SOUTH AUSTRALIA.

# ANNUAL REPORT

OF THE

# DIRECTOR OF MINES

AND

# GOVERNMENT GEOLOGIST

FOR

# 1922.

ADELAIDE:
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# ANNUAL REPORT OF THE DIRECTOR OF MINES AND GOVERNMENT GEOLOGIST FOR 1922.

I have the honor to submit, for your information, the following report on the operations of the Department of Mines for the year ended December 31st, 1922.

## STAFF.

There was no alteration in the personnel of the department during 1922.

## NEW LEGISLATION.

An Act, cited as the Mining Act Further Amendment Act, 1922, and numbered 1512, was passed during the year. It was concerned almost entirely with the rectification of errors and omissions in the existing body of mining legislation such as had been experienced in the administration of these Acts. The chief amendments dealt with the following points :—

(1) The correction of definitions to cover all requirements of the Mining Acts.

(2) The provision of a means of mining on reserves subject to the protection of public rights and privileges.

(3) The provision of tenure by claim of salt and gypsum deposits pending the granting of a miscellaneous lease over the land comprised in the claim.

(4) The provision for the payment of the annual rental on leases of all kinds in advance.

(5) The provision for making regulations in accordance with the Acts Interpretation Act, 1915.

(6) The provision of the right of amalgamation of leases, so as to permit concentration of labor.

(7) The provision of a specific statement that forfeiture of a lease may be enforced for breach of covenants even if rental has been received.

(8) The provision of the right to a forfeited lease to the complainant at whose instigation it has been found liable to forfeiture.

(9) The provision for the calculation of royalty on the basis of net profits for each period of 12 months.

## WARDEN'S COURT.

During the year only one plaint was filed and set down for hearing, as follows :—

*Plaint No.* 39.—E. Calvert *v.* P. Brophy and W. Hays. Claim for the forfeiture of gold lease No. 1468, situated at Tarcoola. Plaint withdrawn.

## GEOLOGICAL INVESTIGATIONS DURING 1922.

In the following list are mentioned the chief pieces of work which occupied the time and attention of the geologists, and references are given to the publications in which it is possible to consult those reports that have been made public :—

### (A) Investigations and Reports Concerning Mineral Deposits.

The Government Geologist visited the marble quarries at Paris Creek and Macclesfield, and prepared a report, which has been published in Mining Review No. 35.

The Government Geologist prepared reports, with explanatory notes and tabulated statistics, for the use of the Honorable the Premier, during the latter's visit to Great Britain.

The same officer paid a visit of inspection to the borehole, which was being drilled in search of mineral oil, close to American Beach on Kangaroo Island. His report is to be found in Mining Review No. 35.

The Deputy Government Geologist inspected and reported on a mica deposit in the hundred of Yankalilla, and an occurrence of the same mineral in the hundred of Para Wirra was reported on by the Government Geologist.

Visits were paid by the Government Geologist to the site of prospecting operations for lignite and mineral oil, in the neighborhood of Pt. Pearce, where a shallow bed of peaty material had been discovered.

With respect to a proposal to bore for oil shale in section 457, hundred of Kadina, a visit was paid by the two geologists, and a departmental report was made.

The lignite deposits near Morwell, in Victoria, were inspected by the Government Geologist, who visited Melbourne in connection with further drilling equipment, to test the brown coal deposits of this State.

Consequent upon the report of a discovery of alluvial gold near Paratoo, a visit of inspection was made by the Government Geologist. The quantity of gold obtained at this place was quite insignificant, and prospecting was abandoned after very little work had been done.

The Government Geologist and the Deputy Government Geologist visited the copper field at Dome Rock in connection with the proposal to create a reserve for mining and commonage purposes. Their report was favorable, and a portion of the pastoral leases was resumed for the purpose mentioned.

A confidential report dealing with mineral resources was prepared by the Government Geologist for the Navy.

Several visits were paid by the Government Geologist to the localities where departmental drilling operations were in progress, namely, Moonta, Clinton, Moorlands, and Noarlunga.

A departmental report was furnished by the Government Geologist on the material broken in Wakefield's quarry, in the gorge of the River Torrens.

The Deputy Government Geologist made a detailed examination of the Clinton lignite field, and mapped the western boundary of the Tertiary rocks in which the lignite occurs. This plan has been utilised in the scheme of prospecting by boring, and has been printed in Mining Review No. 37.

The same officer made an examination of a quarry from which material is obtained for brick-making, and advised the proprietors regarding the measures to be taken to overcome certain difficulties.

The Deputy Government Geologist visited and reported on a proposed source of road metal near Woodside.

The Deputy Government Geologist spent much time in gathering information in the field with respect to the occurrence of building stones in many parts of the State. The results of these investigations were embodied in Geological Survey Bulletin No. 10.

### (B) Investigations Concerned with Water Supplies.

The Government Geologist furnished a report on a proposal to drill a borehole on a proposed stock route to the east of Lake Frome.

Several reports were furnished on various proposals to put down bores or wells for water on Eyre Peninsula. The Deputy Government Geologist dealt with one concerning the hundreds of Horn and Catt, which were visited for the purpose; and also with a proposal concerning the hundred of Chandada and the adjoining country. The geologists dealt, at different times, with proposals to bore deep holes in the vicinity of Kimba, in the hundred of Smeaton.

The Deputy Government Geologist gave advice with regard to an attempt to obtain useful water by boring on Hindmarsh Island.

The Government Geologist visited Ucolta and prepared a departmental report on a proposal to bore for water there.

The Deputy Government Geologist reported with respect to the further development of the western portion of the Great Australian Artesian Basin.

The Government Geologist prepared a report dealing generally with Artesian Water in Australia for the Australasian Association for the Advancement of Science at its meeting in Wellington, New Zealand, in January, 1923.

The Government Geologist inspected and reported on the leakage of water from the Baroota Reservoir, and on the question of supplying Port Pirie with water from underground sources.

The same officer visited Coonalpyn, and advised regarding the prospects of obtaining useful water by boring in various parts of the district.

### (C) Various Investigations and Reports.

Summary reports with regard to the lignite resources of the State were prepared by the Government Geologist for the information of British and American inquirers; and the same officer furnished more detailed information on this subject to the Director of the Commonwealth Institute of Science and Industry.

A report on the origin of soils on lower Yorke Peninsula was supplied by the Government Geologist to the Department of Agriculture.

In response to a request from New South Wales, the Government Geologist prepared a detailed report on the ways in which State aid is granted to miners and prospectors in South Australia.

A number of departmental reports were written by the Government Geologist to deal with—The valuation of mineral deposits; the further probing of the lignite fields of the State by drilling; the investigation of sources of road metal; the enlargement of the areas that may be taken up under search licences; the utilization of data concerning altitude in geological investigations; the control of mine flotation by legislation; the equipment of a carbonization plant to deal with lignite; and various applications for State assistance in different forms.

The Government Geologist delivered a lecture, illustrated with lantern slides, before the South Australian Chamber of Manufactures in response to the invitation of that body. The matter contained in that lecture, brought up to date by the substitution of later statistics than those available at the time of its delivery, is printed as an appendix to this report.

A memorandum was furnished by the Government Geologist on the mineral exhibit to be prepared for the British Empire Exhibition.

The Government Geologist delivered a lecture under the auspices of the British Science Guild on the use of altitude data in the investigation of underground water supply, as one of a series of three addresses designed to indicate the need for representing heights as well as length and breadth in the standard maps of the State.

The Government Geologist prepared a report on recent additions to the knowledge of structural features and land forms in South Australia for the Wellington meeting of the Australasian Association for the Advancement of Science.

## THE INSPECTION OF MINES.

The Chief Inspector of Mines has furnished the following summary report on the work on which he was engaged during the period January to December, 1922 :—

Special visits were made to many quarries, with regard to some of the provisions of the Mines and Works Inspection Act, particularly in connection with the dust problem. It is satisfactory to be able to state that quarry practice now with regard to the suppression of the injurious dust is much improved and, in general, the provisions of the Act are fairly well carried out.

The work of sinking a reinforced concrete caisson through the sand and water strata in order to penetrate the brown coal at Hope Valley was being proceeded with by the company, and visits of inspection were made during the course of this work. The caisson was successfully sunk to the coal, but certain difficulties arose, and the work was stopped for the time being.

The two slate quarries, at Willunga and Mintaro respectively, were inspected, work being actively carried on at each.

The guano caves north of Carrieton, at Buckalowie and Arcoota Creeks were visited, and a report thereon was published in Mining Review No. 36. The quantity and quality of the guano deposits in these caves not having fulfilled expectations, work has ceased.

A visit was paid to the old Baratta mining field, where lead ore was being worked. The veins were, however, of small size, and the field was gradually abandoned again. A report was written on one of the prospecting shows at this place, and was printed in Mining Review No. 37.

The extensive gypsum workings at Marion Bay, at the southern end of Yorke Peninsula, were inspected. A large production of rock gypsum is obtained here, some of which is exported in the crude state for manufacture into plaster. One company, however, has a factory on the spot, manufacturing plaster.

Visits were made to the various lignite areas (Moorlands, Noarlunga, Inkerman, &c.) and bulk samples of the lignite from the two first-mentioned places were obtained at various times for experimental work, both here and in England. Details of some of this experimental work will be found in Mining Review No. 37.

The various barytes mines at Noarlunga were inspected, and also a phosphate rock mine in the same locality.

A fine quality of clay is mined at Teatree Gully, not far from Adelaide, and the various workings at this locality were visited and inspected.

The old Deloraine Gold Mine, which after some years of profitable work finally closed down, was again opened up, and a hauling and crushing plant was installed. These workings were inspected, as well as some new discoveries of gold in the vicinity.

There has been a revival of interest in the Tarcoola gold field, and a number of men have been engaged in mining there, either re-opening some of the formerly worked mines, or endeavoring to locate new lodes. The various workings were inspected, and a visit was also paid to Glenloth, another field where gold lodes have been worked in the past, but no mining was being done at the time of visiting.

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The Inspector of Mines, for the same period, reports the performance of the following work :—

After a considerable period of idleness work was resumed at the Wallaroo and Moonta Company's mines and plant.

A thorough inspection of the extensive underground workings was made, occupying a considerable time, and all surface works, treatment plant, smelters, &c., were also inspected.

Various other mines in the vicinity were also examined, the Wild Dog, Poona, &c., and a visit was made to the Parara Mine, Ardrossan, in connection with some plant on the mine.

The Homeward Bound and Westward Ho Mines, near Mannahill, where a little gold mining is still carried on were visited.

Some matters respecting occupation blocks and rents at Moonta were inquired into and adjusted.

Visits of inspection were made to all the principal quarries of the State, building stone, slate, road material, brickworks, clay, &c., and every endeavor was made to ensure the safe working of these quarries and the proper carrying out of the Mines and Works Inspection Act.

## STATE BATTERIES AND CYANIDE WORKS.

The following report on the operations of the State batteries and cyanide works has been furnished by the General Manager :—

During the year ended December 31st, 1922, work has proceeded as usual at the Government Batteries and Cyanide Works. This work consists of the treatment of ore by battery, the treatment of tailings by the cyanide process, and the testing and assaying of small parcels for the prospector, not included as parcels.

In the period referred to 38 parcels of ore were treated, the total weight being 732 tons 10cwts., for a return of 670ozs. 11dwts. 17grs. of gold bullion, valued at £2,353 8s. 1d.

In the course of the year 316 assays and pan tests of small parcels of ore of a few pounds weight, and ore and tailings under treatment were made. The total weight of tailings treated by the cyanide process amounted to 561 tons. Of the total gold recovered, 602ozs. 10dwts. 18grs., valued at £2,073 4s. 1d., were recovered by amalgamation, and 69ozs. 1dwt., valued at £276 4s., were recovered by the cyanide process. The average value per ton of ore treated for the 12 months was £3 4s. 11d., but in viewing this value it must be remembered that many parcels are not sent in for their high value, but, being of recognised low value, are treated to prove their actual gold contents.

The work carried out at State Batteries and Cyanide Works during the year has, in addition to the testing of small parcels for the prospector, enabled a return to be made to the prospector of £1,885 8s. 6d. as proceeds on the treatment of the various parcels of ore ; added to the foregoing the amount paid over on account of gold bullion smelted and purchased, makes the total paid to the owners of £2,102 4s. 7d.

During the period under review the department has received from the Gold Producers' Association a premium averaging 5s. 2·5d. per ounce of standard gold, and this amount, not included in any foregoing figures, has been paid over in full to those having parcels treated at State Batteries and Cyanide Works.

The total value of gold bullion recovered to date at State batteries and cyanide works is £98,648 2s. 8d.

## GOVERNMENT DRILLING OPERATIONS.

The No. 1 diamond drill was continuously at work throughout the whole of the year within the Yelta reservation at Moonta, the holes drilled being numbered 33 to 36 in the series. Altogether 1,128ft. of drilling were completed by work on one shift daily. The results are described in Mining Reviews Nos. 36 and 37.

No other diamond drilling was carried out.

The calyx drilling at Clinton and Moorlands was continued ; and, owing to the demand for drills, a third plant of an extremely portable character was designed by the Engineer for Boring and purchased for the department. This third drill, specially designed for shallow boring such as was required at Moorlands, more than justified the expectations formulated before it was put into action, and by its aid the cost of boring was lowered materially, and the time consumed in moving from one bore site to another was reduced to a minimum.

At Clinton boreholes numbered 4 to 18 were drilled during 1922, the total amount of drilling completed in these 15 boreholes being 4,370ft.

At Moorlands 38 boreholes were drilled, the serial numbers of these holes being 31 to 68. Altogether 3,478ft. of drilling were completed on this field within the period under review.

At Noarlunga, the first hole bored with the modern calyx drill was numbered 6 in the series (the first 5 boreholes having been drilled many years ago), and was carried to a depth of 387ft. 6in. by the end of the year 1922.

All particulars regarding the results obtained by these drilling operations may be found on reference to Mining Reviews Nos. 36 and 37. The data obtained are recorded in detail in these publications, which contain also plans showing the location of the boreholes and sections of the strata traversed in each hole. The Chief Inspector of Mines has provided valuable tables showing the average results obtained in each field, and these figures have the utmost importance now that it is possible to calculate the averages on so large a body of detailed information.

## GEOGRAPHICAL DISTRIBUTION OF MINERAL PRODUCTION FOR THE YEAR 1922

| Division and County. | Value of Mineral Production for 1922. | Details of Production. |
|---|---|---|
| | £ | |
| I. Central— | | |
| Adelaide | 9,065 | Gold, £394; barytes, £5,639; magnesite, £387; talc, £225; clay, £891; ochre, £50; flint pebbles, £573; phosphate, £906. |
| Carnarvon | 22,230 | Salt, £22,230. |
| Eyre | — | — |
| Fergusson | 101,126 | Alunite, £210; gypsum, £22,765; limestone, £27,080; salt, £51,071. |
| Gawler | 371 | Salt, £371. |
| Hindmarsh | — | — |
| Light | 2,985 | Gold, £115; barytes, £98; phosphate, £2,772. |
| Sturt | — | — |
| Total | £135,777 | |
| II. Lower North— | £ | |
| Burra | 557 | Gold, £9; magnesite, £548. |
| Daly | 97,566 | Gold, £1,372; silver-lead, £372; copper, £73,055; iron, £109; clay, £194; salt, £22,464. |
| Kimberley | — | — |
| Stanley | — | — |
| Victoria | — | — |
| Total | £98,123 | |
| III. Upper North— | £ | |
| Blachford | — | — |
| Dalhousie | — | — |
| Derby | — | — |
| Frome | — | — |
| Granville | — | — |
| Hanson | — | — |
| Herbert | 66 | Ochre, £50; magnesite, £16. |
| Lytton | — | — |
| Newcastle | — | — |
| Taunton | — | — |
| Total | £66 | |
| IV. South-Eastern— | £ | |
| Buckingham | — | — |
| Cardwell | — | — |
| Grey | 2,059 | Flint pebbles, £2,059. |
| McDonnell | — | — |
| Robe | — | — |
| Total | £2,059 | |
| V. Western— | £ | |
| Bosanquet | — | — |
| Buxton | — | — |
| Dufferin | — | — |
| Flinders | 845 | Talc, £845. |
| Hopetoun | — | — |
| Jervois | — | — |
| Kintore | 14,573 | Salt, £18; gypsum, £14,555. |
| LeHunte | — | — |
| Manchester | 71,354 | Salt, £13,286; iron, £58,068. |
| Musgrave | — | — |
| Robinson | — | — |
| Way | — | — |
| York | — | — |
| Total | £86,772 | |
| VI. Murray Mallee— | £ | |
| Albert | 48 | Salt, £27; gypsum, £21. |
| Alfred | 309 | Gypsum, £309. |
| Buccleuch | — | — |
| Chandos | — | — |
| Hamley | — | — |
| Russell | 11 | Salt, £11. |
| Young | — | — |
| Total | £368 | |
| Outside Counties— | £ | |
| North | 350 | Ochre, £350. |
| North-Eastern | 596 | Silver-lead, £5; copper, £591. |
| North-Western | 7,310 | Gold, £2,358; manganese, £4,585; barytes, £367. |
| Western | — | — |
| Total | £8,256 | |

Total value of mineral production for the State, £331,421 (excluding sulphuric acid, £93.).

In the work mentioned in the foregoing report all members of the Department of Mines have borne some part. To them I would record my personal indebtedness and appreciation of the work which they have performed in the interest of the community.

I have, &c.,

L. KEITH WARD,

Director of Mines, Government Geologist, and Secretary to the Minister of Mines.

To the Honorable the Minister of Mines.

# APPENDIX.

## MINING AND THE MANUFACTURER.

(A lecture delivered before the S.A. Chamber of Manufactures, Incorporated, by the Director of Mines on August 7th, 1922, amended to embody statistics of later date.)

### General Statement.

The contribution of the mineral industry to all secondary industries and to all manufacturing processes is probably much more extensive than it is commonly thought to be. On looking over the membership list of the South Australian Chamber of Manufactures, one is struck by the large number of firms directly engaged in the manufacture of articles of commerce from metallic and non-metallic minerals. And a little reflection will enable us to realise that some of the first articles manufactured in South Australia, as elsewhere in the world, were of mineral origin. The factories were not elaborate in those days, which long preceded the period of European occupation, but at least they allowed the operatives a larger amount of fresh air than many carefully-designed factories of recent date. Far back in the distant past the Australian aborigines fashioned stone implements from the flints of the shore and from the easily-split slate of the interior, and those who lived near the places of occurrence fashioned more of these articles than were necessary for their own immediate use. This stage of culture contains the germ of manufacturing, when man began to shape the tools and weapons that have helped him, in his conquest of Nature, to rise above the beasts. No metals were worked in the period prior to the European occupation, and no material advance was made. To-day the case is very different, from the nature and complexity of the demands of a very different culture.

Everywhere to-day we find the manufacturer, even where he is not directly engaged upon the work of producing manufactured products from minerals, dependent on the mining industry for his tools, his fuel, and his lubricants, for the paint that preserves his timbers and his walls, for the means of handling his products and conveying them to his markets, for the metal coins which he gives in exchange for raw materials and receives for manufactured products, for much of the material of which his house is built, for the utensils that prepare his meals and the plates and dishes on which they are served, as well as the knives, forks, and spoons of the table. The pictures and photographs that adorn the walls of his home have been prepared with the aid of pigments and chemical products which have a mineral origin. This list might be extended to an almost unlimited degree, for the contribution of the mineral industry towards every part of the fabric of modern civilisation is intimate and essential.

So wide is the field of enquiry within which we may wander, and still keep strictly within the limits of the discussion of aspects of mining that affect the manufacturer, that we must needs select arbitrarily certain specific matters for consideration on this occasion. And in deciding on the particular phases of mining that are of special interest to-day in South Australia, we turn naturally to the statistics of production and especially to those of recent years. We find that, of the total mineral production of Australia to the end of 1920, South Australia has provided about 3.9 per cent. in value; but that the contribution of this State has been larger during recent years. It will be seen also that there is a very uneven distribution of the mineral wealth in the different component parts of the Commonwealth. South Australia, which has yielded more copper than any other State, has on the other hand produced no appreciable quantities of either tin or coal. Yet it will very shortly assume the leadership in the total production of iron ore—the mineral of greatest industrial value. The total value of the annual output of minerals from South Australia within recent years compares favorably with the corresponding values of the production from Victoria and Tasmania, although smaller than that of New South Wales, Queensland, and Western Australia.

Yet, interesting as these figures may be when the history of mining is under consideration, we must not attach too much importance to them. The production of the past is not always an indication of what remains to be produced. All too often has it been forgotten that the future of a mine depends almost entirely upon its present reserves of ore, and not upon its past production. In most cases the mineral deposits which are sufficiently concentrated to be the objective of mining operations were formed by natural agencies operating over vast periods of time. They are not renewed while we draw upon them; and what we take away reduces, by just that amount, the total quantity available for human consumption. So we shall proceed to the consideration of the present status of the industry here; the part which it is playing in the industrial life of the Commonwealth; and, above all, some of the possibilities of future expansion.

Brief mention has been made already of the irregularity in the distribution of mineral wealth in Australia. No less noticeable are these facts of occurrence when the whole world is brought within the scope of our view. Countries, like individuals, are not endowed alike. And there is a marked difference between the extent to which workable deposits of the different minerals are localised. The ores of some metals, such as copper, iron, and gold, are found widely scattered over the world. Other metallic ores and minerals, such as nickel ores, vanadium ores, and platinum, as well as some non-metallic minerals, like the nitrates and potash, have been obtained from very few localities in commercial quantities. Even where the distribution is wide, the occurrences of large and rich deposits, such as those of Kalgoorlie, Broken Hill, Mount Morgan, Wallaroo and Moonta, Mount Bischoff, Mount Lyell, and Iron Knob, are exceptional and occupy strictly limited areas. The many smaller deposits of metallic ores play an important part in the aggregate, but are relatively ephemeral. There are other mineral deposits—such as the mineral fuels, the beds of limestone shale and gypsum—which occupy comparatively large tracts of country, but these occurrences also are strictly limited by geographical boundaries and structural features.

Yet the mere occurrence of a mineral deposit within our territory is not sufficient to ensure that it will be worked. There are a number of factors which determine whether or not any particular mineral occurrence is commercially available to provide the raw material used in manufacture. Chief among these factors are:—

(1) *Geographical Position.*—The actual location must receive careful consideration and the cost of transport to the market or markets. Actual and possible lines of transport must be studied, not only for the deposit under review, but also for other deposits of like character close at hand, and for deposits containing supplies of higher grade that may be able to compete in spite of the handicap of distance. The improvement of transport systems and the lowering of freight rates may induce future competition from sources not now supplying the markets. The study of the general geographical distribution of many products is therefore imperative, and this is all the more necessary in the case of minerals which have a low monetary value per ton or per cubic yard.

(2) *The Character and Quality of the Deposit.*—The nature of every mineral occurrence must be determined separately. No generalisations are possible. The metals, for example, are recovered by the treatment of different kinds of minerals. Some of these are more easily and more cheaply treated than others. Some are far richer than others. Some contain deleterious ingredients which must be removed at considerable expense, or which call for special metallurgical treatment. And all these characteristics of any given deposit must be compared with those of other deposits from which the same products are obtainable. The nature of the ore and its probable permanence of character must be considered from the viewpoint of the geologist—as, for example, in the case of the copper ores which are very different in composition near the outcrop from the deeper parts of the same lodes below water-level.

(3) *The Size of the Deposit.*—It is clear that the extent of the deposit, in length, breadth, and depth, is a factor of basal significance, since an adequate tonnage must be available before the investment of the necessary capital to ensure low costs of production, beneficiation, and manufacture is justified. There are, for example, many known deposits of iron ore in South Australia, but only those of Iron Knob and the Middleback Range are of sufficiently large size to receive serious consideration as sources of ore for a modern steel-making plant. Many failures in the treatment of copper ores in the Flinders Range have been due to the erection of treatment plants before the mines were opened up and enough ore proved to ensure continuous smelting operations. The same factor may determine whether or not there is justification for obtaining the elaborate and expensive machinery required for stripping overburden and mining lignite by open-cut methods. A relatively small deposit of a rare mineral may be workable, whereas the common and less highly-priced minerals are not worked unless the deposits are large.

(4) *The Market or Demand.*—The population of a country and the nature of its industries determine the demand in the case of all those mineral products which do not find their way, by export, to the larger markets of the world. And for many minerals export from Australia is not feasible, since the world's markets can obtain adequate supplies from nearer sources. The geography of the markets must be studied together with that of the main occurrences.

It has been found generally that the demand for minerals increases more rapidly than the population.

In the case of several minerals the demand depends upon the coexistence of others within reasonable distance. Thus fuel and ironstone; clay and limestone; salt, fuel, and limestone are mutually involved in the iron, cement, and alkali industries. On the other hand, the lack of demand has curtailed recent prospecting operations in search of opal; and general industrial depression is at once reflected in the metal market.

(5) *Water, Fuel, and Supplies.*—For many metallurgical processes as well as for human consumption a reliable supply of water of good quality is essential. In regions favored with a larger rain fall than South Australia this factor does not assume such important proportions, but it cannot be overlooked here in any proposals for operations on a large scale.

So many processes call for water that the mining industry cannot do without it. Special dry methods, like that of dry-blowing for gold, are of limited application only. The larger industrial and manufacturing centres will be located in all cases at sites where water is obtainable.

In some remote localities the question of firewood or other fuel is a serious one, and the cost of obtaining food and stores may make an appreciable increase in the cost of working a mine.

## South Australian Mineral Production, Actual and Potential.

Applying these general considerations to the mining problems of the State, we shall arrive at a better understanding of our present position as producers of minerals, and our opportunities of increasing production from our reserves.

The mineral production in South Australia during the ten-year period 1913-1922 is shown in the following table:—

| | Quantity. | Value. |
|---|---|---|
| | | £ |
| Gold | 48,523 ozs. | 206,113 |
| Silver | 20,515 ozs. | 3,092 |
| Silver-lead ore | 1,680 tons | 31,198 |
| Copper | 53,001 tons | 4,853,845 |
| Ironstone | 2,354,383 tons | 2,606,407 |
| Manganese ore | 5,185 tons | 43,211 |
| Molybdenite | 1 ton 6½ cwts. | 527 |
| Tungsten ore | 1 ton 1½ cwts. | 127 |
| Radium ore | — | 9,521 |
| Asbestos | 28 tons 7 cwts. | 376 |
| Alunite | 373 tons | 1,521 |
| Barytes | 10,993 tons | 34,995 |
| Talc | 936 tons | 3,916 |
| Felspar | 4 tons | 8 |
| Fireclay and Pipeclay | 18,790 tons | 12,226 |
| Gypsum | 253,518 tons | 209,404 |
| Kaolin | 19,033 tons | 32,012 |
| Limestone | 575,817 tons | 198,071 |
| Magnesite | 2,012 tons | 3,637 |
| Mica | 37 tons 10 cwts. | 337 |
| Ochre | 1,189 tons | 4,506 |
| Opal | — | 52,425 |
| Flint pebbles | 8,193 tons | 30,457 |
| Phosphate rock | 57,332 tons | 72,620 |
| Salt | 640,971 tons | 1,047,929 |
| Soapstone | 515 tons | 705 |

This productivity is distributed over a large part of South Australia, the far north-western portion alone offering no contribution to the output.

Taking some of the minerals separately, we find many features of interest.

*Gold.*—Although the gold production of South Australia has been at no period large, the occurrences are widely scattered. The alluvial fields of Echunga, Teetulpa, Barossa, and Ulooloo have given an output that is large in comparison with the produce of lodes in their vicinity. Within recent years the chief source of gold has been the copper ore of Wallaroo and Moonta, from which it is recovered by smelting followed by electrolytic refining. Lately there has been increased activity at Tarcoola, consequent upon the subdivision of a large area more suited to the operations of small parties than of a large company.

*Silver and Lead.*—The future production of these metals will be stimulated by the revival of active smelting at Port Pirie, so unfortunately idle at a time when the metal markets were specially favorable. Very little work indeed has been done on the lodes lately discovered at Eukaby Hill. Some silver is recovered from the copper ores of Yorke Peninsula.

*Copper.*—Of the total value of the whole mineral output from South Australia, since mining commenced and up to the end of 1922, over 80 per cent. is due to copper ores. Until 1919 copper maintained its lead in the value of the annual production, but has been displaced from that date. A considerable proportion of the copper won hitherto has been from the oxidised ores found at shallow depths. The many mines of the Flinders Range are all shallow, and none have yet shown promise of permanence in depth. Still there is a considerable tonnage of oxidised ore, not suitable for concentration by ordinary methods, in the northern mines awaiting treatment, if successful methods can be devised at a cost low enough to permit commercial operations.

The great mines of Wallaroo and Moonta produced 61·7 per cent. of the total copper production of the State up to the end of 1922. Their recent failure is due, not to the complete exhaustion of the ore bodies of normal grade, but to the increased cost of production due to the combined influence of many factors, and to the fall in the price of copper. It was no longer possible to raise the grade of the ore treated to balance the higher costs and the falling market.

The prospect of a better price for copper is not hopeful, and the whole production of Australia can have little effect on the world's market, which will be governed by the output from those countries that can sell profitably very large quantities at a low price. The rate of production of copper in the world has increased more rapidly than that of any other metal except aluminium during the past few decades. The abnormal economic conditions of to-day make it impossible to say whether any check in the demand was pending in 1914. Now the arrears to be made up are extensive, but returning prosperity alone will revive the demand and raise the price of the metal.

*Iron.*—South Australia is fortunate in the possession of the largest and one of the most accessible iron ore deposits of the Commonwealth, but unfortunate in the absence of coke-making coal. The ore has therefore gone to the coalfields of the Hunter River Basin, which is, moreover, nearer to the centre of population of the continent than any part of this State. A detailed account of the great industry that has been built up at Newcastle with the raw iron ore taken from Iron Knob has been presented to the Chamber of Manufactures in 1921, and needs very little amplification. It should be remarked, however, that the recent survey of the field by the Deputy Government Geologist indicates that the reserves are probably much larger than was formerly estimated. Mr. Jack places the probable reserves of ore in the Iron Monarch and Iron Knob at 133 million tons, with an average content of 63·64 per cent. iron, and those of the adjoining deposits in the Middleback Range at about 32 million tons of slightly higher grade.

*Manganese.*—Manganese of high grade is obtainable in large quantities from South Australian deposits, but our output within recent years has been small. The uses of manganese should be examined first of all in any attempt to judge the future productivity of the State in regard to this metal. The steel industry consumes over 90 per cent. of the total output of the world, and the demand is increasing. A few special alloys contain manganese; and there is a demand for the high-grade ore for the manufacture of chlorine and bromine, for correcting the greenish color in glass, for making dry batteries, for imparting special colors to glass, tiles, pottery, and bricks, &c. The use governs the specifications under which the crude ore is purchased. The steel producer needs a high metallic content of manganese and a low content of phosphorus. The chemical manufacturer requires as much oxygen as possible and freedom from any impurity that will cause waste of acid. The dry-cell maker requires high-grade ore free from iron and chlorine. The ore used to decolorise glass should carry less than 1 per cent. of iron.

The large consumption in the steel industry has governed the world's production of manganese, and the map of the distribution of manganese deposits must show also the chief centres of steel production.

The greater part of the world's production prior to the war came from the southern part of Russia, to the south of the Caucasus mountains; from India; and from Brazil. It is considered likely that these sources will provide much of the world's future supplies for very many years. But a recently-discovered deposit of large size at Dagwin, in the Gold Coast Colony, is already contributing a large tonnage to the steel furnaces of Great Britain.

Australia has quite a number of deposits, of which those situated near Pernatty Lagoon on the Transcontinental railway are not only well situated, but also of high grade. Some special grades have found a market for chemical work and glass making, and a very large tonnage of ore suitable for use in steel manufacture has been proved.. The steel works at Newcastle will probably draw supplies from this district in the future.

The ore may need washing to rid it of the salt which is objectionable when dry batteries are made from it, but these deposits should provide the raw material (to be mixed with South Australian graphite) for the dry batteries of Australasia. In the United States 25,000 tons of manganese ore are used annually for this purpose alone.

*Alunite.*—South Australia possesses large supplies of high-grade alunite which appeared at one time likely to be in great demand as a source of potash. The fortunate outcome of the War, however, destroyed the almost complete monopoly of high-grade potash deposits by Germany. At Mulhouse, in Alsace, there is a deposit estimated to contain 300,000,000 tons of pure potash, which was once under German control, but is now in the hands of the French. This deposit, discovered in 1904, and tested by the Germans, was permitted by legislation to produce only 4 per cent. of the total output of Germany.

It is now considered improbable that any alunite deposits will be used primarily as a source of potash in successful competition with the French and German deposits of Alsace and Stassfurt.

The chief use to be made of alunite will be to make alum and aluminium sulphate, and possibly to provide alumina for the production of the metal aluminium. A limited amount may be burnt with lime for horticultural use, and this practice has been followed by one enterprising firm in South Australia.

*Barytes.*—The South Australian deposits of barytes are quite the most important in the Commonwealth at the present time, and the quality of the material placed on the market is very good. But it must be remembered that the supply of such high-grade barytes may not be sufficient for a long-continued demand. We should be prepared to maintain our supply by treating the second-grade barytes with acid to remove the iron oxide. This treatment is necessary throughout the world, and will certainly be necessary in South Australia in the future. It is unwise to delay the preparations for dealing with the second-grade ore until the supplies of picked ore of higher grade are giving out.

*Gypsum.*—From our coastal deposits of gypsum practically the whole of the raw material for the plaster factories of Australia is being derived, as well as most of the gypsum used in the manufacture of portland cement. Our supplies are large, and plaster of paris is being made at Port Adelaide and at the extremity of Yorke Peninsula. A considerable quantity of gypsum is exported to the eastern States. South Australia supplies also the gypsum that is used as "land plaster" for correcting soils overcharged with black alkali. There is comparatively little demand for gypsum as a manure within our own borders, save in the irrigation settlements along the River Murray.

The deposits of lower Yorke Peninsula and the coast near Fowler's Bay are so large and of such high quality that they must retain their position as the most important sources of gypsum for the Commonwealth in the future; and it is hoped that the gypsum will be manufactured into plaster in our own State in ever increasing proportions, rather than exported to the other States.

*Opal.*—Of all gems there is none that surpasses the opal in beauty. Yet the demand for this wonderful mineral has never been so slack as at the present time, in spite of the fact that there is very little obtainable elsewhere than in Australia. The field at Stuart's Range is the most prolific of all the Australian districts from which opal has been obtained, and only a very small portion of the known opal-bearing country has yet been tested. In common with all other gems opal is now difficult to dispose of because of the reduced purchasing power of all communities throughout the world. With a return of prosperity the recovery of the market may be expected.

*Phosphate Rock.*—The largest contribution to the domestic production of phosphate rock in the Commonwealth is made by South Australia, where the deposits are distributed along a belt of country over 200 miles in length, from Myponga in the south, to the district round Carrieton in the north. Selected ore of high grade (over 60 per cent. tricalcic phosphate) is sent to the superphosphate factories of Wallaroo and Port Adelaide, but a large tonnage of lower-grade material remains unused. With the object of finding a market for this material, the co-operation of the Department of Agriculture has enabled a start to be made with experimental tests designed to find whether the low-grade lime and aluminium phosphate have a commercial value sufficient to pay the cost of mining and very fine grinding. The application of this finely-ground raw phosphate rock is to be sought in districts with over 20in. of annual rainfall, and the cost of mining and crushing must be kept at the lowest possible figure to allow profitable exploitation.

*Salt.*—One of the most important mineral products of the State is salt, which is the very basis of many chemical industries. We owe our predominance in salt production to our climatic conditions, and no artifice can deprive South Australia of its natural advantage in this respect. Hitherto most of the salt produced has been won by scraping the dry lakes after the winter rains have been evaporated by the summer sun. Within recent years a considerable quantity of salt has been obtained by the solar evaporation of sea-water at the heads of Spencer's Gulf and Gulf St. Vincent. The production has been limited by the demands of the Australasian market, for it would be possible to obtain vastly more salt than can be consumed at the present time. Many millions of tons of salt are known to be available on the surface of the dry lakes alone.

The chief hope for the future expansion of this branch of mining industry lies in the establishment of the alkali industry in South Australia.

The world's production of salt at the present time is approximately 17,000,000 tons, and its significance to industry is enormous. To quote Geoffrey Martin :—

"From salt as the parent substance, there spring huge industries which are concerned with the manufacture of sodium sulphate, hydrochloric acid, sodium carbonate, caustic soda, chlorine, hydrogen, &c. Out of these industries, in their turn, spring the industries concerned with the manufacture of soap, glass, glycerine, dynamite, and other nitroglycerine explosives, bleaching powder, chlorates, &c. These products in their turn form the raw materials of great trades, which ramify one into another in a way which is difficult for the non-technical reader to realize. For example, a stoppage in our supplies of salt would cripple the house-building trade, because window glass would be unobtainable in quantity, since sodium sulphate or sodium carbonate are used in glass manufacture, and these products are derived from salt. The production of explosives would suffer because glycerine (and incidentally soap) would cease to be producible in quantity; and so mining operations would become difficult, and coal would become dear. The textile and paper trades would be crippled, because bleaching, sizing, cheap soap for scouring, and other chemicals—all derived ultimately from salt—would cease to be obtainable in quantity. These trades would react on other trades in a way altogether difficult to foresee."

Apart from the metals and minerals that have already contributed to the mineral production of the State, some mention should be made of some mineral substances, of which important reserves exist within our borders, and which seem destined to appear in future statistics of production.

*Graphite.*—The more valuable variety of graphite known as "flake graphite" occurs in this State, but has not yet been worked on a commercial scale. The best deposits known here are those of Eyre Peninsula.

This mineral is used largely in the manufacture of refractory crucibles for the heat treatment of many metals and alloys. Hence, though during the war it was in great demand, the market has weakened with the general depression in metal mining.

It has been shown by actual experiment that South Australian graphite gives results as satisfactory for the manufacture of dry cells as does the high-grade manganese ore occurring at Pernatty Lagoon.

*Sub-Bituminous Coal and Lignite.*—The most important thing to find out about a newly-discovered coal seam is the type of coal represented. There are very many varieties of fossil fuel; all derived from vegetation, but differing quite widely in their physical and chemical properties. Some seams of coal are found where the vegetation that gave rise to them grew and flourished in the past—in many cases under climatic conditions very different from those existing on the coalfields to-day. In the case of other seams the vegetable matter may have drifted from a distant source before burial, but these cases are relatively rare. When accumulated, the vegetation has suffered some chemical alteration, probably with the active assistance of bacteria, and subsequently a further alteration by compression and earth movements. The several factors that determine the actual type of coal represented in any particular field are numerous, the more important being (1) the kind of vegetation giving rise to the seam, (2) the interval between accumulation and burial, (3) the length of time since the time of formation and burial, (4) the depth of burial and the amount of compression by overlying sediments and by earth movements, and possibly (5) the escape of volatile constituents through pores and joints in the coal and the overlying rocks.

Many of these influences can be traced in studying the coalfields of Australia, but it must be remembered that they interfere with one another. So we do not always find the deepest coal to be the most altered from the condition of living vegetation, nor is the oldest coal in all cases more changed than those of younger age.

Of all the varieties of coal known in South Australia the best in quality is that which occurs in thin seams, deeply buried, in the south-eastern region. The deep borehole near Robe, drilled in search of mineral oil, was put down with a percussion drill; and fragments of bituminous coal similar in character and composition to the Jurassic coal of Victoria, were recovered between depths of 2,830ft. and 3,950ft. The biggest seam pierced was recorded as having a thickness of 3ft. It does not seem probable that any attempt will be made to work so thin a seam at such a depth.

Of the less inaccessible deposits within the State, the best coal is unfortunately the most remotely situated. The coal seams at Kuntha Hill, 110 miles to the north of Marree, and at Lake Phillipson are far from existing lines of transport, but in quality are better than any others. Next in quality comes the sub-bituminous coal of Leigh Creek, where there is a very large deposit only partly explored, but handicapped by the distance of 170 miles from the nearest port. This coal exhibits many of the characteristics of a lignite, but would be a useful fuel if situated nearer to centres of consumption. The chief hope for its development lies in the application of the coal to railway work when used in the pulverised state. Any northerly extension of the railway system will call for more fuel, and this field is better placed to supply that demand than any other.

The composition of these sub-bituminous coals is given in the following table:—

South Australian Sub-bituminous Coals.

| | Age. | Sulphur after Air-drying. | Moisture at 105°C. | Volatile Matter. | Fixed Carbon. | Ash. |
|---|---|---|---|---|---|---|
| | | % | % | % | % | % |
| Kuntha Hill | Cretaceous | — | 11·68 | 36·63 | 42·70 | 8·99 |
| Lake Phillipson | Jurassic (?) | — | 21·02 | 39·48 | 33·12 | 6·38 |
| Leigh Creek | Triassic | 0·24 | 27·15 | 25·24 | 33·68 | 13·91 |

The lignites of Tertiary age are widely spread in South Australia, and only a few of them have yet been tested in any way as possible sources of fuel. Most of the lignite-bearing localities have been found by boring operations in search of water with apparatus not designed to recover proper samples. Black mud and lignitic clay are recorded from very many bores, and there is no way of determining the value of these records other than by drilling or shaft sinking. But the recent rise in the price of imported bituminous coal and the extended use of lignite in other countries have drawn attention to the necessity for turning our own deposits to account. Very little is known yet with regard to the deposits at Pidinga and in the hundred of Barwell, save that the former is exposed at the surface, while the latter is concealed by cover of sedimentary rocks.

Very little boring has yet been carried out at Bower on the railway line between Eudunda and Morgan, but a thick seam is known to exist at the site of the first discovery. No attempt can be made to indicate the tonnage of lignite at this place, since the necessary data have not yet been obtained.

At Noarlunga, which is distant 25 miles by rail from Adelaide, boring with a modern drill has been carried out recently, and 1,438,000 tons of lignite have been proved in an area of 80 acres up to the end of October, 1923. The main seam has an average thickness of 12·6ft., and occurs at an average depth from surface of 322ft. The composition of the lignite is given in the table below.

At Moorlands, which is distant 87 miles by rail from Adelaide, 85 boreholes have been drilled in the portion of the field already tested and a large tonnage has been proved. The average thickness of the main seam, in all boreholes, is 14·8ft.; and its mean depth from the surface is 79ft. These 85 boreholes have proved the existence of 8,175,000 tons of lignite, in an area of 389 acres tested, of the average composition given in the following table.

At Clinton, 55 miles distant by sea from Port Adelaide, and about 100 miles by rail from Adelaide, the drilling of 19 boreholes has proved the existence of 32,384,000 tons of lignite. The average thickness of the main seam in this field is 21·8ft., and its mean depth from the surface is 292ft. The average composition of the lignite, over the 620 acres already tested, is given in the table below.

At Hope Valley, distant 8 miles by road from Adelaide, 15 boreholes have been drilled, but more work has to be done before a tonnage can be assigned to the area of 200 acres tested. The main seam is 13ft. thick and lies at a mean depth of 164ft. from the surface. Its composition is given below.

At Inkerman, which is distant by rail 58 miles from Adelaide, seven boreholes have proved 10,701,000 tons of lignite within an area of 280 acres. The main seam is 21·7ft. thick, and occurs at an average depth of 242ft. from the surface. The average composition is set out in the table below:

The estimates of quantities in the several fields are based strictly on the work already done. As the further prospecting of the fields proceeds the tonnages recorded will increase. The domestic reserves of fossil fuel of lignitic type amount already to over 50,000,000 tons, and it appears probable that they will be proved ultimately to be many times as great.

THE AVERAGE COMPOSITION OF SOUTH AUSTRALIAN TERTIARY LIGNITES.

| | Moisture at 105°C. after Air-drying. | Sulphur after Air-drying. | Moisture at 105°C. | Volatile Matter. | Fixed Carbon. | Ash. | Bitumen. |
|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % |
| Clinton | 16·71 | 3·26 | 51·69 | 24·51 | 15·55 | 8·25 | 0·96 |
| Moorlands | 15·72 | 3·44 | 51·30 | 21·89 | 14·06 | 12·75 | 0·54 |
| Noarlunga | 21·82 | 4·99 | 48·73 | 24·19 | 15·38 | 11·70 | 1·13 |
| Inkerman | 15·91 | 4·02 | 54·47 | 22·20 | 15·88 | 7·45 | 0·63 |
| Hope Valley | 12·71 | 3·33 | 51·02 | 22·05 | 14·04 | 12·89 | — |

NOTE.—The last five columns record the composition of the lignite as it occurs in place, before being subjected to natural or artificial drying processes.

The figures include all results obtained to October 31st, 1923.

These short notes on the several South Australian deposits of brown coal are far from sufficient to give a complete account of any field. Each area has its own problems, and much of the information essential to the wise development of each remains to be collected. This can be done in one way only—namely, by systematic exploration outwards from the known areas into those that are unknown. We must continually extend the reserves of lignite, gathering full data regarding quality and thickness as we go, and noting also the depth and kind of overburden.

The problems of the best mode of utilisation are themselves rather complex. And the experience to be gained by Victoria during the next year or two will be of great interest and value to South Australia. Different methods of burning the lignite will be followed at Yallourn in the generation of electrical power and in the manufacture of briquettes; quite apart from the use of the lignite in pulverised form, for which success is already confidently claimed.

Reference is made to Victoria and the influence of the experience to be gained there upon the future practice of using our lignite, since the type of fuel at Morwell, Lal Lal, and Altona Bay is the same as that with which we are concerned. In lignite-bearing regions, rather than in countries endowed with fuel of higher rank, will the problems of lignite utilisation be carried out. In those parts of Europe where lignite is relatively abundant, and where coal of higher grade is absent or must be brought from a distance, much use is made of lignite. The viewpoint is quite different from that existing generally in England or eastern North America, where anthracite and bituminous coal are readily obtainable and set a standard of quality. No lignite, nor any sub-bituminous coal, can compare with the bituminous coals or anthracites when the heating values of equal weights of each are compared. But if the bulk of the lower-grade fuel burnt is adjusted (by increasing the grate area, or the rate of feed in the case of powdered fuel) the results obtained from a trial will be very different from those from lignite tests performed on plants designed for the use of high-grade fuel.

There is great uncertainty as to the commercial success of any process of retorting the Victorian lignites with the recovery of the products of distillation at either low or high temperatures. The higher ash content of all South Australian lignites indicates that the value of the retort residues would be materially lower than that of the remarkably clean Morwell lignite.

It is interesting to note, in this connection, that the recent detailed investigation of a proposed "Super-power system for the region between Boston and Washington" resulted in the conclusion that coal must be used in its raw state, under ordinary peace conditions, for the most economical production of power; but that the demands of war alter the aspects of the manner of treatment, since by-products only recoverable from process-fuel plants, must then be obtained without regard to cost. The use of pulverised fuel was regarded by these investigators as not yet proven in large plants for a sufficiently long time to give reliable indication of its value. But provision was made by them for sufficient combustion-chamber volume to allow of a change, if future developments warrant the substitution.

One of the matters for special investigation in the use to be made of all South Australian deposits of lignite yet examined chemically, is the effect of the high sulphur content—whether the lignite be burnt in pulverised form, utilised in producer-gas plants, or made into briquettes. The fact of the high sulphur content cannot be overlooked. Any difficulties that arise from its existence must be overcome.

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THE PART OF THE MANUFACTURER IN THE MINING INDUSTRY.

From the foregoing brief account of the part played by some minerals in industry, it will be apparent that there is a close relationship between the maker of manufactured articles from raw materials and the producer of these materials. If this relationship leads to dependence upon domestic products the reciprocity is strengthened. The greater the population engaged on primary production the larger the home market. So it is of the utmost importance to rely upon sources of raw materials within our borders. The domestic product, even if unknown, may be quite as good as the imported product or it may be even better. Home production can be fostered by the formulation of exact specifications of requirements. Even where it has not been the practice in the past to insist on specifications for the raw materials required, it will be found advisable to prepare them. The best results will be obtained only by demanding and purchasing raw materials of stated composition and of described physical characters. Perhaps the manufacturer is not prepared to write his specifications at once. If this is so, he can at once start to find out what are the precise qualities that his requirements demand; and in the course of this investigation he will almost certainly find a means of improving his existing practice. The exact definition of requirements helps not only the man who seeks to fill them, but also the man who turns the response to account.

And, if the geographical handicap is removed by the introduction of domestic raw materials to replace those imported from abroad, this process of adaptation to each individual environment must be carefully reasoned, and must be commercially sound. No permanence can be attained otherwise, for sentiment finds no place on a balance-sheet.

The manufacturer can do a great deal more than this to develop the mining industry of the land in which he works. He will no doubt be a shareholder associated with many others in syndicates or companies, whose object is to find new deposits or to work those which have been located. Probably his fellow-shareholders will take advantage of his specialised knowledge of business affairs to appoint him to the board of directors. Here is a great opportunity for useful work. The manufacturer can exert a powerful influence against wasteful expenditure if he will decline resolutely to be associated with any venture that is not in capable hands and soundly presented to the public. The prevention of wasteful expenditure is in many cases an unwelcome obligation, and it will not be accomplished easily. But the State as a whole requires such service. The amount of capital available for the development of its mineral resources is limited, and the withdrawal of a portion of this available capital for futile ventures foredoomed to failure, involves the diversion of capital from those propositions that may have a reasonable chance of success. To carry such a resolution into effect there is no demand for any pessimistic outlook. The attitude of the investor should be that of a sensible business man who weighs up all the possibilities and makes provision against the possible interference of influences that may be foreseen. It has been urged repeatedly that every proposal should be allowed full scope, and that there is no cause for anxiety if a venture proves unsuccessful. This is certainly untrue of cases in which failure is inevitable. Waste is always waste.

In the case of syndicates or companies formed to search for new deposits the essential matter is to obtain the services of a reliable man having wide experience. The number of failures through neglect of this fundamental and self-evident axiom is remarkable. One hears again and again of the return from a distant region of a prospecting party bringing back

for assay single specimens from lodes that have been found, in place of the systematic samples with dimensioned plans, which alone can justify further expenditure. Single specimens give little more information as to the nature and grade of the ore to be treated, than a piece of a sail can give as to the speed of the yacht from which it was taken.

In the case of propositions which are concerned with the development of mineral deposits which have been located already there are other considerations before the investor. The prospectus may reveal the qualities of the venture by mere inspection. If, for example, it is suggested that the financial prospects of the mining venture are enhanced by the agricultural or horticultural possibilities of the surface soil, one may reasonably assume that the attractiveness of the mining proposition is felt to be lacking even in the judgment of those optimists who place it before the public. Again, any proposition that will not bear careful investigation is not worthy of notice. The statement that shares must be bought at once lest the opportunity to invest be lost on the morrow, should be regarded with the utmost suspicion. The promises of spectacular dividends from the investment of capital in companies formed to work minerals having a relatively low intrinsic value are absurd.

The prospectus of a company usually contains one or more reports from men professing expert knowledge. The writers of such reports must be entirely disinterested in the venture, if their judgment is to be trusted implicitly. Many investors are misled by an old weakness in human nature to give honour to a self-invited prophet who comes from another country. The reports themselves reveal the extent to which reliance may be placed on those who write them, if the trouble is taken to examine them carefully enough to find out how far they treat of the factors which determine the commercial success of an enterprise. How often does one find in a prospectus vague statements of vast tonnages ready and available for mining? It is as unreasonable as it is immodest to suppose that the State is strewn with huge virgin deposits that have lain neglected, although visible, during the period of our occupation of this territory. New finds are made, of course, in occupied lands; but their dimensions remain almost invariably to be proved by systematic development work. And before any reputable mining engineer will give an estimate of the tonnage available, he must have the necessary openings to give data as to dimensions and to provide samples.

The report should be written in concise and simple language. Technical terms have their proper place and may be used there to advantage, but they can be dispensed with almost entirely in reports dealing with mining problems. It is well to remember that the higher the professional standing of the engineer, the more simply is his report presented. It is the charlatan who seeks to draw a veil of obscurity over his lack of precision by the free use of technical phrases. In making mention of a report setting forth a judgment in simple and precise terms, it is not intended to convey the meaning that the proposition with which it deals is necessarily commended or condemned in a final way. There are many cases in which it is possible to remove doubts as to the probable success or failure of a venture by some expedient involving a moderate outlay. Whether such work is of the nature of further exploration to determine the extent and quality of the reserves of raw materials, or of the nature of an experiment on a scale sufficient to give the assurance that the raw materials can be satisfactorily and economically treated, there should be no hesitation about carrying out the work in a thorough way before incurring the expenditure necessary for operations on a full scale. And, in any case, the data on which any judgment is based must be stated explicitly. They can be verified, if necessary, by any other engineer; and the future of the mine depends on these facts regarding quantity and quality rather than on individual interpretations of their significance.

The account that has been presented of the past mineral production of South Australia, and of some mineral assets that will be developed in the future on account of their intrinsic merits, will, it is hoped, convey the conviction that the part played and to be played by the mineral substances with which this State is endowed is of the utmost importance to the industrial life of the whole Commonwealth. Although the annual value of the minerals raised is exceeded by the value of our cereals, hay and green fodder, wool, meat and dairy products, these latter can be obtained for the Australian market as a whole from other sources more readily than the salt, the gypsum, and the iron ore which were allotted preferential shipping space during that portion of the war period when the problem of maintaining supplies to Australian factories was most serious.

But there is much required beside proper caution in developing these assets, which must be developed to the uttermost if we make full use of our opportunities. The sympathetic attitude of the whole community is best aroused and sustained by a virile independence and an energetic policy of development under skilled management. Mining is not more likely to be successful than any other industrial undertaking, if the control and management are entrusted to those who have not been trained to exercise them rightly. Nor can it succeed if essential portions of the work are left to others to carry out.

With these remarks—perhaps obvious remarks—the future development of our mineral deposits may be safely left in the hands of those who are eager to face facts. Many years have passed since Michael Faraday expressed his strong belief that "that point of self-education which consists in teaching the mind to resist its desires and inclinations, until they are proved to be right, is the most important of all, not only in things of natural philosophy, but in every department of daily life."

In quoting this considered judgment of one of the greatest men of our race, it may be added that special stress has been laid deliberately on the criteria by which genuine mining ventures may be recognised, upon the factors that determine availability, and upon the careful geographical study of each individual problem of supply and demand. For, by systematic attention to these matters at least, no small measure of benefit will accrue to the manufacturer himself and to the mining industry, which is indispensable to his existence.