bangrin, Siam	2 0 0	2 0 0
Bisichi (10s.), Nigeria	9 9	11 0
Briseis, Tasmania	3 0	3 6
Chenderiang, Malay	12 0	11 0
Dolcoath (10s.), Cornwall	9	9
East Pool (5s.), Cornwall	2 0	2 0
Ex-Lands Nigeria (2s.), Nigeria	3 3	3 3
Fabulosa ($1.00), Bolivia	9	9
Geevor (10s.), Cornwall	8 0	9 0
Gopeng, Malaya	2 5 0	2 5 0
Idris (5s.), Malaya	18 0	16 9
Ipoh Dredging (16s.), Malay	1 10 0	1 8 9
Kamunting (5s.), Malay	17 0	17 6
Kinta, Malay	12 9	12 3
Lahat, Malay	13 6	14 0
Malayan Tin Dredging (5s.), Malay	1 6 0	1 9 6
Mongu (10s.), Nigeria	10 9	10 6
Naraguta, Nigeria	1 7 6	1 8 9
Nigerian Base Metals (5s.)	5 3	6 0
N.N. Bauchi, Nigeria (10s.)	1 2 9	1 3 3
Pahang Consolidated (5s.), Malay	10 6	11 0
Pengkalen (5s.), Malay	1 0 3	1 0 3
Petaling (2s. 4d.)	11 6	12 0
Renong Dredging, Malay	1 12 6	1 13 9
Ropp (4s.), Nigeria	9 6	9 3
Siamese Tin (5s.), Siam	17 6	19 6
South Crofty (5s.), Cornwall	6 3	5 3
Southern Malayan	2 12 6	14 0
Southern Perak, Malay	2 15 0	2 16 3
Southern Tronoh (5s.)	11 0	11 0
Sungei Besi (5s.), Malay	13 6	13 9
Tavoy (4s.), Burma	16 6	18 0
Tekka, Malay	1 0 0	1 0 0
Tekka Taiping, Malay	1 2 3	1 2 6
Toyo (10s.), Japan	10 9	10 0
Tronoh (5s.), Malay	19 9	1 0 0
FINANCE, Etc.:		
Anglo-American Corporation	2 0 0	2 5 0
Anglo-French Exploration	1 3 0	1 7 0
Anglo-Oriental (5s.)	11 3	12 6
British South Africa (15s.)	1 17 6	2 1 6
Central Mining (£8)	19 5 0	19 10 0
Chemical & Metallurgical Corp. (2s.)	3 9	4 6
Consolidated Gold Fields	2 18 9	3 2 6
Consolidated Mines Selection (10s.)	18 3	1 0 0
General Mining and Finance	1 7 6	1 7 6
Gold Fields Rhodesian (10s.)	10 6	12 0
Johannesburg Consolidated	2 9 6	2 10 6
London Tin Syndicate	3 11 3	3 17 6
Minerals Separation	3 0 0	4 5 0
National Mining (8s.)	4 6	4 9
Rand Mines (5s.)	3 7 6	3 8 9
Rhodesian Congo Border	3 2 6	4 12 6
Southern Rhodesia Base Metals	5 0	10 0
South-West Africa	16 0	16 0
Tin Selection Trust	1 11 9	1 12 0
Union Corporation (12s. 6d.)	4 11 3	4 15 0

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 PRODUCTION OF PURE ALUMINA

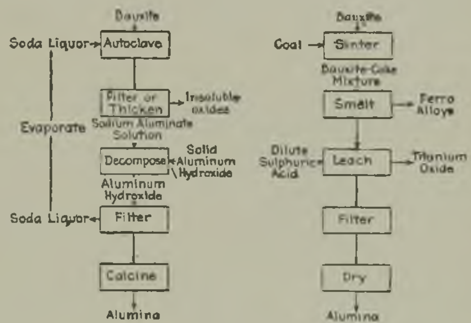
In *Chemical and Metallurgical Engineering* for December, C. L. Mantell, of the Pratt Institute, Brooklyn, discusses the various methods of producing pure alumina for smelting to aluminium in the electric furnace. He expresses the belief that this policy of purifying the raw material will prevail over suggestions for the smelting of alumina of lower grade or of other aluminous materials and the subsequent refining of the impure metal produced, thus ruling out the Hoopes process, which was developed experimentally two or three years ago by the Aluminium Company of America.

The major part of the world's aluminium production is at present derived from bauxite refined by the Bayer method, but the tendency is to exploit not only other and cheaper processes but more readily available ores. Progress in this direction is being made, but, even so, no very radical change is to be expected. It is believed by the author that the refining of aluminous ores will continue to involve chemical processes of some delicacy, calling for appreciable investment in plant and significant amounts for fuel, labour, and reagents. This statement is true whether the raw material be the conventional grades of bauxite, alunite, leucite, kaolin, labradorite, or any other material.

Among processes used or reasonably available for production of high-purity alumina are the following :—(1) Bayer, (2) Hall, (3) Pedersen, (4) Haglund, (5) Berger, (6) Serpek, (7) Svendson, (8) Blanc, (9) Halvorsen, (10) Sherwin, (11) Laist, (12) Specketer. These are briefly discussed by the author in their chemical and economic aspects.

(1) *Bayer Process.* In this process a high grade of bauxite is a necessity, and an extremely high grade of alumina is usually produced. The composition of the ore may be as follows :—Al_2O_3, 60 to 55% ; Fe_2O_3, 25 to 20% ; TiO_2, 2 to 3%; SiO_2, 1 to 3% ; H_2O and organic impurities, 12 to 15%. The ore is crushed, ground in a ball-mill to 70 mesh, mixed with a strong soda liquor, and digested with steam at 60 lb. pressure to dissolve the Al_2O_3. Digestion is carried on in autoclaves at 150° C. for eight hours. The solution is blown into tanks and diluted to a density of about 1·20. It is then filter-pressed, the iron oxide remaining in the residue with most of the TiO_2. From the clear solution of sodium aluminate, the alumina can be precipitated in large tanks or decomposers by slow agitation and the addition of a small proportion of reserve aluminium hydrate. The precipitate is then thickened washed, dried, and calcined at 1,100° C. in a rotary kiln. In a modification of the Bayer method, the ore is ground, mixed with the appropriate quantity of sodium carbonate, and roasted at about 1,000° C., when sodium aluminate will be formed by decomposition of the carbonate. The solid mass, after cooling, is leached with distilled water and the clear liquor treated in decomposers to precipitate alumina.

The Bayer process is technically one of the most difficult to operate and control. The filtration problems alone are perhaps as difficult as those in any other technical process. In addition, the process is expensive. Both in Europe and America the Bayer process has long been in commercial operation. Such plants as those of the Aluminium Ore Company, East St. Louis ; the British Aluminium Company, Burntisland, Scotland ; and Curtius A. G., Duisburg, Germany, are well known. The dry process mentioned is better known in America, while the autoclave method is generally used in Europe. American practice also favours Dorr-type thickeners in place of filter-presses for the separations employed, a fact probably due to the relative cost of labour. The operations are carried out with mechanical exactitude in a well-ordered plant. This presumes, however, a good and invariable composition of bauxite. Low silica is essential, 3% being the upper limit. The objection to silica lies in its rendering a portion of the alumina insoluble, thus hindering the recovery from a given ore. A good, pure alumina for use in the reduction furnaces contains less than 0·01 per cent FeO.



BAYER HALL

(2) *Hall Process.* At the beginning of the aluminium industry in the United States, Charles M. Hall devised an electrical method for the refining of bauxite, but the process in an improved form has only just been put into commercial production. Bauxite of graded composition is ground to a granular form and mixed intimately with an appropriate weight of coal similarly ground. The mixture is then sintered at about 1,000° C., cooled, and a further quantity of coke introduced for the purpose of reducing the impurities. The mixture is then smelted in a furnace using electrodes of the Soderberg type at about 2,500° C. Ferro-silicon and ferro-titanium sink to the bottom of the bath and are tapped off. Pure alumina is blown off by steam and air pressure from the top of the furnace into an iron-lined chamber where it is precipitated in flocculent particles similar to pop-corn. Con-

tamination by carbides is likely to be the chief difficulty. The alumina, after cooling, is leached with hot water and dilute sulphuric acid to remove traces of titanium oxide. The solids are filtered in such a way as not to crush or deform the grains. This process is being commercially operated at Badin, N. C., and Arvida, Quebec. The resulting alumina is in the form of solid bubbles. It has only one-third the density of amorphous Bayer alumina. This is advantageous as a charge for the reduction furnaces. As above outlined the improved Hall process constitutes one of the most important methods of treating bauxite of lower grades than are available for the Bayer process. In the latter, iron and silica are separately removed ; in Hall's method, they are removed in combination by simultaneous reduction. Although accurate balance must be maintained in the charge, a silica content greater than 3% is no longer embarrassing.

(3) *Pedersen Process.* Several processes for refining aluminous ores recognize the need for utilizing much lower grades than those which have been commercially feasible heretofore. If the iron content be sufficiently high, it can be smelted out and at the same time silica can be reduced to ferro-silicon, thus leaving the alumina to be slagged off. Such a method is that devised by Professor Pedersen, of Trondhjem, Norway. An electric smelting furnace is used. The charge consists of iron ore, limestone, and bauxite in the required proportions. Ferrous impurities in the bauxite are smelted out and a richly aluminous slag is obtained. This is tapped off, cooled, crushed, and leached with a hot solution of dilute sodium carbonate containing 10% of free caustic for the purpose of accelerating the process and preventing silica contamination. Obviously the method permits the use of bauxites of high ferrous content which are not economically treatable by the Bayer method. The process is now in operation at the works of the Norsk Aluminium Company, at Hoyangfalden, Norway, where ore of a content of 16 to 18% alumina can be treated, the plant having an annual maximum capacity of 12,000 to 15,000 tons of alumina.

This process has been the subject of considerable experimentation by the United States Bureau of Mines with the co-operation of the Aluminium Company of America, the object being partly to ascertain whether by using a suitable blast-furnace charge an industrially useful aluminous slag could be recovered in addition to pig iron. These tests covered a wide variation of slag content of lime, silica, and bauxite. No difficulty was found in producing a low-sulphur pig iron in conjunction with a slag from which a high grade of alumina could be recovered suitable for use in quick-setting cement or for reduction to aluminium. The bauxite charge will be high in iron or silica content according as the object is to yield reducible alumina or cement respectively.

(4) *Haglund Process.* Owing to the high-purity ore required by the Bayer process and the exact balance which must be maintained between the reacting agents, attempts have been made to substitute methods for dealing with lower-grade minerals of a wider range of composition. The method of T. R. Haglund, introduced several years ago in Sweden, was developed experimentally in Germany and is now operating commercially in Italy. Aluminous ore, usually bauxite, is crushed and mixed with a due proportion of anthracite and pyrites or other metallic sulphides. The proportions will obviously depend on the iron, silicon, and titanium impurities in the ore. On fusing the mass in a smothered arc or resistance furnace, the iron, silicon, and titanium are reduced and tapped off. The slag containing the aluminium is cooled, when a part of it will crystallize out as alumina, the remainder being aluminium sulphide. The latter amounts to about 20% of the total slag. This is sufficient to hold the alumina in solution at the furnace temperature of 1,100° C. In practical operation of this process, low-grade materials as carboniferous clay, coal dross, and the like are charged. An Italian company has been formed to operate under Haglund patents with a plant near Venice, and one at Mori in the Trentino Valley. It will be seen that pig iron is one of the important by-products of the process. The market for this and the ferro alloys will have a bearing on the field for Haglund methods.

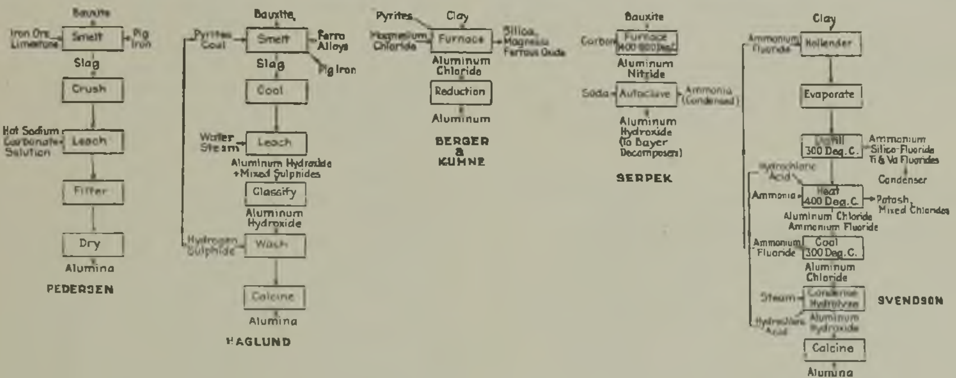
Primarily Haglund's method applies to bauxite having a silica content too high for treatment by the Bayer process, particularly where the alumina content is correspondingly low. The preliminary sulphurization is necessary only where the iron content in the bauxite is high. By this treatment the charge of sulphide can be reduced and the process becomes more nearly regenerative. Where this is not done, the hydrogen sulphide is condensed and the sulphur regained in a Claus furnace.

(5) *Berger Process.* Gerhard Berger and Werner Kuhne, working in Germany, have developed an apparently practicable process in which the raw material treated is not bauxite but kaolin. For the past twenty-five years attempts have been made to separate the alumina from silica in china clay. In the present process the alumina content is converted to the chloride whence the metal is reduced directly by electrolysis of the fused salt. China clay is broken into lumps of about 6 to 7 lb. each and heated in a reverberatory furnace together with about three times as much iron pyrites. The temperature is maintained at 400 to 500° C. and a current of chlorine gas is passed through the chamber. Aluminium chloride is formed which can be electrolysed in a fused bath of sodium and potassium chlorides. In the practical operation of the process, magnesium chloride in appropriate amount is mixed with the kaolin-pyrites charge, and a small addition of iron filings is also made. Aluminium chloride gas distils over, leaving behind it the silica of the clay with magnesia and ferrous oxide. In Germany, where this process was developed, a high grade of kaolin is obtainable from the Halle district and pyrites from Grafontal and Saalfeld. Magnesium chloride is available from the potash mines and takes the place of direct chlorination used on an experimental scale.

This method was devised at a time when bauxite was not readily available ; it is doubtful whether it will compete even in Germany with the present considerable importations of the ore from Hungarian deposits. The evolution of chlorine gas as a by-product of electrolysis is a feature of the process likely to prove embarrassing. The formation of iron chloride is also a difficulty.

(6) *Serpek Process.* In France the production of aluminium has for many years been carried on by a group having collateral interests in electrochemistry. There has, therefore, been a tendency to refine aluminous ores with due consideration to the

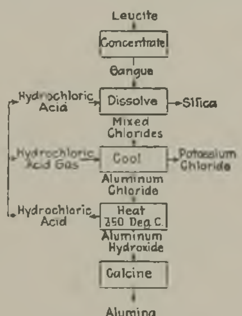
development of commercial by-products. The Serpek process for alumina also yields fixed nitrogen, available for the manufacture of fertilizers or explosives. Bauxite is disintegrated, dried, mixed with crushed carbon, and heated in an electric resistance furnace to 1,600° to 1,800° C. At this temperature the alumina combines with the atmospheric nitrogen and the electrode carbon is oxidized. By the use of a suitable catalyst such as steam or iron the reaction will take effect at a temperature about 1,400° C. The chief merit of this process is its extreme simplicity, the raw material being limited to air and carbon. A considerable quantity of electrical energy is consumed, however. The large rotating furnaces designed by Serpek were of 2,500 kw. direct-current capacity. For the production of ammonia, the aluminium nitride is digested in an autoclave under steam pressure. Ammonia is condensed and the alumina is regenerated for use in the process. Where alumina is the desired product, however, the aluminium nitride from the furnace is treated with soda under pressure, forming sodium aluminate, and ammonia will be driven off and condensed. The alumina can then be separated by the Bayer method, the solution being fed direct to the decomposers. Because nitride of alumina is more easily decomposed, treatment of this material is much cheaper than raw bauxite. It does not appear that the Serpek process is making any commercial progress in France where the Bayer method continues to be standard. The Serpek process was investigated during and after the World War by American producers of alumina and was found not to offer sufficient advantages over the standard Bayer process.



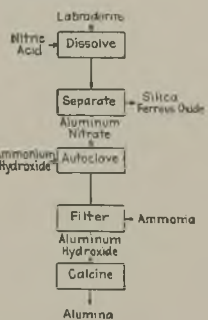
(7) *Svendson Process.* A method for the recovery of alumina and a high grade of silica from clay has been developed by Seglund Svendson. The process has been worked on an experimental scale in the United States. A typical clay for treatment by this method should be free from sand and have upwards of 25% alumina, and up to 60% silica, the remaining elements being the usual potash, soda, ferrous oxide, and lime. For a production of 25 tons alumina, 100 tons of anhydrous clay will be required. After crushing, the raw material is mixed in a hollender with ammonium fluoride solution. At a temperature of 36° C. the fluoride decomposes and attacks the clay, ammonium-silica fluoride being evolved. On evaporating, part of the fluoride will be decomposed, free fluorine acting on the metallic oxides present. The mixture is then heated to 300° C. in order to volatilize the ammonium-silica fluoride as well as the volatile metallic fluorides mentioned. These are condensed, silica gel being recovered and ammonium fluoride returned to the process. The original residue containing the alumina is then raised to 400° C. and equal parts of gaseous hydrochloric acid and ammonia are passed. Aluminium chloride, which distils off together with ammonium fluoride, is formed. On cooling, the latter is condensed at 300° C. and the aluminium chloride at 187° C. This last is hydrolysed with steam, yielding aluminium hydroxide and releasing hydrochloric acid gas. The hydroxide is calcined in the usual way. The most important by-product is silica gel which is separated from the volatilized fluorides after cooling by the addition of water and ammonia. Basically, the entire process is one for the production of silica gel from clay, aluminium oxide, the other simultaneous product, being produced at only one-third the rate. Economically, the method cannot be used unless there be assured a market for silica three times as great as the required alumina production. It follows, therefore, that the commercial feasibility of Svendson's process depends on the market for silica gel in large tonnages. As the field for this product is being restricted in many of its applications by the competition of activated carbon and other materials, the commercial possibilities seem doubtful.

(8) *Blanc Process.* In Italy, particularly in the region between Rome and Naples, considerable deposits of leucite occur. This is an aluminium-potassium silicate of volcanic origin. The process devised by Baron Blanc and used on an industrial scale by the Societa Italiana Potassa of Rome consists in the conversion of the alumina and potash to chlorides and the separation of these by cooling. The original purpose of the process was to recover potash, but the occurrence of alumina as a by-product has led to the consideration of the Blanc method for a source of metallic aluminium.

In commercial practice the leucite rock is crushed and then concentrated by magnetic separation, leaving the enriched, granulated ore free from iron. The concentrates will have a composition of about 23% alumina, 55% silica, and 18% potash. On treatment with hydrochloric acid, the aluminium and potash dissolve with the evolution of considerable heat. On cooling, potassium chloride is precipitated. At the same time, by passing hydrochloric acid in gaseous form, the aluminium chloride is fixed. After separation the latter is decomposed into aluminium hydrate by heating at 350° C. in iron-lined tanks, and the hydrochloric acid is regenerated. The hydrate is then calcined at 600° to 800° C. When treated with acid most silicates yield a gelatinous solution or colloid from which the silica cannot be separated. Leucite has the merit, when treated by the Blanc method, that the resulting solution can be filtered. It is important that the grains shall be about one millimetre in size, and that the mass shall not be agitated during treatment. The chloride solution is usually recirculated through the mass in order to remove any colloidal silica which may have been carried over. On an industrial scale, leucite is being treated to the extent of 1,500 tons of enriched ore monthly by the Societa Italiana Potassa at Roccamontana. At Bussi there is also a plant handling 400 tons of enriched leucite and producing 140 tons of potassium chloride and 80 tons of aluminium chloride per month, the latter being converted to aluminium by the Societa Italiana de Elettro Chemica. Other activities are evidently planned to increase the use of leucite products. Its present status is mainly that of a source for potash, aluminium being a secondary product. The adoption of the Haglund process by an important aluminium-producing group in Italy will tend to limit the scope of leucite treatment.



BLANC



HALVORSEN

(9) *Halvorsen Process.* Norway is one of the most important aluminium-producing countries in the world but is unfortunately not endowed with bauxite deposits. Labradorite, which in some respects is a promising source of alumina, is available in large tonnages. Most Norwegian clays contain only 15% of alumina, whereas labradorite averages nearly double this amount. The preliminary treatment devised by Goldschmidt consisted in crushing, grinding, and treating with hot dilute nitric acid in a series of circulating tanks. Silica and the greater part of the ferrous oxide remain in the residue and the alumina is dissolved. This solution is then heated and evaporated to dryness, whereupon the aluminium nitrate decomposes and water leaching then dissolves out the calcium, sodium, and other nitrates, leaving aluminium hydrate. B. F. Halvorsen's method modifies this process by treating the acid solution from labradorite in an autoclave with ammonium salts for about eight hours at 150 to 200 lb. pressure. The precipitate, after drying and heating at 100° to 200° C., is found to be powdered instead of colloidal. It consists of aluminium hydroxide which can be readily washed and filtered. In this way the difficulty of handling a gelatinous precipitate is avoided. The filtrate contains ammonia, which is reclaimed by heating, as well as soluble aluminium silicates. It is interesting to compare this process with the Blanc on leucite. Neither method appears to have been adopted yet as a commercial source of reducible alumina.

(10) *Sherwin Process.* A method of treating low-grade or high-silica bauxite was devised by R. S. Sherwin as a modification of the Bayer process. It is also claimed that other low-grade residues of appreciable alumina content can be similarly treated. The ore is ground and mixed with enough lime to combine with all the silicate present as calcium silicate. Soda ash is also added to one-half the amount required to produce sodium aluminate with the proportion of silica present. The mass is then sintered and afterwards ground and treated with a soda leach, and the temperature held at 80° to 90° C. Sodium aluminate is produced, and the silicate residue remains practically insoluble. Such of the silica as goes into solution can be precipitated by autoclave treatment for two hours at 145° C. From the aluminate liquor, aluminium hydroxide is precipitated by the introduction of stock alumina and agitation as in the regular Bayer method. The Sherwin method has the advantage of rendering low-grade bauxite available for use by the standard Bayer process but at increased cost. No recovery is possible for the lime, which goes into the calcium silicate.

(11) *Laist Process.* For a number of years past it has been thought that the alunite deposits of Utah would afford a commercially valuable combined source of potash and alumina. These deposits consist of a hydrous basic sulphate of alumina and potash. In pure samples, potash constitutes 11·4%, alumina 37%, sulphur trioxide 38·6%, water 13% of the total. In the Utah potash industry it is customary to calcine, leach the potassium sulphate, and evaporate. Treatment of the alumina has been considered difficult owing to silica impurity. The Laist method has been devised to recover alumina from clay, but is equally applicable and has been used for the treatment of alunite. It was developed by Frederick Laist, Fred F. Frick, and Robert S. Oliver, of the Anaconda Copper Company. The clay or other form of silicate of alumina is mixed with concentrated H_2SO_4 and heated to 300° to 400° C. Sulphates of alumina, potash, and possibly iron are then leached out with hot water. Iron is reduced to the ferrous state by the addition of metallic aluminium. On filtration the insoluble silica is separated. The solution, mixed with hot potassium sulphate, forms potash alum which crystallizes on cooling. Stirring during this stage produces granular crystals of high purity. The alum is now ignited at 1,000° C., when the products of decomposition, oxides of sulphur, are returned to the process and the residue is leached to dissolve out potassium sulphate. Aluminium hydroxide remains and can be calcined to alumina in the customary way.

(12) *Specketer Process.* In this process, which was recently developed by Heinrich Specketer in Germany, clay, leucite, and similar ores are treated with a view to separating the alumina in a pure form and deriving hydrochloric acid as a by-product. The first treatment of the clay after crushing is with sulphuric acid to dissolve out the metallic content. Sodium chloride is then added to the solution in an amount equivalent to the sulphuric acid contained, and the liquid evaporated and heated to 700° C. At this temperature, sodium sulphate and ferrous aluminium sulphate are formed

and hydrochloric acid gas is evolved. For this reaction a rotating tubular furnace is used, and the materials and heating gases are passed through in the same direction. The product is then cooled and leached with water. The alumina and ferric oxide mixture is treated by the Bayer process. A more favourable yield of alumina is obtained in the following modified process. The ore, after crushing, is treated with mixed hydrochloric and sulphuric acids in such proportion that one part of the alumina will be dissolved in sulphuric and two parts in hydrochloric acid. After filtration, salt is added to the solution, which is evaporated, and heated to 500° to 800° C. The alumina-ferric oxide is sintered with coal at 900° to 1,100° C., cooled, leached with water, and the alumina precipitated from the solution by means of hydrogen sulphide or carbon dioxide. After separation the solution can be causticized with lime to yield caustic soda. Evidently this process has not yet been demonstrated on a commercial scale, nor is it established that the product is sufficiently high in quality for aluminium reduction. It is, however, claimed that the method is cheap in respect to investment, raw materials, and labour.

Reviewing the 12 processes described, it will be observed that one and one only, the Bayer method, can still be regarded as standard. Notwithstanding all the promising reports in regard to the reduction of clay, alunite, leucite, and other widely distributed ores, little has been done on a commercial scale to displace the treatment of high-grade bauxite by an alkaline process. Further, the considerable investment and hazard involved in the installation of a plant for treating clay, together with the uncertainty of the operating results, combine to the disadvantage of such grades of raw material. It is believed that the world's principal producers of alumina are fully protected by ample supplies of high-grade bauxite which can be treated by the Bayer process, and that the bulk of the oxide will be derived in this way for many years to come.

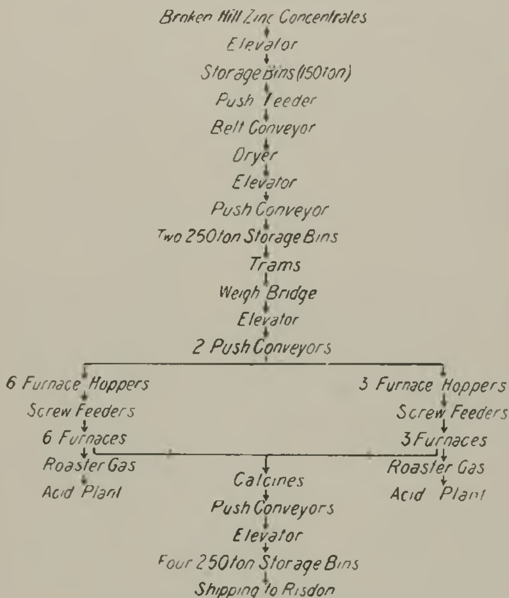
The only new developments of industrial significance are the processes of Hall, Pedersen, and Haglund. All these, however, are dependent on bauxite and not on clay. Somewhat high impurities are permissible as compared with the Bayer process, but even these are subject to strict limits in order to maintain the reacting proportions. By-products are sometimes commercially available, but their value should be discounted when estimating the cost of finished alumina; the demand for the main product and by-products can very seldom be adjusted in the ratio of their production. Both under- and over-production of one material lead to economic loss. The conclusion is inevitable that there is little possibility in the direction of a radical change in methods which would simplify alumina production for the chemical and electrochemical industries.

SULPHURIC ACID AND FERTILIZER MANUFACTURE IN AUSTRALIA

In a Report of the South Australian Department of Mines, J. L. Pearson describes the sulphuric acid plant at Birkenhead, South Australia, operated by the Wallaroo-Mount Lyell Fertilizers Company. This company was formed as a joint enterprise of the two mining companies, the Wallaroo and Moonta and the Mount Lyell Mining and Railway, for the manufacture of superphosphates and there are two works, at Wallaroo and Birkenhead respectively. The source of sulphur has varied from time to time, but since 1919 zinc concentrates from Broken Hill have been chiefly employed, the roasted material going afterwards to Risdon, Tasmania, where zinc is produced electrolytically. The chamber process is used at both works. Mr. Pearson's account of the Birkenhead works is quoted herewith.

The roasting plant consists of a battery of nine circular furnaces of the Herreshoff type, with the necessary equipment for handling ore and calcines. The furnaces have an internal diameter of 10 ft. and are erected on four cast-iron pedestals raised 4 ft. 3 in. above ground level. Each furnace consists of seven hearths and a cover arch, the hearths being spaced at distances of 22½ in. apart, measuring from centre to centre. The central column is a one-piece casting, 15 in. diameter, with the outer circumference protected by a refractory covering consisting of shaped 9 in. by 9 in. firebrick tiles, 3 in. in thickness. These are studded on to the casting, and the boltheads and joints are luted with a grog mixture composed of fireclay, cement, and silicate of soda. There is one rabbling arm to each hearth, and each arm is fitted with eight rabbling teeth. These arms fit into tapered slots in the column, and, when necessary, can be changed in a few minutes. The hearths are connected by dropholes, alternate hearths having inner and outer dropholes. The centre column and rabbling arms make one revolution every 90 seconds, being turned by bevelled toothed wheels attached below the furnace and driven through reducing gearing by shafting connected to a 15 h.p. electric motor, which operates the columns and feed-gear for the nine furnaces. The central column is air-cooled, and the hot air from the top of the column is collected in an air-chest, and then passed through bustle pipes into two air jackets, one on each side of the furnaces covering the space from the No. 2 to No. 7 hearths. This pre-heated air passes from these air jackets into the furnaces through eight openings, equally divided, around the circumference of the furnaces. At the point of admission the temperature of the air averages 340° C. The balance of the air required during roasting is admitted through sliding panels in the working doors of the third and fifth hearths. These also serve to control the temperature, the quantity of air admitted at these points being carefully regulated to maintain the temperature at between 880° and 900° C. on the hottest hearths (Nos. 2, 3, and 4). The furnaces are designed to keep the loss of heat by radiation at a minimum, and no extraneous fuel is used, the sulphur contents of the charges providing the heat required for roasting. The capacity of each furnace is about 8½ tons of wet feed per day, averaging 3% moisture, and the furnace gases average about 5½% of sulphur dioxide. The furnaces operate under induced draught provided by the collector fan fixed in the gas-main system leading to the acid plant. The first furnaces installed (6) stand in line side by side, while those lately added (3) form a parallel line, with room for a further three furnaces should this extension be decided upon. The roasting plant, including accessory equipment, is substantially housed in a wooden-framed iron-covered building equipped with exhaust stacks to assist the ventilation and to carry off fumes that may escape through the working doors during such operations as barring, when the normal drafting is interfered with by the admission of excess air. This type of furnace is well adapted for use at plants where sulphuric acid is made, as the units are comparatively small, and in the case of individual furnace troubles there is only a limited interference with the regular supply of gas to the acid section.

The zinc ores treated consist of a mixture of zinc concentrate and zinc slime concentrate from the Broken Hill mines. The approximate average composition is: Zinc, 46·3%; lead, 5·5%; sulphur, 30·1%; with a silver content of about 5·8 oz. per ton. The material is finely divided, about



FLOW-SHEET OF ROASTING PLANT.

48% of the charge being minus 200 mesh. The ores are delivered by the Government railway service into the company's siding alongside the furnace plant, where they are manually unloaded into a hopper feeding an elevator which delivers into an overhead storage bin of 150 tons capacity. From this bin the ore is fed by a push-feeder on to a belt-conveyor, which delivers on to the centre of a dryer. This consists of a single hearth 14 ft. in diameter, constructed of cast-iron radial plates, and with two rabble arms. The heat is supplied from an external coal-fired box, the gases from which pass over the ore, and then underneath the hearth to the exit flue. In passing through the dryer the moisture content of the ore is reduced to an average of 3%, and the material is then transferred by an elevator and push-plate conveyor to the dried ore storage bins, two 250 ton overhead structures. From this station the ore is manually trucked over a weighbridge into an elevator, which raises it to the distributing conveyor supplying the furnace feed hoppers. These are of 7 tons capacity, and there is one for each furnace, the feed from the conveyor being split among the various hoppers by adjustable sliding doors in the bottom of the conveyor troughing. The elevators are enclosed, the housing consisting of steel plates of standard size, fitted so that any section can be replaced without difficulty when repairs are necessary. The conveyors are of the push-plate type working in rectangular-shaped steel troughing. The conveyor blades consist of $\frac{3}{4}$ in. mild steel plate spaced 12 in. apart, with an 18 in. stroke, and the conveyors work at a rate of 18 strokes per minute, low speeds being adopted throughout the handling system in order to, as far as practicable, limit dusting. From the feed hoppers the furnaces are charged mechanically through a screw-feed fitted with a pawl and rachet attachment for regulating the rate of feed.

The ore is fed into the centre of the top (No. 1) hearth, and from there is rabbled alternately outwards and inwards on successive hearths (by the plough-like action of the revolving rabble arms on the central shaft) and finally discharged from the outside edge of the bottom (No. 7) hearths. The calcined charge drops through a chute on to short push conveyors, which deliver it to the main calcines-collecting conveyor. The latter transfers it into an elevator which raises it to the distributing conveyor working over the calcines-storage bins. These, which number 4, with a total capacity of 1,000 tons of calcines, are circular reinforced concrete structures 22 ft. high and 18 ft. diameter, standing on foundations high enough to admit of a central discharge into side-tipping trucks. On the way to the storage bin the calcines after being allowed to air-cool sufficiently to absorb moisture are damped down at various points by sprays of water to suppress dust in transit, and further moistened when being handled for shipment. The calcines are stored at the works until a full cargo has been accumulated, and then shipped from the wharfs alongside the works to the Electrolytic Zinc Works, Risdon, Tasmania, for recovery of the zinc by the electrolytic process.

The composition of the calcines normally produced approximates: Zinc, 51·5%; lead, 5·0%; sulphur, 6·25%; while the silver contents average about 6 oz. per ton.

The gas offtakes from each furnace are connected with 3 ft. diameter mains, the gas passing from these into cyclone dust arresters and then into the acid section. A large proportion of the lead-zinc compounds are recovered in the form of fine powder comparatively near to the furnaces, and the collector main is cleared at weekly intervals. This is done with a pull-through, which drags the flue dust into down pipes fitted to the under-side of the main, spaced at distance of 13 ft. apart. The cyclones are also cleared once each week. A proportion of the fine lead sulphate fume, and some zinc fume, is carried over with the sulphur dioxide gas and deposited in the acid section to such an extent that the Glover towers and fans have to be washed out at three-day intervals to get rid of the accumulated sulphate and other impurities.

The gas-collector fan, which maintains the exhaust draught in the roasting furnaces, is fixed in the gas mains between the furnace and two flat-bottomed cyclone dust arresters. On leaving the fan the gases are split into two currents and distributed between these cyclones. In the latter the roaster gases, averaging 5½% sulphur dioxide, are enriched to 7% with high-tenor gas obtained by burning brimstone (native sulphur) in the bottom of the cyclones. From these cyclones the gases are drawn by fans through manifolds into the Glover towers, the first units in the acid plant.

The sulphuric acid plant is divided into two sections, each comprising the following principal units :—

Glover Towers—
No. 1 section . 2 No. 2 section . 2 Total . 4

Acid Chambers—
No. 1 section . 4 No. 2 section . 4 Total . 8

Gay-Lussac Towers—
No. 1 section . 2 No. 2 section . 2 Total . 4

The accessory equipment includes :—

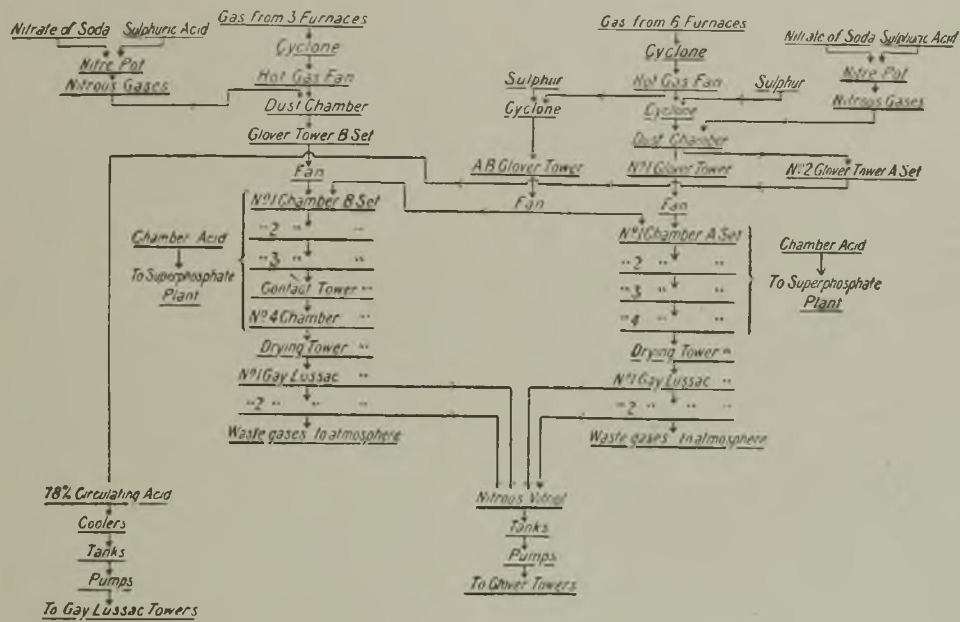
Leading fans 3 (situated between the Glover towers and first chamber of each section).

British Australian manufacture. The packing is laid in checker formation, so that the ascending gases and descending acid can be properly distributed.

The cooling tanks for the hot acid from the Glover towers are circular in shape, equipped with lead coils, and are situated near the towers, so that the acid will flow into them by gravity. Each section of the plant has four acid chambers of the following dimensions :—

	long.	wide.	high.
Leading chamber .	73 ft.	32 ft.	32 ft.
No. 2 chamber . .	66 ft.	32 ft.	32 ft.
No. 3 chamber . .	50 ft.	28 ft.	32 ft.
No. 4 chamber . .	50 ft.	$31\frac{1}{2}$ ft.	22 ft.

The total capacity of the eight chambers is 440,000 cubic feet.



FLOW-SHEET OF ACID PLANT.

Back fans 2 (situated between the last chambers and Gay-Lussac towers of each section).

Nitre pots, which are placed outside the flues, coal fired, and the nitric acid gas generated passed into the flues.

Acid pumps.

Cooling tanks.

Water pumps.

Water spraying systems for the acid chambers.

Nitrate of soda storage tanks and spraying systems.

Acid storage tanks.

The acid chambers stand on floors supported by piles at a distance of 15 ft. above ground level, and the towers at a corresponding elevation. This arrangement leaves the chamber accessible for cooling through slatted floors, as well as for inspection to ensure that the bottoms are not leaking. The Glover towers are of rectangular or square shapes, averaging 10 ft. by 10 ft. and 30 ft. high. The linings consist of acid-proof bricks, and the towers are packed with acid-resisting bricks of

In the original plant the acid chambers were supported by a wooden framework, but during the reconstruction the wood has been replaced by steel. The framing is formed of 7 in. by $3\frac{1}{2}$ in. steel girder posts with steel bracing, to which the side curtains are fastened with lead strips. The tops are suspended by similar means from suitably supported steel piping. The chamber bottoms consist of 10 lb. lead with edges burned together, the sides and tops of 8 lb. lead, and the various chambers are connected by circular flues.

The principal functions of the various units are :—

Of the Glover towers :—

(1) The cooling and cleaning of the furnace gases from impurities.
(2) The denitration of the nitrous vitriol.
(3) The concentration of the weak chamber acid.
(4) The production of sulphuric acid.

The acid-distributing appliances on the tops of the towers are designed to give a uniform distribution of the added acid to assist in exposing it in a finely divided state to the ascending gases.

Of the acid chambers :—

(1) To afford space in which the gases may become properly mixed and for the reactions to take place by which the sulphur dioxide is converted into acid.

(2) To radiate the heat produced by the chemical reactions and to afford surfaces for the condensation of the sulphuric acid as it is formed.

Of the Gay-Lussac tower :—

To recover the oxides of nitrogen issuing from the lead chambers in order that they may be returned into circuit.

The flow of gases and reacting materials is as follows :—The enriched roaster gases from the cyclones containing an average of 7% sulphur dioxide, mixed with the nitric acid gas from the nitre pots, are drawn into the Gover towers of each section by the leading fans. The gases enter the towers near the bottom, and in ascending through the packing come into contact with a down-flowing stream of weak sulphuric acid and nitrous vitriol returned into circuit from the Gay-Lussac towers. During their passage through the Glover, the hot gases evaporate a considerable portion of the water from the weak acid, thereby concentrating the sulphuric acid, and at the same time releasing the nitrous acid from the nitrous vitriol. The released oxides of nitrogen, the sulphur dioxide gas, and the water vapour pass over into the lead chambers, where extra water is added through special platinum sprays of the Becker type as a fine mist, and where the reactions take place for the production of sulphuric acid. On leaving the chambers the gases, consisting of oxides of nitrogen, the excess oxygen, with acid mist and water mist, are passed by the back fans to the Gay-Lussac towers, where the nitrous acid gas is absorbed by strong sulphuric acid, forming nitrous vitriol. This is returned to the Glover towers, where the nitrous acid gas is again liberated by heat and assists in the oxidation of sulphur dioxide in the chambers. The waste gases from the Gay-Lussac tower pass from the top into a flue connected with a stack discharging to the atmosphere.

The various reactions by which the acid is formed generate large quantities of heat, and the normal temperature of the gases entering the first chamber is 88° C. They, however, cool during the passage of the other chambers, and leave the last chamber at a temperature ranging from 26° C. in winter to 40° C. under summer conditions.

The sulphuric acid from the Glover towers drains into the coil tanks for cooling, while the make from the chambers is drained into collecting tanks fixed underneath the chambers. These collecting tanks are connected with the return and storage systems, and the large amount of acid necessary for process purposes is returned to the Glover and Gay-Lussac towers by acid-resisting pumps.

The nitrous vitriol from the Gay-Lussacs is pumped into storage tanks for feeding into the Glover towers. In the chamber process of manufacture the results depend largely on the maintenance of stable conditions throughout the process, and the operating efficiency is seriously affected by : (1) Variations in the supply or tenor of the sulphur dioxide gas ; (2) changes in the strength or quantity of the nitre supply, or nitrous vitriol, to the Glover towers ; (3) fluctuations in the quantity of water being used in the acid chambers. At Birkenhead the operating conditions in the roasting and acid-making sections are systematically checked by regular hydrometer, thermometer, and pyrometer readings at various stages of both processes, thus ensuring a close control throughout the full cycle of operations. These checks enable any unfavourable changes in the conditions to be quickly detected, as the temperature of the gases in the chambers is a sensitive and reliable index of the activity of the process.

The production of chamber acid is equal to 320 tons per week of mono-acid. As has already been stated, this is used for the preparation of superphosphate manures, the manufacture being carried out in a portion of the same works which front the wharves on the Port Adelaide River.

For the manufacture of superphosphate manures the principal constituents are sulphuric acid and phosphate rock. The supplies of the latter used in local manufacture are imported from the Pacific Islands (Ocean, Nauru, Makatea, Angaur), Florida, and Morocco, as, while South Australia has deposits scattered over a wide area, they are generally too low in grade to be suitable for the manufacture of high-class manures and cannot compete economically with the material of better percentage from the oversea deposits mentioned. The Pacific Island phosphate rock is richer in phosphoric acid than any other known deposits, consisting of from 82% to 87% tri-calcic phosphate, while the Morocco and Florida rock carry from 72% to 78%.

The phosphate in the crude rock is insoluble in water, and the process of manufacture consists in converting the insoluble phosphate into a soluble form. This is done by treating it under suitable conditions with sulphuric acid, approximately 1 ton of 60% acid, or its equivalent, being required to treat 1 ton of phosphate rock to produce the ordinary superphosphate.

The process of manfacture at these works is as follows :—In order to reduce the crude phosphate rock to a condition to allow of proper reactions between it and the sulphuric acid, the rock is finely crushed by being passed in turn through rock-breakers and coarse and fine rolls, and the finished product is finally elevated to the feed storage bin for the mixing section. From this bin it is fed into a screw-feeder and passed over a mechanical weighing machine into the mechanical mixer in which the weighed quantities of phosphate rock are mixed in batches with measured quantities of sulphuric acid. After being thoroughly mixed, the semi-liquid mass, as it discharges from the bottom of the mixer, is transferred into one of the series of circular "dens." In these dens the material is stored long enough for the reaction between the rock and acid to continue until the product is converted into the soluble mono-calcic phosphate and calcium sulphate which constitute superphosphate. When this reaction is approximately complete, the dens, which are mounted on wheels, are moved forward to a stationary cutter, which unloads the superphosphate on to a system of belt conveyors and elevators which deliver it to the storage sheds. In these the manures are accumulated until the commencement of the delivery season, and in the meantime undergo further maturing.

When required for bagging, the superphosphate is lifted from the storage piles by a system of underground belt conveyors and placed on portable belt conveyors discharging on to another set of conveyors, which deliver into elevators connected with the screening and bagging mills. After being screened, the superphosphate passes through shoots into bags filled to a uniform weight on scales, and after the bags are sewn is ready for delivery to consumers. The works are connected with the State railway system by a private siding, and the superphosphate for delivery by rail is loaded direct from the bagging platforms into railway trucks, or alternatively for shunting on to the wharf fronting the works for despatch by sea.

The manufacture of the superphosphate is carried on throughout the full year, but the bulk of the production is sent away from the works in time for use in the wheat seeding season The standard product of the company is a superphosphate guaranteed to contain not less than 45% water-soluble phosphate. Besides this, other grades of manures for special purposes are manufactured and marketed.

Molybdenite Mining in Victoria.—*Chemical Engineering and Mining Review* for November contains an account by C. R. Paynter of the molybdenite mining operations at Everton, Victoria, which have been temporarily suspended since 1927 owing to the unremunerative price for the concentrates.

The extent of the field is about 3 miles long and ½ mile wide, and the mineral occurs in granite bosses. For some time the rock broken was hand-picked, and the portions containing less than 1% molybdenite were sent to the waste heap, while the richer ore was trucked to Melbourne for treatment. At the end of 1919 the Standard Molybdenite Mining Co. erected on the lease a plant capable of treating 50 tons of ore per week. This company continued production until early in 1927.

The mining procedure adopted by this company consisted in opening into the hill as an open-cut, tunnelling, and sinking shafts 20 or 30 ft. to the richer deposits. The ore was roughly hand-picked, the poorer material being trucked to the waste heap, while the remainder was trucked a distance of approximately 300 yd. to the treatment mill. The treatment consisted in crushing the rock to about 2 in. size by means of a jaw crusher, the broken material discharging into a storage bin. From this bin the ore was fed by means of an automatic feed (capable of delivering 35 to 40 lb. of ore per minute) to a pair of rolls, which crushed the ore to a coarse powder. The crushed material was elevated to a trommel revolving in a stream of water, the over-size being returned by a chute to the rolls for further grinding. The material that passed through the trommel was sent to a classifier, the coarser underflow being further ground in a grinding pan, the ground material being elevated to the classifier, thus completing the cycle between classifier and grinding pan. The overflow from the classifier was then elevated about 45 ft. to a pair of spitzkasten. The overflow from No. 1 was discharged into No. 2, from which the overflow, being nearly clear water, was discharged to the storage dam. The pulp drawn off from the bottoms of the tanks was then fed into a Minerals Separation six-compartment standard flotation machine with 9 in. stirrers. It contained 4·0 per cent solids. This flotation machine was very efficient and compact, being about 9 ft. in length, 8 ft. high, and 5 ft. in overall width. It consisted of six separate compartments, the ore feeding into No. 1 and the sand and waste material discharging from No. 6 compartment. Hand-operated valves enabled the solution to pass from one compartment to the next, and to keep an even level in each compartment. The propellers were driven at about 590 r.p.m. by pulleys coupled direct to a separate engine. The molybdenite was floated by means of eucalyptus oil—about two drops per minute—entering No. 1 compartment from an overhead supply tank. When extra rich ore was being treated a further two drops of oil entered No. 4 compartment and the supply of oil was increased in No. 1 compartment. The molybdenite floated to the surface as a greyish black froth, and there was rarely any showing in the last compartment. The waste material flowing to the dump was regularly examined for any trace of molybdenite. An automatic skimmer removed the froth of molybdenite, discharging it into storage vats where a large amount of water was removed by running off from the bottom discharge taps. The floated material contained about 60% of molybdenite, and in order to increase this percentage the concentrate was given a further flotation in a one-compartment 6 in. sub-aeration Minerals Separation machine with a 6 in. stirrer. The floated material was hand-skimmed and transferred to steam-heated drying vats. It was then hand-bagged into white calico bags which, for safety against bursting, were placed in hessian bags. Each bag averaged about 90 lb., while the material was graded as 86%. The company had an output of 15 cwt. to 25 cwt. per week, which was transported by rail to Melbourne for shipment abroad.

The Seismic Method in Geophysics.—At the meeting of the Institution of Petroleum Technologists held on January 8, W. H. Fordham read a paper on geophysical surveying, particularly in connection with oil geology. We extract herewith his account of the seismic method which depends on elasticity and on the relative speed of waves of sound or percussion passing through various formations.

The seismic method, as applied in salt dome countries, is based on the fact that sound travels through air at about 1,100 ft. per second, through

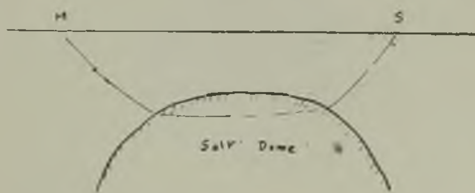


FIG. 1.

ordinary surface formations at about 6,000 ft. per second, and through salt domes at 16,000 ft. per second. Thus, if a charge of dynamite is exploded at the point M in Fig. 1, a compressive wave will travel outwards in all directions. A seismograph at S will record the arrival of the wave. If the velocitv is only 6,000 ft. per second there is no salt dome between M and S. If the velocity measured by the instrument is greater, there is reason to suppose that a dome is present, and that the wave has passed through it in some part of its course.

In another application of the seismic method a number of instruments are set up on radial lines round a mine (explosion centre), and the travel-time curves on the different radii plotted. If the curve for any particular radius is a straight line there is no structural unconformity near the surface; if there is a break in the curve it indicates a plane of discontinuity in the formations below.

The best known seismographs are those designed by Mintrop and Schweydar and made by Askania, though a large number of other methods of recording the arrival of seismic waves have been suggested and some of them are being used. Mintrop's instrument is illustrated in Figs. 2, 3, 4, and 5, which are taken with the descriptions from his patent specification. (English Patent, 156,194, of 1917.) Fig. 2 is a vertical section of the instrument; Fig. 3 a vertical section of the upper part thereof in a plane normal to that of Fig. 2; Fig. 4, a horizontal cross section of the upper part; and Fig. 5, a horizontal section of the lower part. In a closed case, a weight 3 is carried, by means of a spring 2. The case is set perpendicularly by means of a level 4. Upon the weight stands, fixed thereto, a light arm 5, having at its upper

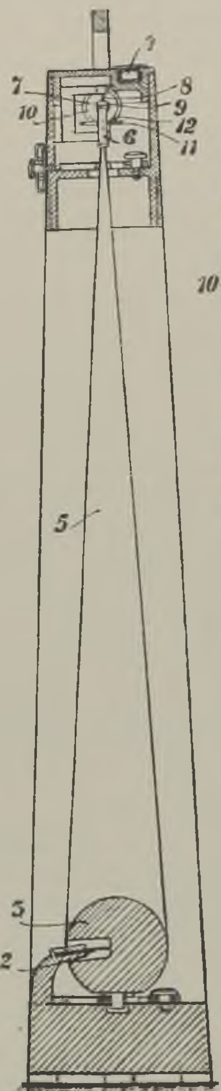


Fig. 2.

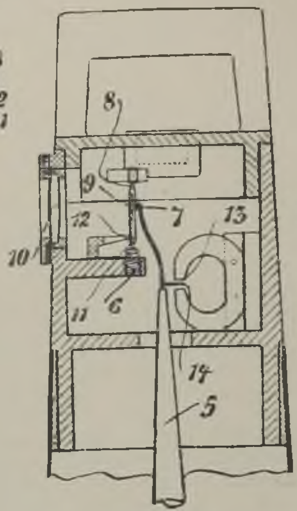


Fig. 3.

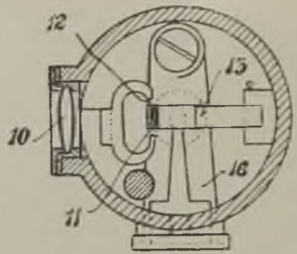


Fig. 4.

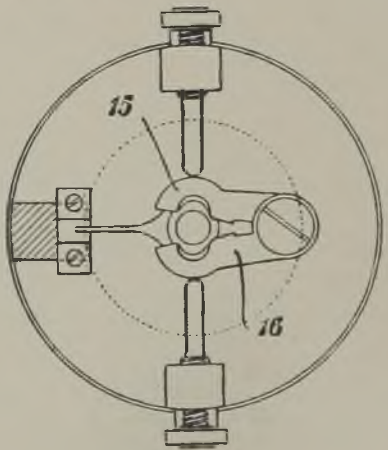


Fig. 5.

FIGS. 2–5.—MINTROP'S SEISMOGRAPH.

end a thin spring 6. The latter bears with light pressure, by means of a small friction block 7, against a thin spindle 8 carrying a small mirror 9. The spindle is easily rotatable on points in jewelled bearings; 10 is a converging lens, through which light can fall upon the mirror and passes out of the casing again. The spindle 8 has fixed to it an iron pin 11, in the field of a magnet 12. The effect of this arrangement is that the mirror, even after the strongest shock, returns to its normal position. The damping of the oscillations of the weight and arm 5 is effected by a magnet 13, into the field of which a small iron plate 14 extends. For purposes of transport the pendulum is made fast by means of two clips 15 and 16. The whole instrument weighs only a few kilograms, and can be carried very easily. The oscillations of the mirror can be visually observed by means of the light beam which it reflects, or can be photographically recorded. In the form of apparatus now in use (Patent 156,228) the oscillations of the mirror are recorded on a moving photographic film, the arrangement illustrated in Fig. 6 being adopted in which the film is driven by clockwork. To measure the time interval a small short-wave radio transmitter sending Morse signals is placed near the mine, fitted up in such a way that on firing the mine the transmitter is cut out. The signals are recorded on the moving film of the seismograph by means of a radio receiving set. A seismograph costs between £400 and £500. This does not include the radio equipment. A survey party consists of three or more groups, each equipped with a seismograph, radio transmitting and receiving sets, apparatus for exploding dynamite charges, etc. Charges are exploded by each group in turn.

The petrolometer of Dr. Spitz is a third variation of the seismic or sonic method. The instrument is reported to be on the same principles as the submarine detector used in the war, and the newer depth-finding apparatus used for mapping the ocean bottom. Dr. Spitz apparently asserts that the only formations which do not reflect the sound waves used by him are oil and oil sands, and that this enables oil pools to be directly located.

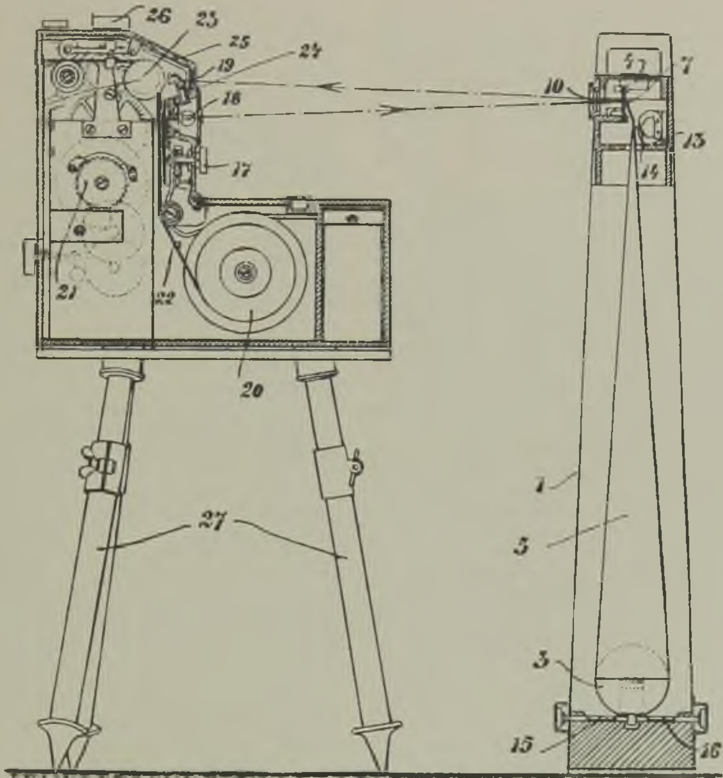


FIG. 6.—MINTROP'S PHOTOGRAPHIC RECORDER.

The United States Copper Industry, 1928.—The United States Bureau of Mines has issued a report on the United States copper industry during the year 1928. According to this report the outstanding feature of the industry was the heavy domestic withdrawals from stocks made during the latter part of the year, which cause the domestic withdrawals for the year to be the highest on record, with the exception of 1918. The price of copper increased throughout the year from a monthly average of 13·96 cents per pound in January, to 15·9 cents per pound in November and approximately the same in December. Demand, followed by the highest prices that had been paid since April, 1923, brought forth a response from the mines in the form of largely increased production. Smelter production from domestic ores increased about 10% during the year and that this increase is largely owing to heavy production in the latter part of the year is shown by the estimate of smelter production in December, 179,000,000 pounds, which is 27,000,000 pounds higher than the average monthly average for the 11 months preceding. As it takes from two to three months for copper in ore mined to appear as refined copper, the increased mine production had not up to the end of the year caused as large an increase in refinery output as it had in smelter output. The increased mine production was not made soon enough to save the producers from drawing largely on their stocks of refined copper to satisfy consumption, and refined stocks have been depleted during the year from 171,000,000 pounds at its beginning to estimated stocks of 95,000,000 pounds on December 31. The drop in imports of refined copper and the increase in exports caused a further depletion of refined stocks. Blister stocks also were decreased in 1928.

The smelter production of copper from domestic ores in 1928, as determined from reports of the smelters showing actual production for 11 months and estimated production for December, was 1,849,000,000 pounds, compared with 1,684,000,000 pounds in 1927. The 1928 production is 10% higher than that of 1927, and is the largest peace-time production on record. The estimated smelter production from domestic ores for December, as reported by the smelters, was 179,000,000 pounds, which is 27,000,000 pounds higher than the average for the 11 months preceding.

The production of new refined copper from domestic sources, determined in the same manner as smelter production, was about 1,763,000,000 pounds, compared with 1,719,000,000 pounds in 1927. In 1928 the production of new refined copper from domestic and foreign sources amounted to about 2,470,000,000 pounds, compared with 2,326,000,000 pounds in 1927, an increase of 144,000,000 pounds, or 6%. The production of secondary copper by primary refineries increased from 210,000,000 pounds to about 240,000,000 pounds in 1928, or 30,000,000 pounds, so that the total primary and secondary output of copper by the refineries was nearly 7% higher in 1928 than in 1927, being about 2,710,000,000 pounds compared with 2,536,000,000 pounds.

The imports of unmanufactured copper during the first 11 months of 1928 amounted to 699,758,092 pounds, a monthly rate of 63,600,000 pounds, compared with 718,322,990 pounds for the entire year 1927, a monthly rate of 60,000,000 pounds. The total imports for 1928 will very likely show an increase in quantity of approximately 50,000,000 pounds for the year.

The exports of metallic copper during the first 11 months of 1928 amounted to 1,039,055,909 pounds, compared with 1,069,493,121 pounds exported during the entire year 1927. If the exports of metallic copper in December equal the monthly average for the first 11 months of the year, over 94,000,000 pounds, the total for 1928 will be about 1,133,000,000 pounds, an increase of about 6% over the exports in 1927. In the first 11 months of 1928, 946,185,124 pounds of refined copper in ingots, bars, rods, and other forms were exported. Of this quantity Germany received 196,897,805 pounds, the highest amount, the United Kingdom 195,090,988 pounds, and France 156,131,812 pounds. In the entire year 1927 Germany received the largest amount, 221,841,647 pounds, the United Kingdom was next with 205,598,270 pounds, and France was third with 112,721,355 pounds. When figures for December are added, exports to Germany will show a small decrease and those to the United Kingdom an increase. Exports to France for 11 months of 1928 were nearly 39% higher than exports for the entire year 1927.

Refineries report that at the end of 1928 approximately 95,000,000 pounds of refined copper would be in stock, a decrease from 171,000,000 pounds at the end of 1927. It is estimated that stocks of blister copper at the smelters, in transit to refineries, and at refineries, and materials in process of refining, would be about 378,000,000 pounds on December 31, compared with 401,000,000 pounds at the end of 1927, a decrease of 23,000,000 pounds. Therefore, a decrease of 99,000,000 pounds in total smelter and refinery stocks is indicated.

The quantity of new refined copper withdrawn on domestic account during the year was about 1,588,000,000 pounds, compared with 1,423,000,000 pounds in 1927, an increase of 165,000,000 pounds, or approximately 12%. Domestic withdrawals in 1928 were the highest ever recorded with the exception of those in 1918.

United States Lead and Zinc Output.—The United States Bureau of Mines reports that during the year 1928 the output of primary domestic desilverized lead in the United States was about 345,000 tons, of soft lead about 226,000 tons, and of desilverized soft lead about 53,000 tons, making a total output from domestic ores of about 624,000 tons of refined lead. The corresponding figures in 1927 were 378,889 tons of desilverized lead, 233,944 tons of soft lead, and 55,487 tons of desilverized soft lead, making a total of 668,320 tons. The output of lead smelted and refined from foreign ore and bullion was about 156,000 tons, as compared with 128,210 tons in 1927. The total primary lead smelted or refined in the United States in 1928 was thus about 780,000 tons, as compared with a total of 796,530 tons in 1927, a decrease of about 2%. The output of antimonial lead in 1928 was about 25,000 tons, as compared with 24,347 tons in 1927.

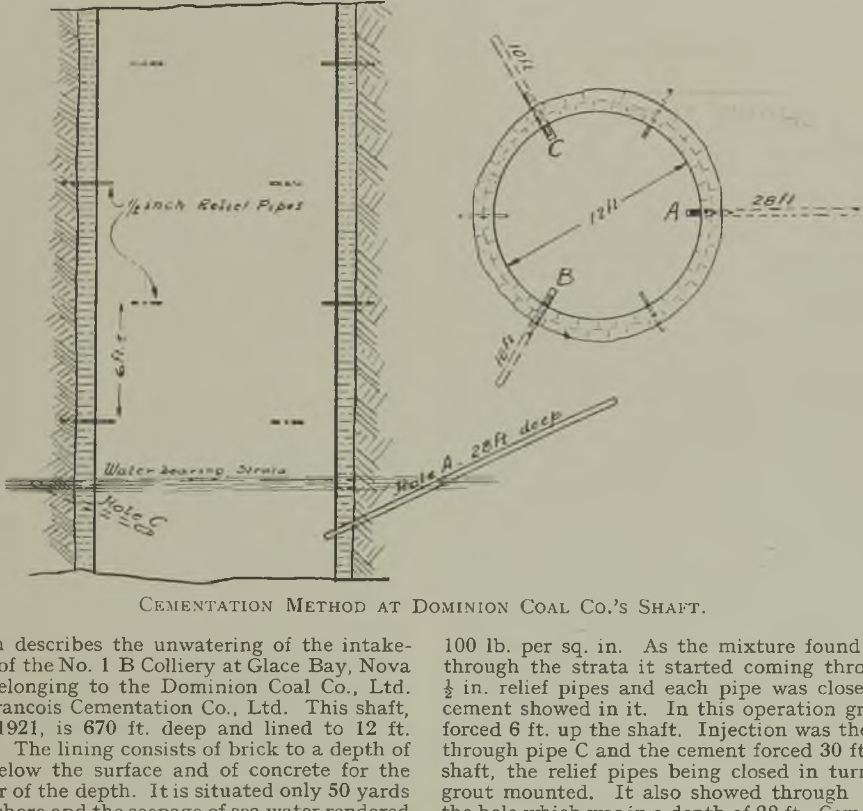
The imports of refined pig lead for eleven months amounted to 605 tons, of which 546 tons came from Mexico. The base bullion imported during the same period contained 114,836 tons of lead, almost wholly from Mexico. The exports of lead of foreign origin amounted to nearly 98,000 tons, as compared with 122,734 tons exported in the entire year 1927. Exports of lead of domestic origin amounted to 10,858 tons, as compared with 2,533 tons exported in 1927. Exclusive of stocks of lead at smelters and refineries and estimating the amount of lead exported with benefit of drawback, for which figures are not available, it is calculated that the new supply of lead made available for consumption in 1928 was about 653,000 tons, as compared with 663,412 tons in 1927.

The output of primary metallic zinc from domestic ores in 1928 was about 582,100 tons and that from foreign ores was about 12,400 tons, making a total of 594,500 tons, as compared with 576,960 tons from domestic ores and 15,556 tons from foreign ores, a total of 592,516 tons in 1927. In addition to the output of primary zinc there was an output of about 52,100 tons of redistilled secondary zinc, as compared with 42,784 tons in 1927, making a total supply of distilled and electrolytic zinc in 1928 of about 646,600 tons, composed of 238,200 tons of high-grade and intermediate, 80,100 tons of select and brass special, and 328,300 tons of prime western zinc. Of the total output of primary zinc in 1928, 160,000 tons was electrolytic zinc produced in Montana and Idaho, 105,000 tons was made in Pennsylvania, 104,000 tons in Illinois, 103,000 tons in Oklahoma, and the remainder in Arkansas, Indiana, Kansas, Texas, and West Virginia.

The imports of slab zinc for eleven months amounted to only 3 tons. The exports of slab zinc made from domestic and foreign ores amounted to 27,855 tons, including 3,869 tons of rolled zinc. The stock of zinc reported at smelters on November 30 was about 41,000 tons. No slab zinc was reported in warehouse. The apparent consumption of primary zinc in 1928 was about 578,000 tons, as compared with 516,371 tons in 1927.

Francois Cementation in Nova Scotia.—In the *Canadian Mining Journal* for January 4, Sydney C. Mifflen describes the unwatering of the intake-air shaft of the No. 1 B Colliery at Glace Bay, Nova Scotia, belonging to the Dominion Coal Co., Ltd. by the Francois Cementation Co., Ltd. This shaft, sunk in 1921, is 670 ft. deep and lined to 12 ft. diameter. The lining consists of brick to a depth of 213 ft. below the surface and of concrete for the remainder of the depth. It is situated only 50 yards from the shore and the seepage of sea water rendered it quite wet when first sunk. Holes were subsequently drilled through the lining and cement grout was forced in under a pressure in the neighbourhood of 70 lb. per sq. in. This ameliorated the situation somewhat but still the shaft continued to make water at about 30 gallons per minute. Being on the intake air, this leakage constituted a serious disadvantage in freezing up badly during the winter months. A contract to dry the shaft was then given to the Francois Cementation Co.

There were two main feeders, at 135 ft. and 100 ft. respectively below the surface. A third, if it might be styled such seeing that it made less than a gallon per minute, was situated at 40 ft. down the shaft. Holes to take ordinary ½ in. pipe were drilled in rings of three at the same elevation, the rings being spaced 6 ft. apart vertically from the bottom feeder to the top. These holes were drilled through the lining 8 in. to 10 in. into the strata and a pipe was wedged in each carrying on its outside end an ordinary stop-cock. Just below each of the larger feeders a ring of three 2¾ in. holes were put in, inclined upwards at about 35° to 40° to cut the water-bearing strata. Holes B and C brought water at 10 ft. and were stopped at that depth, while hole A was drilled to a depth of 28 ft. Pipes, 2 in. in diameter, were then placed in these holes and wedged tight at the mouth of the hole with spun yarn and pitch pine. Connection to the cementing machine at the shaft head was made through a 2 in. pipe first to hole B and two bags of cement in 80 gallons of water to each bag was pumped in, the pressure reaching 100 lb. per sq. in. As the mixture found its way through the strata it started coming through the ½ in. relief pipes and each pipe was closed off as cement showed in it. In this operation grout was forced 6 ft. up the shaft. Injection was then made through pipe C and the cement forced 30 ft. up the shaft, the relief pipes being closed in turn as the grout mounted. It also showed through pipe A, the hole which was in a depth of 28 ft. Cement used in this hole amounted to 22 bags in 80 gallons of water to each bag, the pressure ranging from 50 to 100 lb. per sq. in.; 28 bags in 40 gallons each, the pressure increasing from 100 to 150 lb.; and 9 bags in 25 gallons each, the pressure running up to 200 lb. Connection was then made to pipe A, the deep hole, and from here cement showed 20 ft. up the shaft. Only 26 bags of cement in 80 gallons of water each were needed in this hole, the pressure rising from 100 to 200 lb. This totalled 87 bags of cement, which effectually sealed off the lower feeder. Similar operations requiring 117 bags of cement at a final pressure of 300 lb. sealed the



Cementation Method at Dominion Coal Co.'s Shaft.

second feeder, while only 41 bags were needed to stop the smallest at the top.

The plant consists of a mixing tank, receiving tank, air (or steam) operated pump with suitable pipe and hose to withstand pressures in excess of 2,500 lb. per sq. in. The capacity of each tank is 80 gallons, and each is fitted with a propeller to keep the cement in suspension in the water, the propellers being mounted on vertical shafts, and driven from a countershaft actuated by a small air engine. After being mixed in the first tank the slurry flows by gravity to the second, being screened, on entering, through a ⅛ in. mesh. The pump, which is the property of the Dominion Coal Co., and which has been used successfully by them in rendering waterproof strata adjacent to underground dams, consists of a 10 in. diameter air cylinder while the ram of the hydraulic end is 2 in. in diameter, the stroke being 12 in. Other than its sturdy design to withstand heavy pressure the pump has no unusual features. The whole operation was completed within a week and has rendered the shaft quite dry. In all probability other shafts in this district will be treated in the same way.

SHORT NOTICES

Tin Mining in Malaya.—In the *Engineering and Mining Journal* for December 29, Frank D. Adams, professor of geology at McGill University, writes on the tin alluvials of Malay and the methods of extracting the cassiterite from them.

Concentration at Kennecott.—In the *Engineering and Mining Journal* for December 29, E. J. Duggan describes the concentration plant at the Kennecott copper mine, Alaska, particular attention being given to the floating of the fine carbonate ore by the precipitation on it of a film of copper sulphide by the action of sodium sulphide.

Steel Manufacture in Australia.—The *Iron and Coal Trades Review* for January 11 describes and illustrates the iron and steel works at Port Kembla, New South Wales, erected by Australian Iron and Steel, Ltd., which is a combination of the Australian Hoskins firm with Dorman, Long and Co., and Baldwins, Ltd.

Tin Solders.—In *Industrial and Engineering Chemistry* for January E. E. Schumacher and E. J. Basch describe the use of lead-tin-cadmium solders, to be used particularly as wiping solders.

Determination of Cadmium.—In *Chemical Engineering and Mining Review* for November, C. Blazey, metallurgist to Metal Manufactures Proprietary, Ltd., Port Kembla, describes a method of determining the cadmium content of copper wire containing small percentages of cadmium added for the purpose of increasing the tensile strength of the wire.

Dolomitization as a Guide to Ore Deposits.—In *Economic Geology* for December, D. F. Hewett deals at some length with dolomitization of limestone as a criterion of the existence of ore deposits.

Soapstone in Virginia.—A paper on soapstone mining in Virginia was presented by C. W. Ryan at the February meeting of the American Institute of Mining and Metallurgical Engineers.

Arabian Conditions.—In *Mining and Metallurgy* for January K. S. Twitchell, of New York, gives some account of his experiences during a visit to the Kingdom of Yemen, in southern Arabia.

Mining in 1928.—The *Engineering and Mining Journal* for January 19 contains its usual annual review of mining throughout the world.

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.*

12,435 of 1927 (271,853). Copper Deoxidation Co., New York, and H. H. Stout, Douglas, Arizona. Method of refining copper whereby the oxygen, sulphur, and gas pockets are entirely removed.

15,665 of 1927 (301,553). H. L. Sulman and H. F. K. Picard. London. Extraction of tin from cassiterite ores by conversion into a sulphide soluble in ammonium polysulphide.

16,971 of 1927 (301,099). I. G. Farbenindustrie A.G., Frankfort-on-Main. Improved method of separating metals such as iron, nickel, and cobalt which form carbonyls.

20,190 of 1927 (300,147). W. Kohler, Cleveland, Ohio. Production of metallic magnesium in an electric furnace in which the magnesium-bearing material is dissociated and the magnesium collected as a vapour in a non-oxidizing atmosphere.

20,282 of 1927 (299,750). F. L. Wilder, E. Morris, E. Schiff, and E. S. King. London. Claim No. 9:—" A process for the washing of complex minerals such as tin-bearing sands and recovering the metals and compounds dissolved during the washing, which comprises agitating the material with a solution containing persulphates, an acid sulphate, and chlorides of an alkali metal such as sodium, which solution also contains peracids, ferric sulphate, and ferric sulphide, and a substantial content of free chlorine, filtering the wet mixture, treating the filtrate for the recovery therefrom of dissolved metals such as tin and copper, regenerating the mother liquor by electrolysis with or without addition of sulphur dioxide and/or chlorine, and re-utilizing the regenerated liquor for a further similar washing operation." The coarser crushed ore is sent to the usual concentration process.

20,909 of 1927 (300,519). New Jersey Zinc Co., New York. Furnace for conducting a continuous process for zinc smelting.

20,988 of 1927 (1927). J. F. Robillard. Antananarivo, Madagascar. Improved method of concentrating graphite by flotation.

21,922 of 1927 (300,701). T. J. Taplin, B. Taplin, and Metals Production, Ltd., London. Improvements in the reduction-chlorination process for producing metallic copper from oxidized copper ores described as the "segregation" process described in Patent No. 250,991.

21,987 of 1927 (299,936). I. G. Farbenindustrie A.G., Frankfort-on-Main. Dry separation of ore-minerals from gangue by passing compressed air through layers of the ore.

22,279 of 1927 (301,342). I. G. Farbenindustrie A.G., Frankfort-on-Main. Improvement in the method of extracting metals by means of ammonia by first giving the material a chlorination treatment.

24,307 of 1927 (302,386). F. L. Wilder, E. Morris, E. Schiff, and E. S. King, London. Method of separating gases by entraining them in a downward flowing column of solvent, and subsequently elevating the solvent to such a height that only one of the gases is liberated.

31,820 of 1927 (300,401). O. Matter, Cologne Improvements in the refining of lead azide, having for their object the prevention of misfires when the azide is used in mining detonators.

3,474 of 1928 (284,678). P. L. Hulin, Grenoble. France. Improvements in the electrolytic production of light metals such as magnesium, calcium, glucinum, etc.

3,871 of 1928 (287,130). X. de Spirlet, Brussels. Improved method of driving rotating hearths in roasting furnaces.

5,195 of 1928 (302,087). T. R. Haglund, Stockholm. Method of mixing the charge in electric furnaces in which special steel alloys are produced from iron ores in such a way that the slag shall be subsequently useful in the manufacture of refractory material.

6,522 of 1928 (288,253). Metallbank und Metallurgische Gesellschaft, Frankfort-on-Main. Method of producing anhydrous zinc chloride.

8,784 of 1928 (288,266). Metallbank und Metallurgische Gesellschaft, Frankfort-on-Main. Extracting copper and zinc from burnt pyrites still containing some sulphur by chloridizing-roasting in such a way that the copper is produced as sulphate and the zinc as chloride which can be leached fractionally.

10,300 of 1928 (302,851). E. A. Ashcroft, Ashburton, Devon. Extracting tin from ore by treatment with ferrous chloride and iron powder whereby stannous chloride and ferrous oxide are formed, the stannous chloride being subsequently electrolysed for the production of tin and the regeneration of the reacting ferrous chloride.

10,715 of 1928 (288,579). Siemens und Halske, Berlin. Improved process for producing iron-beryllium alloys.

19,252 of 1928 (302,129). J. A. Weil, H. Rawlinson, and Imperial Chemical Industries, Ltd., London. Improved method of preparing vanadium pentoxide suitable for use as a catalyst.

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.

Methods in Non Ferrous Metallurgical Analysis. By Robert Keffer, C. L. McNeil, and Allison Butts. Cloth, octavo, 336 pages, illustrated. Price 20s. New York and London : McGraw Hill Book Co.

Nomenclature of Petrology : a Dictionary of Rock Names. Second Edition. By Dr. Arthur Holmes. Cloth, small octavo, 284 pages. Price 7s. 6d. London : Thomas Murby and Co.

Mining Drawing, and Materials of Construction. Parts 2 and 3. By H. C. Harris. Cloth, small quarto, 72 pages each. Price 3s. each. London and Glasgow : Blackie and Sons, Ltd.

The British Carboniferous Producti, II. By Helen Muir-Wood. Quarto, paper covers, 220 pages, with many plates. Price 9s. This is Part I of Vol. 3 of the Memoir on Palæontology, published by the Geological Survey of Great Britain.

Notes on the Geology of Mamfe Division, Cameroons Province. By Dr. R. C. Wilson. Quarto, paper covers, 24 pages, with map. Price 2s. Occasional Paper No. 6 of the Geological Survey of Nigeria. London : The Crown Agents for the Colonies.

Field and Colliery Surveying. Second Edition. By T. A. O'Donahue and T. G. Bocking. Cloth, octavo, 330 pages, illustrated. Price 10s. 6d. London : Macmillan and Co., Ltd.

The Principles of Underdrainage. By R. D. Walker. Cloth, octavo, 230 pages, illustrated. Price 15s. London : Chapman and Hall, Ltd.

Flotation Practice : Papers and Discussions presented at Meetings of the American Institute of Mining and Metallurgical Engineers in 1927 and 1928. Cloth, octavo, 260 pages, illustrated. Price 15s. New York : The American Institute of Mining and Metallurgical Engineers ; London : Mining Publications, Ltd.

Geology of the Union of South Africa. By A. W. Rogers, A. L. Hall, P. A. Wagner, and S. H. Haughton. Being Vol. 7, section 7*a* of the Handbuch de Regionale Geologie. Octavo, paper covers, 232 pages, illustrated. Price 17 marks. Heidelberg: Carl Winters Universitatsbuchhandlung.

Diatomite : Its Occurrence, Preparation, and Uses. By V. L. Eardley-Wilmot. Octavo, paper covers, 182 pages, illustrated. Price 30 cents. Ottawa : The Department of Mines.

Firedamp Explosions within Closed Vessels : " Pressure Piling." By C. S. W. Grice and R. V. Wheeler. Octavo, paper covers, 26 pages, illustrated. Price 1s. Paper No. 49 issued by the Safety in Mines Research Board. London : The Mines Department.

Second Report of the National Fuel and Power Committee. Pamphlet, 46 pages. Price 9d. London : The Board of Trade.

African Manual on Mining, Industry, and Agriculture, 1928–9. Edited by C. Carlyle-Gall. Cloth, octavo, 1,320 pages. Price 21s. London : Mining and Industrial Publications of Africa, Ltd.

COMPANY REPORTS

Wolhuter Gold Mines.—This company has worked an outcrop mine in the central part of the Rand since 1887. Control was for some years with Neumann's, but of recent years has been with the Central Mining-Rand Mines group. A year ago it was expected that the end was fast approaching, but as the amount of ore coming from shaft pillars and reclamation has exceeded expectations operations have been prolonged. The payable tonnage is, however, limited and it is improbable that operations can be continued much longer. The report for the year ended October 31 last shows that 414,434 tons of ore was raised and that, after the rejection of 12½% waste, 362,800 tons, averaging 4.87 dwt. gold per ton, was sent to the mill. The total output of gold was 81,392 oz., worth £345,380, and osmiridium and silver brought the income £346,582, or 19s. 1d. per ton. The working cost was £338,724, or 18s. 8d. per ton, leaving a working profit of £7,858, or 5d. per ton. The additional claims bought from the New Goch a few years ago proved unworkable by the Wolhuter company and they were disposed of to the Nourse Mines.

Ashanti Goldfields Corporation.—This company has worked a gold mine at Obuasi, Gold Coast Colony, since 1897, and has paid large dividends. Three years ago the developments became unsatisfactory, but at about the same time a new lode was discovered further down the shaft. The report now published covers the year ended September 30 last. During this period 102,985 tons of ore was treated for a yield of 104,612 oz. of gold, the yield per ton being 20·35 dwt. The total income was £459,050, or 89s. 1d. per ton, and the working cost was £295,610, or 57s. 4d. per ton, leaving a working profit of £163,440, or 31s. 9d. per ton. Out of the profit, £137,500 has been distributed as dividend, the rate being 55%. Development on the Obuasi shoot has given much better results lately and the disturbed zone appears to have been passed through. The new reef has added substantially to the reserve, but at lower levels the developments are not so good. There are indications that the Obuasi shoot and the new reef will unite on the 24th level which is now being opened up. The ore reserve is estimated at 549,400 tons averaging 24·2 dwt. gold per ton, as compared with 419,700 tons of the same value a year ago. At the metallurgical plant the percentage of recovery has been increased to 93·2%, and still further improvements are expected when the whole of the modifications of the plant have been effected.

Rambutan.—This company belongs to the Wickett-Osborne-Chappel group and was formed in 1905 to acquire alluvial tin properties at Tanjong, Perak, Federated Malay States. The report for the year ended June 30 shows that 638,500 cu. yd. of ground gave 170 tons of tin concentrate, the yield per yard being 0·6 lb., as compared with 590,900 cu. yd., 118½ tons, and 0·45 lb. the previous year. This advance is due to the increasing amount of ground treated in the Toh Kiri section where better values are found. The revenue from the sale of concentrates was £22,197, and the profit was £10,259, out of which £6,666 has been distributed as dividend, the rate being 6⅔%.

Jos Tin Area (Nigeria).—This company was formed in 1910 to work alluvial tin properties in the Jos and Ropp districts, Northern Nigeria. The report for the year ended July 31 last shows that 206 tons of tin concentrate was won, as compared with 196 tons the year before. The profit, after writing £5,000 off purchase of mining leases, was £9,517, out of which £9,375 has been paid as dividend, the rate being 12½%.

Apex (Trinidad) Oilfields.—This company was formed in 1919 by the Anglo-French Exploration Co. and the British Borneo Petroleum Syndicate to operate oil lands in the Fyzabad district, Trinidad. Production of crude oil started in 1921, and the payment of dividends the next year. The oil is sold to Trinidad Leaseholds for refining. The report for the year ended September 30 last shows that the production of oil was 294,775 tons as compared with 281,181 tons the year before. The net profit for the year was £246,429, out of which £168,000 has been paid in dividends, the rate being 35%. A year ago the net profit was £404,356 and the dividend was at the rate of 80%. The fall in the profits for the past year was due to the low prices prevailing.

San Francisco Mines of Mexico.—This company was formed in 1913 to acquire from a company of similar name lead-zinc-silver mines in the Parral district of Mexico. Control is now with the Union Corporation. The report for the year ended September 30 last shows that 300,010 tons of ore was sent to the dressing plant, of which 247,400 tons was sulphide ore, 48,630 tons partly oxidized ore, and 3,980 tons zinc residues. The ore averaged 8·2% lead, 11·5% zinc, 0·6% copper, and 264 grammes silver and 1·1 grammes gold per ton. The products were 36,334 tons of lead concentrates averaging 60·3% lead, 11·3% zinc, 2·7% copper, 1,520 grammes silver, and 5·3 grammes gold, together with 48,807 tons of zinc concentrates averaging 54·4% zinc, 1·6% lead, 1·1% copper, 251 grammes silver, and 1·3 grammes gold. The average grade of the ore developed during the year was lower than in previous years owing chiefly to much of the development being beyond the lateral limits of the higher-grade ore-shoots. The ore reserves are estimated at 1,194,000 tons of fully blocked sulphide ore averaging 8·5% lead, 10·9% zinc, 0·6% copper, 234 grammes silver, and 0·9 grammes gold, together with 197,000 tons of oxidized ore averaging 5·5% lead, 0·4% copper, 350 grammes silver, and 1·8 grammes gold. In addition the partly blocked ore is estimated at 349,000 tons of sulphide ore averaging 7% lead, 9·8% zinc, 0·7% copper, 206 grammes silver, and 0·8 grammes gold, together with 133,000 tons of oxidized ore averaging 4·7% lead, 0·4% copper, 286 grammes silver, and 1·3 grammes gold. The downward extension of the large ore-shoot on the 7th level, main vein, will be tested by driving on the 8th level during the current year. The highest-grade ore-shoots developed during the year were on the lowest levels, namely, the Foot-Wall Vein 9th level north shaft and the Brown Vein 7th level south shaft. The milling capacity has been increased from 750 tons to 800 tons daily, the latter figure being the maximum amount of ore that can be delivered to the mill by the aerial ropeway. The development of the Clarines property was continued during the year, but has now been suspended for a time. Work was confined largely to the development of the Pilares vein on the 120 metre level, which was sufficiently encouraging to make it worth while to consider sinking to the 200 metre level. The amounts show receipts from the sale of concentrates £650,083 and a net profit of £283,130, out of which £281,992 has been distributed as dividend, the rate being 37½%.

NEW COMPANIES REGISTERED

Asbestos Mining Trust.—Registered January 24. Capital: £500 in 2s. shares. Directors: W. Dewar, D. Barron. Office: 97, Gresham Street, London, E.C. 2.

Gallois Lead and Zinc Mines, Ltd.—Registered December 20. Capital: £10,000 in 5s. shares. Objects: To acquire the Cwmystwyth mines, Wales. Directors: S. J. Palandji, P. Fermanoglu. Office: 23, Aldgate, London, E. 1.

International Selection Trust.—Registered January 23. Capital: £250,000 in 5s. shares. Directors: J. A. Dunn, R. M. Geppert, H. Micklem, Col. R. Micklem, Major-Gen. H. L. Reed, A. Thorp. Office: Selection Trust Building, Mason's Avenue, London, E.C. 2.

Naraguta Durumi Areas.—Registered January 23. Capital: £150,000 in 5s. shares. Business: To acquire alluvial tin leases in Northern Nigeria. Directors: Sir E. A. Speed, John Waddington, R. Benard, L. H. Barnard. Office: 341, Salisbury House, London, E.C. 2.

Salay Oil Lands.—Registered January 30. Capital: £150,000 in 10s. shares. Objects: To enter into an agreement with the British Burmah Petroleum Co. London managers: John Taylor and Co. Office: 6, Queen Street Place, London, E.C. 4.

Trinidad Consolidated Oilfields.—Registered January 28. Capital: £100 in £1 shares. Directors: A. H. Fellows, W. Taylor, directors of Venezuelan Consolidated Oilfields, Ltd. Office: Finsbury Pavement House, London, E.C. 2.