CHAPTER XXVII.

MINERAL INDUSTRY.

NOTE.—Values of Australian oversea trade shown throughout this chapter are expressed as £A. f.o.b. port of shipment, except where otherwise indicated. Further detailed information on the subjects dealt with in this chapter is contained in the annual printed Bulletin *Primary Industries, Part II.—Non-Rural Industries and Value of Production* issued by this Bureau, and in *The Australian Mineral Industry—Annual Review* and other publications issued by the Bureau of Mineral Resources, Geology and Geophysics, which also issues, in co-operation with this Bureau, a quarterly publication *The Australian Mineral Industry*, comprising two parts—Part I.—Quarterly Review, and Part II.—Quarterly Statistics. The mimeograph statistical bulletin *Mining and Quarrying* of this Bureau contains annual statistics of the industry prepared and published as soon as possible after the data have been compiled. A monthly statistical bulletin *The Gold Mining Industry, Australia* is issued also, and other current information on mining or mine products is contained in the *Quarterly Summary of Australian Statistics*, the *Monthly Review of Business Statistics*, the *Digest of Current Economic Statistics*, and the *Monthly Bulletin of Production Statistics*.

§ 1. Introduction.

1. **Sources of Statistics.**—In the main, the data contained in this chapter consist of official statistics of the Mines Departments of the several States and of the Northern Territory Mines Branch. The particulars shown have been compiled as far as practicable on the standardized basis which has been used in Australia since 1950, and this presentation has involved some rearrangement of official statistics published by the Mines Departments in some States. These statistics have been supplemented, as necessary, by data obtained from the Statisticians of the several States, the Commonwealth Bureau of Mineral Resources, the Joint Coal Board, the Australian Mines and Metals Association (Inc.), the Mineral Resources Division of the United Kingdom Overseas Geological Surveys and from several other sources.

2. **Presentation of Mineral Statistics.**—(i) *Mineral Industry Data.* The mineral industry includes all mining and quarrying and the recovery of minerals from ore dumps, tailings, etc. Ore-dressing and elementary smelting of metallic minerals (e.g., in the case of gold) and miscellaneous treatment of non-metallic minerals, where these are carried out in an associated plant at or near the mine, are included in the mineral industry. However, establishments primarily engaged in smelting and/or refining (including the smelting and refining sections of the large plants operated at Mount Morgan and Mount Isa in Queensland and at Mount Lyell in Tasmania are omitted and classified to the manufacturing industry.

For mines and quarries which produce more than one product, it is not possible to apportion some particulars relating to the operations of the mine (employment, salaries and wages paid, and costs incurred in production) to the minerals produced. It is, therefore, the practice to record these data only as a total for each mine and then to classify each mine to the industry of the most important mineral produced. Thus a mine producing, say, both tin and tungsten minerals, would be classified as a tin mine if tin were the more important product by value, or vice versa if tungsten were the dominant product.

The mineral industries are classified into four major groups, namely, Metal Mining, Fuel Mining, Non-metal (excluding Fuel) Mining, and Construction Material Quarrying.

Mineral industry data have been obtained annually, since 1952, from the Mining and Quarrying Census. This census is carried out in collaboration with the several Mines Departments and involves the uniform collection of particulars from all establishments employing on the average four or more persons during the period worked by the mine. A representative specimen collection form is included in the Bulletin *Primary Industries, Part II.*, No. 54, 1959–60, pages 47 and 48. For smaller mines, either simplified Census returns covering number of persons employed and value of output are collected, or these particulars are compiled from data made available by the Mines Departments.

Statistics of oil search operations have been excluded in accordance with the definition of the mining industry set out above, but a special article on current developments in the search for oil, contributed by the Commonwealth Bureau of Mineral Resources, may be found in § 15 of this chapter. Details of the activities of establishments engaged in the mining and treatment of uranium ore have been excluded because of the confidential nature of these operations.

(ii) *Mineral Product Data.* In the preparation of Australian mineral production statistics, the quantities and values of individual minerals produced are recorded in terms of the products in the form in which they are dispatched from the locality of each mine. For example, in the case of a metal mine, the output is recorded as ore when no treatment is undertaken at the mine, or as a concentrate where ore-dressing operations are carried out in associated works in the locality of the mine. In addition to the basic quantity data, the

contents of metallic minerals and contents or average grade of selected non-metallic minerals are recorded. Whenever practicable, contents (based on assay) of metallic minerals are shown for each metal which is a " pay metal " or a " refiners' prize " when present in the particular mineral. Other metallic contents which are not recovered are excluded.

Minerals are divided into four major groups, namely, Metals, Fuels, Non-metals (excluding Fuels) and Construction Materials. In this chapter, individual mineral products are arranged in these four groups.

Particulars relating to uranium-bearing minerals are excluded.

3. **Occurrences of Minerals.**—The greatest part of the area of outcropping rock on the Australian continent is Precambrian in age. These basement rocks form the western and central core of the continent and are flanked by younger Palaeozoic rocks which, along the eastern edge of the continent, form a belt several hundred miles wide extending from north Queensland to Tasmania. Smaller areas of Palaeozoic rocks occur in other States. Mesozoic sediments overlie large areas of the continent and reach their greatest development in central Queensland. Cainozoic rocks occur mainly in the southern parts of Victoria and South Australia and as residual basalt cappings over an extensive area of the Palaeozoic rocks of eastern Australia.

Minerals occur widely throughout the Precambrian and Palaeozoic rocks of the continent. Palaeozoic mineralization is perhaps more varied, but the deposits now being worked are in general smaller than those found in Precambrian rocks. Most of the larger deposits of minerals now being mined in Australia are shown in the following table according to the geological era in which they were formed.

PRINCIPAL AUSTRALIAN MINERAL DEPOSITS.

Age of Geological Formation in which Located.	Metal or Mineral.	State or Territory.	Locality.
Precambrian (more than 520 million years old)	Copper ..	Queensland ..	Mount Isa
		Northern Territory	Tennant Creek
	Gold	Western Australia	Kalgoorlie and other localities
	Iron	South Australia ..	Middleback Ranges
		Western Australia	Yampi Sound
	Lead–Silver–Zinc	New South Wales	Broken Hill
		Queensland ..	Mount Isa
	Uranium ..	Queensland ..	Mary Kathleen
		South Australia ..	Radium Hill
		Northern Territory	Rum Jungle and South Alligator River Area
Palaeozoic (between 200 and 520 million years old)	Black Coal ..	New South Wales	Hunter Valley, Lithgow, South Coast
		Queensland ..	Baralaba, Blair Athol, etc.
		Western Australia	Collie
	Copper–Gold ..	Queensland ..	Mount Morgan
		Tasmania ..	Mount Lyell
	Lead–Silver–Zinc	Tasmania ..	Mount Read and Rosebery
	Tin (lode) ..	Queensland ..	Herberton
		Tasmania ..	North-east of State
	Tungsten ..	Tasmania ..	King Island and North-east of State
Mesozoic (between 75 and 200 million years old)	Black Coal ..	Queensland ..	Ipswich
		South Australia ..	Leigh Creek
		Tasmania ..	St. Marys
	Mineral Sands(*a*)	New South Wales	North Coast
		Queensland ..	South Coast
Cainozoic (less than 75 million years old)	Brown Coal ..	Victoria ..	Gippsland
	Tin (alluvial) ..	New South Wales	Tingha
		Queensland ..	Herberton
		Tasmania ..	North-east of State

(*a*) The deposition of mineral sands, derived from Palaeozoic granites, continued throughout the Cainozoic Era.

The large bauxite (aluminium) deposits of Cape York Peninsula in Queensland, for which an extensive mining programme is being developed, were formed during the early part of the Cainozoic Era as a result of climatic conditions then prevailing.

Of the non-metallic minerals, many, such as clay, sand and silica, etc., are not restricted to the rocks of any particular era. However, Precambrian rocks do contain important deposits of asbestos in Western Australia, limestone and dolomite in South Australia, and mica in the Northern Territory. All crude salt is produced by the evaporation of water from pans constructed along the sea coast or from inland lakes.

4. Mineral Concentrates.—Concentration is a physical process involving the removal of mineral impurity from the ore. Most mines now dispatch ore in concentrate form, as this considerably reduces the transport costs and produces a saleable product in the form required by smelters. Most concentrates are nearly pure mineral and the ore-dressing processes (with the exception of that for uranium) involve no chemical change to the mineral being won. Various methods are used in concentration. Sulphide ores which now comprise the greatest tonnages treated are, in most instances, separated from the gangue by flotation. In this method of concentration, the ore is ground finely enough to liberate the individual mineral particles, aerated, and agitated in tanks of water to which chemicals have been added. Under certain conditions, particles of one sulphide mineral adhere to the froth bubbles and are collected in the froth overflow, while gangue and even other sulphides are depressed. By treating the tailings of one flotation process with different chemicals and conditions, it is often possible to separate a further concentrate, as is done at Broken Hill where the zinc sulphide is recovered from the tailings of the lead sulphide concentration process. Until operations ceased in 1962, differential flotation was extensively developed at Captain's Flat, in New South Wales, where successive concentrates of copper, lead, zinc and pyrite were obtained from a lead-silver-zinc-copper ore.

Other methods of concentration used are gravity (alluvial tin, mineral sands, some lead-zinc ores), electromagnetic (wolfram, scheelite, glauconite and mineral sands) and electrostatic (mineral sands).

Particulars of an average Broken Hill ore mined during 1960, showing metal contents before and after differential flotation, are shown in the following table. It should be noted that in both the ore and the concentrate, lead and zinc are contained in the form of lead sulphide and zinc sulphide respectively. Most of the silver is contained in minerals which are collected with the lead sulphide.

ORE TREATED AND CONCENTRATES PRODUCED BY DIFFERENTIAL FLOTATION AT BROKEN HILL (*a*), 1960.

Particulars.	Quantity.	Proportion of weight of ore mined.	Average Assays.			Proportion of Metal Distribution.		
			Lead.	Silver.	Zinc.	Lead.	Silver.	Zinc.
	tons.	%	%	f. oz.	%	%	%	%
Ore treated ..	1,996,365	100.0	11.4	4.1	11.9	100.0	100.0	100.0
Lead Concentrate	294,555	14.8	75.3	25.9	4.1	97.9	94.0	5.2
Zinc Concentrate	413,727	20.7	0.8	0.7	52.3	1.5	3.8	91.4
Residues(*b*) ..	1,288,083	64.5	0.1	0.1	0.6	0.6	2.2	3.4

(*a*) Average particulars for the five operating companies. (*b*) These are of no economic use at present and are either pumped as filling for underground workings or otherwise discarded.

§ 2. The Mineral Industry.

1. **Persons Engaged.**—Particulars collected in the Population Censuses of Australia at 30th June, 1947 and 1954, showing the numbers of persons whose " industry " was stated to be " mining and quarrying ", were included in previous issues of the Year Book. Corresponding particulars from the 1961 Census are not yet available.

Particulars of the numbers of persons engaged in the various mining and quarrying industries, as collected in the Annual Mining and Quarrying Census, are included in paras. 4 (ii) and (iii), pages 1051-2.

2. **Size Classification of Mines and Quarries.**—Most of the mines and quarries worked during 1960 employed less than four persons, including working proprietors. However, more than half of the persons engaged in mining and quarrying were in the 56 mines each employing 200 persons or more. The following table shows the distribution of the total number of mines into various size groups according to the average number of persons employed during the period worked by each mine in 1960. For particulars of the method of compiling these industry statistics, *see* para. 2 (i), page 1045.

MINING AND QUARRYING: SIZE CLASSIFICATION OF ESTABLISHMENTS, 1960.

Mines and Quarries employing on the average(*a*)—	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T. (*b*)	Aust.
Less than 4 persons—								
Establishments ..	639	83	298	271	248	64	71	1,674
Persons	1,026	147	433	478	578	126	105	2,893
From 4 to 20 persons—								
Establishments ..	181	108	85	91	73	41	6	585
Persons	1,429	1,020	920	722	590	314	52	5,047
From 21 to 200 persons—								
Establishments ..	90	27	74	12	28	13	2	246
Persons	6,878	1,203	(*c*)	(*c*)	1,657	608	125	14,347
More than 200 persons—								
Establishments ..	31	3	4	2	11	4	1	56
Persons	13,002	1,770	(*c*)	(*c*)	5,230	1,903	222	26,823
Total—								
Establishments ..	**941**	**221**	**461**	**376**	**360**	**122**	**80**	**2,561**
Persons	**22,335**	**4,140**	**8,796**	**2,329**	**8,055**	**2,951**	**504**	**49,110**

(*a*) Average during period worked. Includes working proprietors. (*b*) Includes Australian Capital Territory, details of which are not available for publication separately. (*c*) Not available for publication; included in total.

3. **Value of Production.**—(i) *General.* In 1960, the local value of mining and quarrying in Australia (the value of output, or the selling value of mine and quarry products at the mine or quarry) was £180,898,000, or 12.3 per cent. of the production of all primary industries. The most important State was New South Wales with £79,204,000, followed by Queensland with £37,608,000 and Western Australia with £22,166,000.

(ii) *Local and Net Values of Production*, 1960. Local and net values of mining and quarrying production for each State are shown for 1960 in the following table. A more detailed reference to the value of production of mining and quarrying and other industries in Australia as well as a brief explanation of the terms used will be found in Chapter XXX.—Miscellaneous.

MINING AND QUARRYING: LOCAL AND NET VALUES OF PRODUCTION, 1960.

(£'000.)

State or Territory.	Local Value (Value of Output at Mine or Quarry).	Cost of Power, Fuel, Light and Other Materials and Stores Used.	Net Value. (*a*)
New South Wales	79,204	16,427	62,777
Victoria	16,267	3,109	13,158
Queensland	37,608	10,148	27,460
South Australia	13,952	2,548	11,404
Western Australia	22,166	6,722	15,444
Tasmania	8,162	2,591	5,571
Northern Territory(*b*)	3,539	668	2,871
Australia	**180,898**	**42,213**	**138,685**

(*a*) Local value less cost of power, fuel, light and other materials and stores used; depreciation and maintenance costs have not been deducted. (*b*) Includes Australian Capital Territory, details of which are not available for separate publication.

(iii) *Local Values*, 1956 *to* 1960. In the following table, the local values of mining and quarrying production are shown by States and Territories for the years 1956 to 1960.

MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION.(*a*)

(£'000.)

Year.	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
1956 ..	88,790	11,891	30,204	11,910	20,230	10,555	2,594	146	176,320
1957 ..	83,170	12,728	25,576	11,872	20,979	8,421	2,195	170	165,111
1958 ..	71,414	13,694	27,632	12,308	20,777	7,358	2,564	208	155,955
1959 ..	71,090	14,935	33,329	13,209	21,787	7,639	2,727	269	164,985
1960 ..	79,204	16,267	37,608	13,952	22,166	8,162	*b* 3,539	(*c*)	180,898

(*a*) Value of output or selling value of products at the mine or quarry. (*b*) Includes Australian Capital Territory. (*c*) Not available for publication; included with Northern Territory.

(iv) *Net Values of Production*, 1956 *to* 1960. In the following table, the net value of mining and quarrying production and the value per head of population are shown by States and Territories for the years 1956 to 1960.

MINING AND QUARRYING: NET VALUE OF PRODUCTION.(a)

Year.	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
				NET VALUE OF PRODUCTION.(a) (£'000.)					
1956	72,053	9,457	24,148	9,487	14,350	8,298	2,084	105	139,982
1957	66,091	9,944	18,810	9,320	14,889	5,897	1,741	110	126,802
1958	55,801	10,987	19,796	9,999	14,454	5,168	1,997	134	118,336
1959	56,331	12,101	24,481	10,698	14,765	5,398	2,202	179	126,155
1960	62,777	13,158	27,460	11,404	15,444	5,571	(b)2,871	(c)	138,685
				NET VALUE OF PRODUCTION(a) PER HEAD OF POPULATION. (£.)					
1956	20.1	3.6	17.3	11.0	21.2	25.6	104.6	2.9	14.7
1957	18.2	3.7	13.2	10.5	21.5	17.8	82.0	2.8	13.0
1958	15.0	4.0	13.6	11.0	20.5	15.3	88.7	3.1	11.9
1959	14.8	4.3	16.6	11.5	20.6	15.7	89.6	3.6	12.4
1960	16.2	4.5	18.3	11.9	21.2	15.9	(b) 35.5	(c)	13.3

(a) Local value, or value of output, less cost of power, fuel, light and other materials and stores used; depreciation and maintenance costs have not been deducted. (b) Includes Australian Capital Territory. (c) Not available for publication; included with Northern Territory.

4. **Statistics of the Principal Mining and Quarrying Industries.**—(i) *Summary*, 1960. In the next table, statistics of numbers of mines and quarries, persons employed, local and net value of production and other particulars are shown for the major industry groups for the year 1960. For particulars of the method of compiling these industry statistics, *see* para. 2 (i), page 1045.

MINING AND QUARRYING: SUMMARY OF OPERATIONS, INDUSTRY GROUPS, AUSTRALIA, 1960.

Industry Group.	Mines and Quarries.	Persons Employed. (a)	Salaries and Wages Paid. (b)(c)	Local Value of Production. (d)	Total Fuel, Materials, etc., Used.	Net Value of Production. (e)	Value of Additions and Replacements to Fixed Assets.(b)
	No.	No.	£'000.	£'000.	£'000.	£'000.	£'000.
Metal Mining ..	746	19,889	26,727	83,918	23,504	60,414	6,823
Fuel Mining ..	221	19,812	27,703	61,609	11,942	49,667	12,861
Non-metal (excluding Fuel) Mining(f) ..	702	2,925	2,664	10,866	2,340	8,526	588
Total, All Mining ..	*1,669*	*42,626*	*57,094*	*156,393*	*37,786*	*118,607*	*20,272*
Construction Material Quarrying(g) ..	892	5,016	3,628	24,505	4,427	20,078	1,624
Total, All Mining and Quarrying	**2,561**	**47,642**	**60,722**	**180,898**	**42,213**	**138,685**	**21,896**

(a) Average number employed (including working proprietors) during whole year. (b) Excludes mines and quarries employing less than four persons. (c) Excludes drawings by working proprietors; the amounts are net after deducting value of explosives sold to employees. (d) Value of output or selling value of products at mine or quarry. (e) Local value less cost of power, fuel, light and other materials and stores used; depreciation and maintenance costs have not been deducted. (f) Incomplete for some industries outside the normal administrative control of State Mines Departments (e.g., clays and salt). (g) Incomplete owing to difficulties of coverage.

In the next table, statistics of numbers of mines and quarries, persons employed, local and net value of production are shown for each State and for the Northern Territory for the year 1960. Details for the Australian Capital Territory are included with the Northern Territory.

MINING AND QUARRYING: SUMMARY OF OPERATIONS, 1960.

State or Territory.	Mines and Quarries.	Persons Employed. (a)	Salaries and Wages Paid. (b)(c)	Local Value of Production. (d)	Total Fuel, Materials, etc., Used.	Net Value of Production. (e)	Value of Additions and Replacements to Fixed Assets. (b)
	No.	No.	£'000.	£'000.	£'000.	£'000.	£'000.
New South Wales ..	941	22,091	29,489	79,204	16,427	62,777	10,665
Victoria	221	3,853	4,695	16,267	3,109	13,158	2,857
Queensland ..	461	8,454	10,900	37,608	10,148	27,460	4,160
South Australia ..	376	2,153	2,003	13,952	2,548	11,404	1,294
Western Australia ..	360	7,791	9,400	22,166	6,722	15,444	2,119
Tasmania	122	2,799	3,587	8,162	2,591	5,571	557
Northern Territory(f)	80	501	648	3,539	668	2,871	244
Australia ..	**2,561**	**47,642**	**60,722**	**180,898**	**42,213**	**138,685**	**21,896**

(a) Average number employed (including working proprietors) during whole year. (b) Excludes mines and quarries employing less than four persons. (c) Excludes drawings by working proprietors; the amounts are net after deducting value of explosives sold to employees. (d) Value of output or selling value of products at mine or quarry. (e) Local value less cost of power, fuel, light and other materials and stores used; depreciation and maintenance costs have not been deducted. (f) Includes Australian Capital Territory, details of which are not available for separate publication.

(ii) *Employment in Mining and Quarrying*, 1960. The following table shows the average numbers engaged in the various mining industries in each State or Territory in 1960.

MINING AND QUARRYING: EMPLOYMENT(a), 1960.

Industry.	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal Mining—									
Gold Mining ..	16	(b)	127	(b)	5,031	..	137	..	5,544
Lead-Silver-Zinc Mining	5,349	..	(b)	(b)	29	(b)	..	..	8,731
Copper-Gold Mining ..	49	..	(b)	(b)	235	(b)	224	..	2,364
Tin Mining	110	..	295	..	45	482	14	..	946
Mineral Sands Mining	659	..	328	..	140	..	..	..	1,127
Other Metal Mining ..	38	13	13	(b)	498	(b)	18	..	1,177
Total, Metal Mining	*6,221*	*(b)*	*4,468*	*(b)*	*5,978*	*2,173*	*393*	..	*19,889*
Fuel Mining—									
Black Coal Mining—									
Underground ..	13,030	407	3,092	..	990	(c) 313	..	..	17,832
Opencut	133	..	139	257	52	..	..	..	581
*Total	*13,163*	*407*	*3,231*	*257*	*1,042*	*313*	..	..	*18,413*
Brown Coal Mining ..	..	1,399	..	..	..	..	..	..	1,399
Total, Fuel Mining	*13,163*	*1,806*	*3,231*	*257*	*1,042*	*313*	..	..	*19,812*
*Non-metal (excluding Fuel) Mining(d)	*1,060*	*(b)*	*263*	*(b)*	*491*	*128*	*13*	..	*2,925*
Total, All Mining	*20,444*	*2,358*	*7,962*	*1,331*	*7,511*	*2,614*	*406*	..	*42,626*
*Construction Material Quarrying(e) ..	*1,647*	*1,495*	*492*	*822*	*280*	*185*	*(f) 95*	*(g)*	*5,016*
Total, All Mining and Quarrying ..	**22,091**	**3,853**	**8,454**	**2,153**	**7,791**	**2,799**	*(f)* 501	*(g)*	**47,642**

(a) Average employment during whole year, including working proprietors. (b) Not available for publication. (c) Includes persons engaged by one mine which has both underground and opencut workings. (d) Incomplete for some industries outside the normal administrative control of State Mines Departments (e.g., clays and salts). (e) Incomplete owing to difficulties of coverage. (f) Includes Australian Capital Territory. (g) Not available for publication; included with Northern Territory.

(iii) *Employment in Mining and Quarrying, 1956 to 1960.* The following table shows particulars of mining employment in Australia for the years 1956 to 1960. The figures show the average number of persons employed during the whole year.

MINING AND QUARRYING: EMPLOYMENT(*a*), AUSTRALIA.

Industry.	1956.	1957.	1958.	1959.	1960.
Metal Mining—					
Gold Mining	6,488	6,205	5,901	5,948	5,544
Lead-Silver-Zinc Mining	10,627	10,354	9,461	9,031	8,731
Copper-Gold Mining	2,301	2,151	2,057	2,301	2,364
Tin Mining	938	856	944	926	946
Mineral Sands Mining	1,592	2,062	1,102	1,019	1,127
Other Metal Mining	1,407	1,300	1,030	1,031	1,177
Total, Metal Mining	*23,353*	*22,928*	*20,495*	*20,256*	*19,889*
Fuel Mining—					
Black Coal Mining	23,895	22,345	20,795	18,678	18,413
Brown Coal Mining	1,566	1,579	1,540	1,519	1,399
Total, Fuel Mining	*25,461*	*23,924*	*22,335*	*20,197*	*19,812*
Non-metal (excluding Fuel) Mining(b)	*2,708*	*2,749*	*2,728*	*2,975*	*2,925*
Total, All Mining	*51,522*	*49,601*	*45,558*	*43,428*	*42,626*
Construction Material Quarrying(b)	*4,329*	*4,640*	*4,581*	*4,116*	*5,016*
Total, All Mining and Quarrying	**55,851**	**54,241**	**50,139**	**47,544**	**47,642**

(*a*) Average employment during whole year, including working proprietors. (*b*) Incomplete.

(iv) *Salaries and Wages Paid in Mining, 1956 to 1960.* Salaries and wages paid in the mining and quarrying industries in Australia during each year 1956 to 1960 are shown in the following table. Information regarding rates of wages paid in the mining industry is shown in Chapter XII.—Labour, Wages and Prices (p. 402) and also in the *Labour Report.*

MINING AND QUARRYING: SALARIES AND WAGES PAID(*a*), AUSTRALIA.
(£'000.)

Industry.	1956.	1957.	1958.	1959.	1960.
Metal Mining—					
Gold Mining	6,551	6,422	6,492	6,504	6,655
Lead-Silver-Zinc Mining	17,299	16,241	13,462	13,944	13,555
Copper-Gold Mining	2,114	2,289	2,362	2,710	2,938
Tin Mining	733	753	737	814	905
Mineral Sands Mining	1,644	2,177	1,327	1,188	1,336
Other Metal Mining	1,504	1,402	1,108	1,058	1,338
Total, Metal Mining	*29,845*	*29,284*	*25,488*	*26,218*	*26,727*
Fuel Mining—					
Black Coal Mining	25,862	25,105	24,501	23,437	25,918
Brown Coal Mining	1,649	1,640	1,694	1,710	1,785
Total, Fuel Mining	*27,511*	*26,745*	*26,195*	*25,147*	*27,703*
Non-metal (excluding Fuel) Mining(b)	*2,300*	*2,400*	*2,384*	*2,631*	*2,664*
Total, All Mining	*59,656*	*58,429*	*54,067*	*53,996*	*57,094*
Construction Material Quarrying(b)	*2,738*	*3,219*	*3,241*	*3,490*	*3,628*
Total, All Mining and Quarrying	**62,394**	**61,648**	**57,308**	**57,486**	**60,722**

(*a*) Excludes mines and quarries employing less than four persons, and drawings by working proprietors; the amounts are net after deducting value of explosives sold to employees. (*b*) Incomplete.

(v) *Accidents in Mining.* Particulars of numbers of persons killed and injured in accidents in mines and associated treatment plants are recorded by State Mines Departments. Numbers injured are not reported on a uniform basis in all States, as varying criteria are used in determining what constitutes injury for the purpose of these records. In 1960, 36 persons were recorded as having been killed and 1,537 as having been injured in mining (excluding quarrying) accidents. Recorded deaths and injuries in that year were highest in black coal mines (16 and 463, respectively), gold mines (8 and 409) and lead-silver-zinc mines (3 and 319).

(vi) *Local and Net Values of Mining and Quarrying Production,* 1960. The following two tables show particulars of the local and net value of production for individual mining industry groups and quarrying for the year 1960. It should be noted that these statistics are on an industry basis and not by product. For particulars of the method of compiling these industry statistics, *see* para. 2 (i), page 1045.

MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION(*a*), 1960.

(£'000.)

Industry.	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal Mining—									
Gold Mining	19	471	225	1	14,347	..	889	..	15,952
Lead-Silver-Zinc Mining	21,929	..	(*b*)	3	112	(*b*)	..	..	45,552
Copper-Gold Mining	15	..	(*b*)	1	337	(*b*)	2,072	..	8,411
Tin Mining	192	..	773	..	166	973	15	..	2,119
Mineral Sands Mining	2,577	..	2,002	..	405	..	..	..	4,984
Other Metal Mining	89	21	(*b*)	4,425	1,492	(*b*)	53	..	6,900
Total, Metal Mining	*24,821*	*492*	*27,704*	*4,430*	*16,859*	*6,583*	*3,029*	..	*83,918*
Fuel Mining—									
Black Coal Mining	42,240	418	7,829	1,154	2,436	687	..	..	54,764
Brown Coal Mining	..	6,845	..	..	..	..	..	..	6,845
Total, Fuel Mining	*42,240*	*7,263*	*7,829*	*1,154*	*2,436*	*687*	..	..	*61,609*
Non-metal (excluding Fuel) Mining—									
Clays(*c*)	1,142	1,104	108	352	137	80	..	..	2,923
Gypsum	201	71	..	405	33	..	..	..	710
Limestone	1,042	695	(*b*)	747	(*b*)	(*b*)	7	..	3,356
Salt	..	114	(*b*)	718	(*b*)	..	20	..	959
Other Non-metal (excluding Fuel) Mining	625	2	(*b*)	866	1,367	(*b*)	17	..	2,918
Total, Non-metal (excluding Fuel) Mining	*3,010*	*1,986*	*731*	*3,088*	*1,667*	*340*	*44*	..	*10,866*
Total, All Mining	*70,071*	*9,741*	*36,264*	*8,672*	*20,962*	*7,610*	*3,073*	..	*156,393*
Construction Material Quarrying(c)	*9,133*	*6,526*	*1,344*	*5,280*	*1,204*	*552*	(*d*) *466*	(*e*)	*24,505*
Total, All Mining and Quarrying	79,204	16,267	37,608	13,952	22,166	8,162	*d* 3,539	(*e*)	180,898

(*a*) Value of output or selling value of products at the mine or quarry. (*b*) Not available for publication. (*c*) Incomplete. (*d*) Includes Australian Capital Territory. (*e*) Not available for publication; included with Northern Territory.

MINING AND QUARRYING: NET VALUE OF PRODUCTION(a), 1960.
(£'000.)

Industry.	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal Mining—									
Gold Mining	18	(b)	178	(b)	9,715	..	795	..	11,043
Lead-Silver-Zinc Mining	16,239	..	(b)	(b)	75	(b)	..	..	33,446
Copper-Gold Mining	(c)—75	..	(b)	(b)	201	(b)	1,668	..	5,123
Tin Mining	166	..	541	..	102	768	12	..	1,589
Mineral Sands Mining	1,743	..	1,397	..	282	..	..	..	3,422
Other Metal Mining	76	20	41	(b)	1,142	(b)	53	..	5,791
Total, Metal Mining	*18,167*	(b)	*19,597*	(b)	*11,517*	*4,348*	*2,528*	..	*60,414*
Fuel Mining—									
Black Coal Mining	33,179	286	6,534	972	1,921	553	..	..	43,445
Brown Coal Mining	..	6,222	..	..	..	..	..	..	6,222
Total, Fuel Mining	*33,179*	*6,508*	*6,534*	*972*	*1,921*	*553*	..	..	*49,667*
Non-metal (excluding Fuel) Mining—									
Clays(d)	921	1,032	(e) 108	317	97	74	..	..	(f)2,549
Gypsum	161	64	..	320	24	..	..	..	569
Limestone	718	(b)	(b)	(b)	(b)	(b)	(e) 7	..	(f)2,294
Salt(d)	..	(e) 114	(b)	613	(b)	..	(e) 20	..	(f) 818
Other Non-metal (excluding Fuel) Mining	498	(e) 2	29	816	(b)	(b)	(e) 17	..	(f)2,296
Total, Non-metal (excluding Fuel) Mining	*2,298*	(b)	*496*	(b)	*1,151*	*233*	*44*	..	*8,526*
Total, All Mining	*53,644*	*8,472*	*26,627*	*7,569*	*14,589*	*5,134*	*2,572*	..	*118,607*
Construction Material Quarrying(d)	(e)*9,133*	*4,686*	*833*	*3,835*	*855*	*437*	(g) *299*	(h)	*f 20,078*
Total, All Mining and Quarrying	62,777	13,158	27,460	11,404	15,444	5,571	(g)2,871	(h)	138,685

(a) Local value (i.e., value of output at mine) less cost of power, fuel, light and other materials and stores used; depreciation and maintenance costs have not been deducted. (b) Not available for publication. (c) Cost of materials used, etc., exceeds value of output. (d) Incomplete. (e) No allowance has been made for costs of power, fuel, light and other materials and stores used, particulars of which are not available. (f) Refer to footnote (e). (g) Includes Australian Capital Territory. (h) Not available for publication; included with Northern Territory.

§ 3. Mineral Production.

1. **Quantity of Principal Minerals Produced in 1960.**—In the following table, particulars of the quantity of the principal minerals produced during 1960 are shown for each State and the Northern Territory.

QUANTITY OF PRINCIPAL MINERALS PRODUCED, 1960.

Mineral.	Unit.	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T.	Aust.
METALLIC MINERALS.									
Antimony Ore and Concentrate	ton	253	3	..	..	..	..	..	256
Bauxite	„	3,647	4,231	32,093	..	29,464	..	..	69,435
Beryllium Ore	„	9	..	..	..	181	..	..	190
Chromite	„	..	..	529	..	..	..	..	529
Copper Ore(a)	„	80	..	59,706	30	7,727	758	20	68,321
Copper Concentrate	„	4,228	..	342,759	..	3,552	46,760	35,427	432,726
Copper Precipitate	„	85	..	10	..	..	26	1,180	1,301
Gold Concentrate	„	2	41	..	..	32	..	..	75
Gold—Other Forms(b)	oz.	1,164	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Ilmenite Concentrate	ton	1,192	..	22	..	105,372	..	..	106,586
Iron Ore(d)	'000 tons	..	..	..	3,427	928	..	..	4,355
Lead Ore(e)	ton	253	..	13,463	..	..	..	..	13,716
Lead Concentrate	„	310,408	..	122,128	..	2,264	14,790	..	449,590
Lead-Copper Concentrate	„	..	..	..	..	..	6,797	..	6,797
Manganese Ore	„	1,573	27	3,710	69	53,842	..	1,425	60,646
Pyrite Concentrate	„	32,770	..	18,720	66,077	53,299	67,764	..	238,630
Rutile Concentrate	„	54,002	..	34,120	..	515	..	..	88,637
Tantalite-Columbite Concentrate	lb.	..	..	..	..	23,677	..	..	23,677
Tin Concentrate	ton	307	..	1,236	..	281	1,233	42	3,099
Tungsten Concentrates—									
Scheelite Concentrate	„	(f)	..	..	..	..	420	..	420
Wolfram Concentrate	„	..	..	..	..	..	1,106	25	1,131
Zinc Concentrate	„	444,652	..	46,976	..	..	57,372	..	549,000
Zircon Concentrate	„	66,328	..	32,016	..	4,018	..	..	102,362

NOTE.—*See* next page for footnotes.

QUANTITY OF PRINCIPAL MINERALS PRODUCED, 1960—*continued.*

Mineral.	Unit.	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T.	Aust.
FUEL MINERALS.									
Coal, Black—									
Semi-anthracite ..	'000 tons	..	..	48	..	..	2	..	50
Bituminous	"	17,737	77	2,531	..	..	296	..	20,641
Sub-bituminous ..	"	..	..	71	885	922	..	..	1,878
Total	"	*17,737*	*77*	*2,650*	*885*	*922*	*298*	..	*22,569*
Coal, Brown (Lignite) ..	"	..	14,967	..	..	..	..	..	14,967
NON-METALLIC (EXCLUDING FUEL) MINERALS.									
Asbestos	short ton	1,072	..	..	..	14,541	..	..	15,613
Barite	ton	60	..	..	11,357	..	..	..	11,417
Clays—									
Brick Clay and Shale..	'000 tons	2,078	(g)1,258	335	408	(g) 310	157	..	4,546
Other(h)	"	507	212	13	96	34	18	..	880
Diatomite	ton	3,941	718	..	..	..	..	..	4,659
Dolomite(i)	"	3,357	..	2,139	182,290	404	2,678	..	190,868
Felspar	"	5,325	..	..	1,147	1,942	..	..	8,414
Gypsum	"	95,514	100,386	..	340,762	44,216	..	..	580,878
Limestone(i)	'000 tons	2,400	1,157	(j)	1,064	(j)	215	(f)	5,669
Magnesite	ton	61,668	..	..	498	..	..	..	62,166
Mica—Muscovite, trimmed	lb.	..	..	..	..	..	..	9,500	9,500
Phosphate Rock ..	ton	..	..	..	2,234	87	..	..	2,321
Salt, Crude	"	..	71,176	(j)	359,027	(j)	..	930	463,296
Silica (Glass, Chemical, etc.)(h)	"	165,447	..	15,882	14,615	8,925	5,231	..	210,100
Talc	"	1,136	..	..	9,064	5,470	..	..	15,670
CONSTRUCTION MATERIALS.(k)									
Sand	'000 tons	2,975	1,113	(l)	1,814	(l)	21	11	5,934
River Gravel and Gravel Boulders	"	1,770	156	(l)	655	(l)	343	8	2,932
Dimension Stone ..	"	157	4	5	39	112	(f)	1	318
Crushed and Broken Stone	"	3,098	8,059	2,181	7,859	908	512	(m) 226	22,843
Other (Decomposed Rock, etc.)	"	15,055	(j)	(l)	(l)	(j)	(f)	..	15,264

(*a*) Includes cupreous ore for fertilizer. (*b*) Bullion, alluvial, retorted gold, etc. (*c*) Gross weight not available. (*d*) Iron oxide for metal extraction. (*e*) Includes lead-silver ore. (*f*) Less than half the unit of quantity shown. (*g*) Estimated. (*h*) Incomplete; figures relate only to production reported by Mines Departments. (*i*) Excludes quantities used directly as a building or road material. (*j*) Not available for publication. (*k*) Incomplete owing to difficulties of coverage. (*l*) Not available. (*m*) Includes Australian Capital Territory which is not available for separate publication.

NOTE.—Particulars of uranium concentrate produced are not available for publication and have been excluded from the table above.

2. **Quantities of Principal Minerals Produced, Australia.**—The following table shows the quantities of the principal minerals produced in Australia during the years 1956 to 1960.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA.

Mineral.	Unit.	1956.	1957.	1958.	1959.	1960.
METALLIC MINERALS.						
Antimony Ore and Concentrate	ton	547	852	1,116	1,022	256
Bauxite	„	10,329	7,707	6,909	14,985	69,435
Beryllium Ore	„	318	395	247	317	190
Chromite	„	6,096	3,049	776	120	529
Copper Ore(*a*)	„	47,209	56,447	58,109	77,738	68,321
Copper Concentrate	„	205,304	222,168	279,976	358,774	432,726
Copper Precipitate	„	134	557	1,536	1,379	1,301
Gold Concentrate	„	107	(*b*)959	1,855	1,487	75
Gold—Other Forms(*c*)	oz.	(*d*)	(*d*)	(*d*)	(*d*)	(*d*)
Ilmenite Concentrate	ton	4,274	71,155	69,948	83,577	106,586
Iron Ore(*e*)	'000 tons	3,914	3,801	3,917	4,141	4,355
Lead Ore(*f*)	ton	20,121	20,758	*g* 21,854	12,693	13,716
Lead Concentrate	„	475,731	497,404	492,908	461,055	449,590
Lead-Copper Concentrate	„	6,315	7,366	7,630	6,010	6,797
Manganese Ore	„	59,384	77,010	59,683	89,971	60,646
Pyrite Concentrate	„	171,859	229,125	226,744	223,004	238,630
Rutile Concentrate	„	96,816	128,903	83,328	81,905	88,637
Tantalite-Columbite Concentrate	lb.	159,655	50,038	13,507	18,950	23,677
Tin Concentrate	ton	2,926	2,867	3,128	3,304	3,099
Tungsten Concentrates—						
Scheelite Concentrate	„	1,495	1,449	733	1	420
Wolfram Concentrate	„	877	656	517	903	1,131
Zinc Concentrate	„	530,777	556,763	503,752	473,276	549,000
Zircon Concentrate	„	72,458	88,561	59,269	113,356	102,362
FUEL MINERALS.						
Coal, Black—						
Semi-anthracite	'000 tons	81	71	57	54	50
Bituminous	„	17,681	18,229	18,616	18,576	20,641
Sub-bituminous	„	1,512	1,619	1,769	1,668	1,878
Total	„	*19,274*	*19,919*	*20,442*	*20,298*	*22,569*
Coal, Brown (Lignite)	„	10,560	10,741	11,644	13,035	14,967
NON-METALLIC (EXCLUDING FUEL) MINERALS.						
Asbestos	short ton	9,709	14,670	15,568	17,875	15,613
Barite	ton	6,009	9,778	6,802	6,214	11,417
Clays—						
Brick Clay and Shale	'000 tons	3,426	3,531	3,829	4,299	4,546
Other(*h*)	„	717	748	775	823	880
Diatomite	ton	5,789	6,221	4,240	5,089	4,659
Dolomite(*i*)	„	115,564	192,103	138,832	160,084	190,868
Felspar	„	18,629	8,819	7,016	6,750	8,414
Gypsum	„	463,355	478,436	504,938	516,791	580,878
Limestone(*i*)	'000 tons	4,264	4,572	5,324	5,305	5,669
Magnesite	ton	64,685	83,473	69,391	60,586	62,166
Mica—Muscovite, trimmed	lb.	28,837	36,713	42,479	44,665	9,500
Phosphate Rock	ton	6,788	11,430	7,421	4,775	2,321
Salt, Crude	„	408,689	427,600	429,534	467,532	463,296
Silica (Glass, Chemical, etc.)(*h*)	„	142,485	149,339	145,483	154,778	210,100
Talc	„	13,160	14,441	15,393	16,376	15,670

NOTE.—*See* next page for footnotes.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA(a)—*continued.*

Mineral.	Unit.	1956.	1957.	1958.	1959.	1960.
CONSTRUCTION MATERIALS. (j)						
Sand	'000 tons	4,314	4,125	4,118	4,623	5,934
River Gravel and Gravel Boulders	,,	2,116	1,759	2,265	2,524	2,932
Dimension Stone	,,	231	230	272	283	318
Crushed and Broken Stone ..	,,	14,817	15,587	15,543	19,822	22,843
Other (Decomposed Rock, etc.)	,,	11,113	12,546	12,722	13,699	15,264

(a) Includes cupreous ore for fertilizer. (b) Includes a small quantity of gold ore. (c) Bullion, alluvial, retorted gold, etc. (d) Gross weight not available. (e) Iron oxide for metal extraction. (f) Includes lead-silver ore. (g) Includes a small quantity of lead-zinc ore. (h) Incomplete; figures relate only to production reported by Mines Departments. (i) Excludes quantities used directly as a building or road material. (j) Incomplete owing to difficulties of coverage.

NOTE.—Particulars of uranium concentrate produced are not available for publication and have been excluded from the table above.

3. **Contents of Metallic Minerals Produced in 1960.**—The following table shows the contents of metallic minerals produced in 1960 which were " pay metals " or which were recovered as " refiners' prizes ". Further particulars for earlier years are shown in the following paragraph and in the sections later in this chapter covering principal contents.

CONTENTS OF METALLIC MINERALS PRODUCED, 1960.

Content of Metallic Minerals Produced.	Unit.	N.S.W.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	N.T.	Aust.
Alumina (Al_2O_3)	ton	1,386	2,306	(a)14,442	..	(a)13,259	..	..	(b)31,393
Antimony ..	,,	784	2	..	..	..	..	..	786
Beryllium Oxide (BeO) ..	unit (c)	120	..	..	..	2,101	..	..	2,221
Cadmium ..	ton	893	..	..	..	..	56	..	949
Chromic Oxide (Cr_2O_3) ..	,,	..	..	(a) 265	..	..	..	..	(a) 265
Cobalt ..	,,	65	..	..	..	..	(d)	..	65
Copper ..	,,	3,572	..	82,753	5	1,661	11,680	9,764	109,435
Gold	fine oz.	13,628	28,566	78,267	36	869,966	23,994	72,252	1,086,709
Iron(e) ..	'000 tons	..	..	..	(a) 2,228	586	..	..	(b) 2,814
Lead	ton	235,868	..	57,518	..	1,739	13,038	..	308,163
Lithium Oxide..	,,	1	..	..	..	..	..	..	1
Manganese(f) ..	,,	342	12	(a) 1,670	..	26,561	..	..	28,585
Manganese Dioxide (MnO_2)g	,,	623	..	..	45	9	..	940	1,617
Monazite ..	,,	38	..	76	..	(a) 230	..	..	(b) 344
Platinum ..	oz.	4	..	..	..	..	..	..	4
Silver.. ..	'000 fine oz.	8,398	1	5,122	..	196	1,398	85	15,200
Sulphur(h) ..	ton	204,358	..	24,612	(a)31,717	24,556	54,757	..	b 340,000
Tantalite-Columbite (Ta_2O_5+ Nb_2O_5) ..	lb.	..	..	..	..	11,500	..	..	11,500
Tin	ton	223	..	(a) 885	..	190	884	20	(b) 2,202
Titanium Dioxide (TiO_2) ..	,,	52,799	..	33,281	..	58,664	..	..	144,744
Tungstic Oxide (WO_3) ..	,,	(d)	..	..	..	..	1,095	16	1,111
Zinc	,,	234,170	..	24,394	35	..	31,625	..	290,224
Zircon	,,	65,764	..	31,752	..	(a) 3,978	..	..	b 101,494

(a) Estimated. (b) Partly estimated. (c) 1 unit = 22.4 lb. (d) Less than half the unit of quantity shown. (e) Excludes iron content of iron oxide not intended for metal extraction. (f) Content of metallurgical grade manganese ore. (g) Content of manganese ore of other than metallurgical grade. (h) Sulphur content of pyrite and other minerals from which sulphur is extracted.

NOTE.—Particulars of production of uranium oxide (U_3O_8) are not available for publication and have been excluded from the table above.

4. **Contents of Metallic Minerals Produced in Australia, 1956 to 1960.**—Particulars of the contents of metallic minerals produced in Australia in the years 1956 to 1960 are shown in the following table. Graphs showing details of the mine production of principal metals and coal from 1930 to 1961 may be found on pages 1077–78.

CONTENTS OF METALLIC MINERALS PRODUCED: AUSTRALIA.

Content of Metallic Minerals Produced.	Unit.	1956.	1957.	1958.	1959.	1960.
Alumina (Al_2O_3) ..	ton	4,618	3,758	3,533	6,914	(a) 31,393
Antimony ..	,,	903	1,209	1,356	1,280	786
Beryllium Oxide (BeO)	unit(b)	3,768	4,570	2,900	3,587	2,221
Bismuth	lb.	5,120	1,344	2,328	..	..
Cadmium ..	ton	922	979	872	860	949
Chromic Oxide (Cr_2O_3) ..	,,	2,624	(a) 1,420	(a) 386	(c) 60	(c) 265
Cobalt	,,	59	68	71	60	65
Copper	,,	54,547	59,255	75,715	94,950	109,435
Gold	fine oz.	1,029,821	1,083,941	1,103,980	1,085,104	1,086,709
Iron(d) ..	'000 tons	2,536	2,463	2,539	2,700	2,814
Lead	ton	299,485	333,753	328,347	316,293	308,163
Lithium Oxide ..	,,	..	..	..	..	1
Manganese(e) ..	,,	25,856	34,904	25,623	40,966	28,585
Manganese Dioxide (MnO_2)(f) ..	,,	1,464	1,239	2,819	2,475	1,617
Molybdenum Disulphide(MoS_2)(c)	lb.	190	5,236	8,568	..	..
Monazite ..	ton	93	132	423	331	(a) 344
Osmiridium ..	oz.	27	69	43	3	..
Platinum ..	,,	18	17	22	..	4
Silver	'000 fine oz.	14,617	15,811	16,340	15,161	15,200
Sulphur(g) ..	ton	306,072	342,474	(a)322,619	(a)310,545	(a)340,000
Tantalite-Columbite ($Ta_2O_5+Nb_2O_5$)	lb.	85,690	23,499	6,736	8,499	11,500
Tin	ton	(a)2,078	1,952	2,237	(a)2,351	(a)2,202
Titanium Dioxide (TiO_2)	,,	95,502	163,751	119,233	125,301	144,744
Tungstic Oxide (WO_3)	,,	1,582	1,409	850	653	1,111
Zinc	,,	278,082	291,582	263,044	249,133	290,224
Zircon	,,	71,769	87,703	58,745	112,352	(a)101,494

(a) Partly estimated. (b) 1 unit = 22.4 lb. (c) Estimated. (d) Excludes iron content of iron oxide not intended for metal extraction. Partly estimated. (e) Content of metallurgical grade manganese ore. (f) Content of manganese ore of other than metallurgical grade. (g) Sulphur content of pyrite and other minerals from which sulphur is extracted.

NOTE.—Particulars of production of uranium oxide (U_3O_8) are not available for publication and have been excluded from the table above.

5. **Local Value of Minerals Produced, 1956 to 1960.**—Particulars of the estimated values of minerals (mine and quarry products) produced during the years 1956 to 1960 are shown in the following table. The values represent the estimated selling value at the mine or quarry of minerals produced during the years concerned.

LOCAL VALUE OF MINERALS PRODUCED: AUSTRALIA.
(£'000.)

Mineral.	1956.	1957.	1958.	1959.	1960.
METALLIC MINERALS.					
Copper Ore, Concentrate, etc.(a)	18,287	12,345	14,770	21,165	25,436
Gold Ore, Concentrate, Other Forms, etc. ..	15,509	16,090	16,251	15,853	15,873
Iron Ore(b)	4,449	4,295	4,393	4,633	4,844
Lead and Lead-Silver Ore and Concentrate, Lead-Copper Concentrate, etc.(a) ..	34,552	28,810	22,493	21,477	20,491
Manganese Ore	337	589	460	626	329
Pyritic Ore and Concentrate	1,023	1,166	1,112	1,068	1,136
Rutile Concentrate	6,430	8,577	4,524	3,838	3,639
Tin Concentrate	1,599	1,612	1,739	2,043	1,940
Tungsten Concentrates	3,332	2,167	871	410	940
Zinc Ore and Concentrate	8,215	3,655	2,565	4,888	7,730
Zircon Concentrate	604	854	487	1,008	972
Other Metallic Minerals	415	602	525	512	575
Total, Metallic Minerals	*94,752*	*80,762*	*70,190*	*77,521*	*83,905*
FUEL MINERALS.					
Coal, Black	52,439	52,279	51,658	49,211	54,764
Coal, Brown	4,644	5,228	5,418	6,123	6,845
Total, Fuel Minerals	*57,083*	*57,507*	*57,076*	*55,334*	*61,609*
NON-METALLIC (EXCLUDING FUEL) MINERALS.					
Total, Non-metallic (excluding Fuel) Minerals	*(c) 8,041*	*(c) 9,002*	*(c) 10,192*	*(c) 10,533*	*10,843*
CONSTRUCTION MATERIALS.(d)					
Total, Construction Materials	*16,444*	*17,840*	*18,497*	*21,597*	*24,541*
TOTAL.					
Total, All Minerals and Construction Materials (d)	176,320	165,111	155,955	164,985	180,898

(a) Prior to 1958, the value of lead-copper concentrate was included with copper ore, concentrate, etc. (b) Includes the value of iron oxide for fluxing for years prior to 1959. (c) Excludes Australian Capital Territory, details of which are included with construction materials. (d) Incomplete owing to difficulties of coverage.

NOTE.—Particulars of the value of uranium concentrate produced are not available for publication and have been excluded from the table above.

Particulars of the local value (or value of output) and net value (or value of production) of production of the principal Mining and Quarrying industries for the year 1960 are shown in para. 4 (vi.), page 1053. Owing to the necessity of classifying individual mines according to the principal mineral produced, the values in the tables on pages 1050 and 1053 for mining industry groups differ slightly in some cases from totals of the corresponding groups of mine products shown in the table above.

§ 4. Gold.

1. Historical.—The earliest definite record of the discovery of gold in Australia was made on 15th February, 1823, by James McBrien, a surveyor, while surveying the Fish River between Rydal and Bathurst, New South Wales, and there are records of gold having been identified in several places during the next 27 years. It is believed that the first authentic

discovery of gold from which actual mining operations resulted was made in January, 1846, about 10 miles east of Adelaide, South Australia. However, credit for the first discovery of payable gold is generally given to E. H. Hargraves, who, on 3rd April, 1851, notified the Government of New South Wales of his find, located at the junction of the Summerhill and Lewis Pond Creeks in the Bathurst (N.S.W.) district. This caused a gold rush, and prospecting started in many localities.

The Colony of Victoria was separated from New South Wales on 1st July, 1851, and within a few days of its inception, the new government was notified of the discovery of gold in several places. It would appear that the Hon. W. Campbell discovered gold near Clunes (Victoria) in March, 1850, but temporarily concealed the fact, and his discovery was not disclosed until 8th July, 1851. The discovery of gold at Ballarat and Bendigo followed soon afterwards.

The early discoveries were of alluvial gold, and only crude equipment was required to work them. As a consequence, cities and towns were depleted of their population as large numbers rushed to the diggings. The Australian population growth from 438,000 at the end of 1851 to 1,168,000 at the end of 1861 can be said to be due largely to the discoveries of gold.

Discoveries continued to be made, including such important fields as Canoona (Queensland) in 1858, Forbes (New South Wales) in 1862, Gympie (Queensland) in 1868, and Charters Towers and Mount Morgan (both in Queensland) in 1882. With the discovery at Mount Lyell (Tasmania) in 1886, the major discoveries in the eastern States ceased.

Western Australia did not enter the field for a considerable time after gold mining had become well established in most of the other States. Although some specimens had been found between 1850 and 1870, it was not until 1886 that the Kimberley field was discovered, followed by Yilgarn in 1887. In 1892, Bayley and Ford discovered Coolgardie, and in May of the following year Hannan and Flannigan found Kalgoorlie. In the years since, there have been no further discoveries of major goldfields although many profitable deposits in other localities have been found and worked.

The amount of gold won in Australia in any one year attained its maximum in 1903, the year in which Western Australian production reached its highest level. For the other States, the years in which the greatest yields were obtained were as follows:—New South Wales, 1852; Victoria, 1856; Queensland, 1900; South Australia, 1904; and Tasmania, 1899. In recent years, output from the Northern Territory has expanded considerably and the highest annual production was recorded as recently as 1956.

Owing to the exhaustion of the more easily worked deposits and increased costs due to deep mining, the production of gold in Australia declined from 3,837,979 fine oz. in 1903 to 427,160 fine oz. in 1929, the lowest output since its discovery. Increased activity in prospecting due to prevailing economic conditions resulted in some improvement in 1930, but the marked development between that year and 1939 was caused by the heavy depreciation of Australian currency in terms of gold. Following the outbreak of the 1939–45 War, there was a sharp fall in gold production to 656,867 fine oz. in 1944 and 657,213 fine oz. in 1945, but with the release of man-power after the war, there has been an upward trend in mine production of gold, which in 1953 exceeded 1,000,000 fine oz. for the first time since 1942. The devaluation of Australian currency in September, 1949, gave an impetus to gold production, but this was offset in the following years by increasing costs which forced several large producers to cease operations. The payment of gold subsidy since 1954 has been an important factor in maintaining production slightly in excess of 1,000,000 fine oz. annually in subsequent years.

2. Present Methods of Mining and Treatment.—Gold ores can be divided into two types, namely, free-milling and refractory. Free-milling ores are those that, when finely ground, will yield their gold content to amalgamation and/or cyanidation, and these are found in most of the gold deposits of Australia.

Some refractory ores, which are not amenable to amalgamation, allow their gold to be dissolved by cyanidation, from which solution the gold is then precipitated. However, on the Coolgardie field, where gold-bearing sulphide and telluride minerals occur, it is necessary first to recover these from gangue by flotation. This concentrate is then roasted and the resulting calcine, an impure oxide containing free gold, is cyanided to yield gold. This is usually smelted as bullion, in which form it leaves the vicinity of the mine.

3. Mine Production.—The table hereunder shows the mine production of gold (gold content of minerals produced) during 1960 according to the mineral in which it was contained and the State or Territory of origin. It should be noted that the minerals shown below contain certain other metals in addition to gold.

GOLD : MINE PRODUCTION, 1960.

(Fine oz.)

Mineral in which contained.	N.S.W.	Vic.	Q'land.	S.A.	W.A.	Tas.	N.T.	Aust.
Copper Ore, Concentrate, etc. ..	3,066	..	64,222	..	1,313	7,188	12,545	88,334
Gold Ore, Concentrate, etc. ..	1,167	28,566	14,045	36	868,653	307	59,707	972,481
Lead Concentrate ..	7,679	..	..	..	..	3,397	..	11,076
Lead-Copper Concentrate ..	..	..	..	..	..	10,978	..	10,978
Pyrite Concentrate..	..	..	..	..	(a)	..	..	(a)
Zinc Concentrate ..	1,716	..	..	..	..	2,124	..	3,840
**Total Gold .. **	**13,628**	**28,566**	**78,267**	**36**	**869,966**	**23,994**	**72,252**	**1,086,709**

(a) A small quantity of gold recovered from pyrite concentrate dispatched from Kalgoorlie for sulphuric acid manufacture is included with gold ore, concentrate, etc.

The principal sources of production during 1960 were as follows.

(i) *New South Wales.* There are now no mines employing four or more hands engaged solely in gold mining in New South Wales. Most of the gold produced during 1960 was contained in lead and zinc concentrates produced at Broken Hill and copper, lead, zinc and gold concentrates milled at Captain's Flat.

(ii) *Victoria.* At Chewton, near Castlemaine, one mine produced more than half of the State's production. In addition, four gold mines located in the north-east of the State each produced more than 1,000 fine oz.

(iii) *Queensland.* The copper concentrate produced at Mount Morgan contained more than three-quarters of the State's output of gold, nearly all the remaining production coming from a mine at Cracow.

(iv) *South Australia.* The only gold produced was won by prospectors.

(v) *Western Australia.* More than half of the total production came from the Coolgardie goldfields, while most of the remaining production came from the Dundas, Murchison and Yilgarn goldfields. A single mine at Fimiston maintained its position as the largest gold producer in Australia, mining 174,219 fine oz. during 1960, and three other mines each produced over 100,000 fine oz. in the same period.

(vi) *Tasmania.* Lead-copper, lead and zinc concentrates milled at Rosebery contained more than two-thirds of the gold produced in Tasmania during 1960, nearly all of the remaining production being contained in copper concentrate produced at Mount Lyell.

(vii) *Northern Territory.* Gold production in the Northern Territory is centred around Tennant Creek.

The following table shows the recorded mine production of gold (i.e., gold content of minerals produced) in the several States and in Australia as a whole during each of the ten decennial periods from 1851 to 1950, and in single years from 1951 to 1960. Owing to defective information in the earlier years, it is likely that the recorded production falls considerably short of the actual totals.

GOLD : MINE PRODUCTION.(a)

('000 fine oz.)

Period.	N.S.W.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	N.T.	Aust.
1851–60	2,714	21,973	3	..	..	1	..	24,691
1861–70	3,220	15,327	489	..	..	3	..	19,039
1871–80	2,019	9,564	2,527	136	..	165	19	14,430
1881–90	1,014	6,689	3,259	58	42	357	168	11,587
1891–1900	2,432	7,040	5,648	52	5,252	550	214	21,188
1901–10	2,253	7,095	5,512	73	17,784	604	111	33,432
1911–20	1,145	3,067	2,263	55	10,671	202	23	17,426
1921–30	204	593	434	10	4,557	43	2	5,843
1931–40	569	1,052	1,021	53	8,474	130	84	11,383
1941–50	572	800	750	13	6,683	157	148	9,123
1951	49	66	79	(b)	648	15	39	896
1952	39	68	85	(b)	727	16	45	980
1953	26	64	92	(b)	823	17	53	1,075
1954	32	53	98	(b)	862	19	54	1,118
1955	30	38	64	(b)	835	17	65	1,049
1956	29	39	56	(b)	814	17	75	1,030
1957	31	46	63	(b)	850	20	74	1,084
1958	19	41	75	(b)	875	22	72	1,104
1959	13	35	92	(b)	861	21	63	1,085
1960	14	29	78	(b)	870	24	72	1,087
Total, 1851-1960 ..	**16,424**	**73,679**	**22,688**	**450**	**61,628**	**2,400**	**1,381**	**178,650**

(a) Gold content of minerals produced. (b) Less than 500 fine oz.

4. Refinery Production.—Amalgam and gold slimes from cyanide extraction are treated at the mines to produce gold bullion, which at some mines may be partly refined before dispatch to the Royal Mints, located in Melbourne and Perth. By-product gold from lead smelting is refined at Port Pirie in South Australia, while the gold contained in copper refinery sludges, resulting from electrolytic copper refining at Mount Lyell and Port Kembla, is recovered at Port Kembla. Gold bullion and other gold-bearing materials are also refined in Sydney.

Details of the refinery production of gold in Australia and the value of refined newly-won gold of Australian origin are shown in the following table for each of the years 1957 to 1961. The value of the refined newly-won gold is based on the price fixed by the Reserve Bank, but allowance is made for premiums on sales of gold overseas and for industrial purposes in Australia.

PRODUCTION OF REFINED GOLD IN AUSTRALIA.

Particulars.	1957.	1958.	1959.	1960.	1961.
QUANTITY (FINE OZ.).					
Australian Origin—					
Newly-won Gold.. ..	1,078,419	1,069,774	1,067,129	1,045,139	1,036,947
From Scrap	21,480	17,350	20,617	22,699	22,593
Oversea Origin—					
Newly-won Gold.. ..	171,970	136,998	141,624	142,526	155,598
From Scrap	1,248	888	1,075	1,164	1,277
Total	**1,273,117**	**1,225,010**	**1,230,445**	**1,211,528**	**1,216,415**
VALUE (£'000).					
Newly-won Gold of Australian Origin	**16,872**	**16,720**	**16,677**	**16,396**	**16,241**

5. Changes in Stocks of Gold held in Australia.—The following table shows particulars of production, imports and exports of gold and changes in stocks of gold held in Australia for each of the years 1956 to 1960.

CHANGES IN STOCKS OF GOLD HELD IN AUSTRALIA.

(Fine oz.)

Particulars.	1956.	1957.	1958.	1959.	1960.
Mine Production of Gold(*a*) ..	1,029,821	1,083,941	1,103,980	1,085,104	1,086,709
Imports of Gold(*b*)(*c*) ..	201,883	159,998	160,232	136,674	144,033
Total	*1,231,704*	*1,243,939*	*1,264,212*	*1,221,778*	*1,230,742*
Exports of Gold(*b*).. ..	531,010	783,814	128,550	128,052	2,513,906
Gold Content of Ores and Concentrates Exported ..	18,177	19,561	22,453	17,941	25,803
Net Industrial Consumption of Gold	33,778	33,028	29,135	33,938	40,972
Total	*582,965*	*836,403*	*180,138*	*179,931*	*2,580,681*
Changes in Stocks of Gold held in Australia(*d*)	+ 648,739	+ 407,536	+1,084,074	+1,041,847	−1,349,939

(*a*) Gold content of minerals produced in Australia. (*b*) Includes gold contained in matte. Excludes specie, leaf and foil and gold in unrefined forms other than the gold content of unrefined gold and silver bullion. (*c*) Excludes gold imported in some minor minerals. (*d*) Includes gold content of change in stocks of mineral products awaiting refining. The sign near the figure indicates increase (+) or decrease (−) in stocks during the period shown.

6. Production in Principal Countries.—The quantities of gold produced in the principal producing countries and the estimated world total production in each of the years 1956 to 1960, according to data published by the Mineral Resources Division of the United Kingdom Overseas Geological Surveys, are shown in the table hereunder.

GOLD: PRODUCTION IN PRINCIPAL COUNTRIES.

('000 fine oz.)

Country.	1956.	1957.	1958.	1959.	1960.
South Africa	15,897	17,031	17,656	20,066	21,383
Canada	4,384	4,434	4,571	4,483	4,603
United States of America ..	1,827	1,794	1,739	1,603	1,667
Australia	**1,030**	**1,084**	**1,104**	**1,085**	**1,087**
Ghana	638	790	853	913	879
Rhodesia and Nyasaland ..	540	540	559	572	568
Colombia	438	325	372	398	434
Philippines	406	380	423	403	411
Mexico	350	346	332	314	300
Japan	241	253	261	262	260
Congo	381	381	362	354	252
Estimated World Total(a) ..	*27,800*	*29,000*	*29,900*	*32,000*	*33,400*

(*a*) Excludes U.S.S.R. The United States Bureau of Mines has estimated U.S.S.R. production at 9–10 million fine oz. per annum in recent years.

7. **Prices of Gold.**—Under existing legislation, all gold produced in Australia is sold to the Reserve Bank. The official price of gold is fixed by the Reserve Bank. On 1st May, 1954, it was raised from £15 9s. 10d. to £15 12s. 6d. per fine oz. and has remained unchanged since that date. The current price reflects the " parity " value of Australian currency established by the International Monetary Agreement Act 1947. Prior to 1947, the price of gold was based on the price for which it could be sold abroad in official markets, less cost of movement.

Average prices of gold per fine oz. at mints in Australia and on the London gold market, for the years 1957 to 1961, are shown in the following table.

PRICES OF GOLD: AUSTRALIA AND LONDON.

(per fine oz.)

Place of Sale.	1957.	1958.	1959.	1960.	1961.
At Mints in Australia £A. *s. d.*	15 12 6	15 12 6	15 12 6	15 12 6	15 12 6
London .. £stg. *s. d.*	12 10 3	12 9 9	12 9 10	12 11 2	12 11 0

8. **Sales of Gold on Oversea Premium Markets.**—In November, 1951, the Commonwealth Government decided to allow Australian gold producers to benefit from the higher prices then being paid for gold on some oversea markets. To implement this decision, the Gold Producers' Association Limited was incorporated in December, 1951, and the first sales were made in that month. By arrangement with the Reserve Bank of Australia, the total quantity of newly-won gold delivered to the Bank by members of the Association in any calendar month, less the quantity required for industrial purposes in Australia, is available to the Association for sale on oversea premium markets during the ensuing two calendar months. The net proceeds from premium sales are distributed to members in proportion to their production of gold. The actual volume of sales on oversea premium markets has been dependent largely on the premium over the Australian fixed price.

The following table shows the quantity and value of gold sold on oversea premium markets and the average price realized for these sales during the years 1957 to 1961. It should be noted that this series is in no way indicative of the average return to gold producers for all gold produced.

GOLD SOLD ON OVERSEA PREMIUM MARKETS.

Particulars.	Unit.	1957.	1958.	1959.	1960.	1961.
Quantity ..	fine oz.	687,114	1[illegible]	37,346	383,970	701,392
Value	£A. f.o.b.	10,760,214	2,964,6[illegible]	584,129	6,056,003	11,008,009
Average Price ..	£A. *s. d.*	15 13 2	15 12 10	[illegible] 10	15 15 5	15 13 11

9. **Assistance to the Gold-Mining Industry.**—(i) *Gold Subsidy.* Towards the end of 1953, the price of gold on oversea premium markets fell sharply and conditions in the gold-mining industry became acute. Many producers were faced with the likelihood of closing down. To meet this situation, the Gold-Mining Industry Assistance Act was assented to on 18th November, 1954. The purpose of this Act was to assist the gold-mining industry in Australia and the Territories of Papua and New Guinea by the payment of a subsidy, subject to certain conditions, on the production and sales of gold. To be eligible for the subsidy, the value of a producer's output of gold must exceed 50 per cent. of the total value of his mine output. The subsidies paid under the original Act were increased under amendments enacted on 22nd October, 1957, and 22nd May, 1959. Under the Act as it now stands, the subsidy payable to small producers whose annual output does not exceed 500 fine oz. is £2 8s. 0d. per fine oz., irrespective of cost of production. For large producers, subject to certain provisions, subsidy is paid at the rate of three quarters of the excess of the average cost of production over £13 10s. 0d. per fine oz. with a maximum amount of subsidy of £3 5s. 0d. per fine oz. A producer whose output during the year exceeds 500 fine oz. may elect to be treated as a small producer. In this case the amount of subsidy allowable is reduced by one penny for each fine oz. in excess of 500 fine oz. produced. Where a producer receives an amount in excess of the official price of £15 12s. 6d. per fine oz. as a result of sales on oversea premium markets or otherwise, the subsidy payable is reduced

by the amount of the excess. The subsidy is also limited to the extent that the annual net profit of a producer shall not, with the addition of the subsidy, exceed 10 per cent. of the capital investment in the company. The maximum expenditure on development allowable in determining costs is £5 5s. 0d. per fine oz. A further condition of the Act is that the recovery rate of the mine shall not fall below nine-tenths of that for the year previous to the commencement of the Act. Payments under the Act are to continue until 30th June, 1965.

Payments under the Act commenced in March, 1955, and the amounts paid to gold producers in the various States and Territories of Australia in each of the years 1957 to 1961 are shown in the following table.

NET SUBSIDY PAYMENTS TO GOLD PRODUCERS.
(£.)

Year.	New South Wales.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	Nor. Terr.	Papua and New Guinea.	Total.
1957	34	56,044	620	..	512,708	..	8,345	10,761	588,512
1958	26,951	38,380	3,958	..	623,394	..	16,360	44,485	753,528
1959	107	41,500	2,937	55	652,266	..	39,181	52,449	788,495
1960	14	45,881	881	35	698,242	..	4,253	65,292	814,598
1961	145	63,036	1,325	..	585,306	..	4,930	44,758	699,500

(ii) *Income Taxation Exemption.* Income from gold mining is exempt from taxation in the hands of the producer. If the producer is a company, such income is exempt from taxation in the hands of the shareholders when paid as dividends.

10. **Employment in Gold Mining.**—Particulars of the numbers of persons employed in gold mining are shown in paras. 4 (ii) and (iii), pages 1051–2.

§ 5. Lead, Silver and Zinc.

1. **Historical.**—Prior to the discovery of the great Broken Hill lead-silver-zinc lode in 1883 by Charles Rasp, a boundary rider, the mining of lead-silver-zinc ores at other localities in New South Wales had been intermittent and only small quantities were produced. The Broken Hill lode has proved to be one of the biggest in the world and to date over 80 million tons of ore have been raised. The Broken Hill Proprietary Co. Ltd., now engaged in steel manufacture, was the company first formed to operate at Broken Hill and continued operations there until 1939 when the ore in its leases became exhausted. The first ores mined at Broken Hill were oxidized and required only simple smelting to produce a lead-silver bullion. No initial attempt was made to recover zinc and it was not until 1897 that the first commercial zinc concentrate was produced. The exhaustion of the oxidized ore early this century led to the mining of the deeper sulphide ores. The need to produce separate lead and zinc concentrates for smelting purposes, with economic metal recoveries, resulted in the perfection at Broken Hill of the differential ore flotation process. The preparation of sulphide concentrates by flotation methods is now used throughout the world. Mining operations at Broken Hill are now mainly carried on to the north and south of the original leases. In 1939, Lake George Mines Ltd. at Captain's Flat, near Canberra, commenced large-scale mining of a lead-zinc-copper ore body which had been first worked in 1882. The Captain's Flat mine ceased operations during 1962 because of the exhaustion of ore reserves.

Lead-silver-zinc ores have been mined in Queensland since 1870, but it was not until 1923 that the largest ore-body, at Mount Isa, was discovered by John Miles. Mount Isa Mines Ltd. commenced mining operations at this centre in 1931. Mount Isa is now the second largest centre in Australia producing lead-silver-zinc ores and the largest producer of copper. During the 1939–45 War, mining of lead-silver-zinc ores at Mount Isa was suspended in favour of copper production.

Lead-silver ores were first discovered in Western Australia in the Northampton District in 1848 and most of the subsequent production in that State has been from that District.

The first recorded production of lead in Tasmania was in 1888, and of zinc, in 1919. Production has been restricted to the West Coast.

2. **Present Methods of Mining and Treatment.**—Nearly all ores now mined are composed of deep-lying sulphide minerals and it is therefore necessary to mine these ores by underground methods. At all large mines, it is the practice to produce separate lead and zinc concentrates

with the lead concentrate containing most of the silver. These concentrates are prepared by differential flotation except in cases where a satisfactory concentrate can be obtained by gravity methods. In flotation plants, the ore is finely ground and by differential flotation a lead concentrate is first produced, with the zinc concentrate subsequently separated from the tailings. At Captain's Flat, differential flotation methods were used to produce successive concentrates of copper, lead, zinc and pyrite.

Particulars of representative Broken Hill lead and zinc concentrates are shown in para. 4 page 1047.

3. **Mine Production.**—The following table shows for 1960 the mine production (metal content of ores and concentrates produced) of lead, silver and zinc in Australia, and the respective minerals in which these metals were contained.

LEAD, SILVER AND ZINC: CONTENT OF ORES AND CONCENTRATES PRODUCED, 1960.

Mineral in which contained.	N.S.W.	Vic.	Q'land.	S.A.	W.Aust.	Tas.	N.T.	Aust.
LEAD (tons).								
Lead Ore(*a*)	44	..	1,256	..	..	..	..	1,300
Lead Concentrate	231,658	..	55,411	..	1,739	9,060	..	297,868
Lead-Copper Concentrate	..	..	..	..	..	2,204	..	2,204
Zinc Concentrate	4,166	..	851	..	..	1,774	..	6,791
Total Lead	**235,868**	..	**57,518**	..	**1,739**	**13,038**	..	**308,163**
SILVER (fine oz.).								
Copper Ore	7	..	11	..	..	..	..	18
Copper Concentrate	58,760	..	501,512	..	4,983	47,092	84,785	697,132
Gold Concentrate, etc.	271	576	15,904	..	190,386	..	18	207,155
Lead Ore(*a*)	6,527	..	46,337	..	..	..	..	52,864
Lead Concentrate	8,002,023	..	4,409,933	..	1,387	447,959	..	12,861,302
Lead-Copper Concentrate	..	..	..	..	..	716,940	..	716,940
Silver Ore	..	..	16,919	..	..	..	..	16,919
Zinc Concentrate	330,301	..	131,084	..	..	186,433	..	647,818
Total Silver	**8,397,889**	**576**	**5,121,700**	..	**196,756**	**1,398,424**	**84,803**	**15,200,148**
ZINC (tons).								
Zinc Ore	..	..	..	(*b*) 35	..	..	..	(*b*) 35
Zinc Concentrate	234,170	..	24,394	..	..	31,625	..	290,189
Total Zinc	**234,170**	..	**24,394**	(*b*) 35	..	**31,625**	..	**290,224**

(*a*) Includes lead-silver ore. (*b*) Estimated.

The principal sources of production of lead, silver and zinc during 1960 were as follows.

(i) *New South Wales.* Lead and zinc concentrates, produced only at Broken Hill and Captain's Flat, contained nearly all the New South Wales production of lead and silver and all the zinc. The five Broken Hill mines now operating, are:—Zinc Corporation Ltd., New Broken Hill Consolidated Ltd., North Broken Hill Ltd., Broken Hill South Ltd., and Barrier Central Pty. Ltd. These mines, during 1960, produced (in terms of the contents of all ores and concentrates produced) more than three-quarters of Australia's lead and zinc and more than one half of the silver.

(ii) *Victoria.* All the silver produced was obtained from gold mining operations. No zinc-bearing minerals are mined in Victoria and lead was last mined in 1957.

(iii) *Queensland.* Mount Isa produced all the zinc concentrate and nearly all the lead concentrate in Queensland during 1960. These contained most of the State's production

of lead and silver and all the zinc. Nearly all the remaining silver was contained in copper concentrate produced at Mount Morgan.

(iv) *South Australia.* A small quantity of zinc ore for fertilizer was mined during 1960; there was no mine production of lead or silver during the year.

(v) *Western Australia.* Most of the silver produced in Western Australia was obtained from gold bullion produced by the gold-mining industry. All the lead produced was contained in lead concentrate. No zinc was produced during 1960.

(vi) *Tasmania.* All the lead, silver and zinc was produced from mines on the West Coast. All the zinc and most of the lead and silver were produced from mines at Rosebery and Mount Read and milled at Rosebery to produce separate lead, zinc, and lead-copper concentrates.

(vii) *Northern Territory.* All the silver was contained in copper concentrates produced from Tennant Creek and Rum Jungle. No ores containing lead or zinc were mined.

The table hereunder shows the quantities of lead, silver and zinc contained in minerals won in the several States and the Northern Territory during the years 1956 to 1960.

LEAD, SILVER AND ZINC: CONTENT OF ORES AND CONCENTRATES PRODUCED.

State or Territory.	1956.	1957.	1958.	1959.	1960.
LEAD (tons).					
New South Wales	238,319	266,928	246,896	246,449	235,868
Victoria	..	4	..	..	..
Queensland	43,104	51,269	65,799	54,415	57,518
South Australia	17	20	13	8	..
Western Australia	5,828	3,087	1,854	1,382	1,739
Tasmania	12,217	12,445	13,785	14,039	13,038
Australia	**299,485**	**333,753**	**328,347**	**316,293**	**308,163**
SILVER (fine oz.).					
New South Wales	9,289,583	9,969,102	8,992,293	8,555,203	8,397,889
Victoria	2,255	3,157	3,018	2,016	576
Queensland	3,731,477	4,305,886	5,710,031	4,953,209	5,121,700
South Australia	653	975	613	394	..
Western Australia	192,589	187,530	189,375	179,601	196,756
Tasmania	1,372,881	1,299,062	1,394,818	1,369,070	1,398,424
Northern Territory	27,365	45,417	49,664	101,138	84,803
Australia	**14,616,803**	**15,811,129**	**16,339,812**	**15,160,631**	**15,200,148**
ZINC (tons).					
New South Wales	229,126	241,509	211,667	202,675	234,170
Queensland	16,231	19,536	17,484	13,983	24,394
South Australia(*a*)	7	97	113	..	35
Western Australia	..	..	20	..	..
Tasmania	32,718	30,440	33,760	32,475	31,625
Australia	**278,082**	**291,582**	**263,044**	**249,133**	**290,224**

(*a*) Estimated.

4. Smelter and Refinery Production.—(i) *Lead Concentrate.* Lead concentrate produced at Broken Hill is railed to Port Pirie, in South Australia, for smelting and refining. Lead-silver bullion is produced from initial smelting, and lead, silver and gold are then refined. Cadmium is obtained from smelter fumes and refined to produce rods of metal. The sulphur dioxide gas formed during pre-smelter sintering operations is used to manufacture sulphuric acid. The antimony contained in the concentrate is alloyed with lead to form marketable antimonial lead while the copper is processed to the matte and speiss stage and sent to copper refineries for copper extraction. Because of the continued low price of lead, production in 1960 of refined metal at Port Pirie was below capacity. Some of the Broken Hill concentrate not treated at Port Pirie was exported.

Lead ore and concentrate produced at Mount Isa is smelted at the mine to derive a lead bullion which is rich in silver. All this bullion is exported to the United Kingdom for refining. A lead-copper dross is produced as a by-product of lead smelting and this is also exported.

Lead and lead-copper concentrates produced in Tasmania, and lead concentrates produced in Western Australia and at Captain's Flat in New South Wales, are exported.

(ii) *Zinc Concentrate.* More than half of the zinc concentrate produced at Broken Hill is exported, and the remainder is shipped from Port Pirie to Risdon, near Hobart, for refining. At Risdon, the Broken Hill concentrate, together with all zinc concentrate produced in Tasmania, is roasted to form zinc oxide, or calcine. Sulphur dioxide formed during this roasting process is used for the manufacture of sulphuric acid. The calcine is leached with a weak solution of sulphuric acid to form a zinc sulphate solution which, after purification, is electrolysed. Zinc of high purity is deposited on the cathodes and this zinc is melted and cast into ingots. Cadmium metal and cobalt oxide are also recovered. Lead-silver residues are recovered and forwarded to Port Pirie for smelting with lead concentrates. Copper residues are sent to Port Kembla for treatment.

Prior to 1960, zinc concentrates produced at Mount Isa and Captain's Flat were exported. Part of the 1960 production by Mount Isa and all the 1961 production at Captain's Flat were shipped to Risdon, Tasmania, for refining.

In the following table, details are given of the production and sales of refined primary lead, silver and zinc as recorded from data received from the Bureau of Mineral Resources and the Australian Mines and Metals Association. The figures shown for refined silver production include small quantities recovered from imported materials.

REFINED LEAD, SILVER AND ZINC : PRODUCTION AND SALES, AUSTRALIA.

Particulars.	1956.	1957.	1958.	1959.	1960.
LEAD (tons).					
Refined Lead—					
Production(*a*)	194,506	192,161	191,474	185,805	189,823
Sold to Australian consumers(*b*) ..	38,616	37,291	39,928	33,563	32,985
Sold for export(*b*)	151,628	152,432	158,075	133,340	132,957
Silver-Lead Bullion—					
Produced for export (lead content)(*a*) ..	41,658	46,891	57,171	50,310	52,723
SILVER ('000 fine oz.).					
Production(*a*)	8,232	8,011	9,101	7,805	8,085
Sold to Australian consumers(*b*)	1,893	4,410	4,184	4,775	5,284
Sold for export(*b*)	6,214	3,397	5,074	2,722	2,740
ZINC (tons).					
Production(*a*)	104,993	110,348	114,773	116,461	120,230
Sold to Australian consumers(*b*) ..	69,760	78,874	72,844	78,753	90,240
Sold for export(*b*)	32,718	37,316	37,989	40,950	29,335

(*a*) Source: Bureau of Mineral Resources. (*b*) Source: Australian Mines and Metals Association.

5. **Production in Principal Countries.**—The following table shows, for the years 1956 to 1960, particulars of lead, silver and zinc production (mine basis) in principal producing countries, together with the estimated world total, according to data published by the Mineral Resources Division of the United Kingdom Overseas Geological Surveys.

LEAD, SILVER AND ZINC: MINE PRODUCTION IN PRINCIPAL COUNTRIES.

Country.	1956.	1957.	1958.	1959.	1960.
LEAD ('000 tons).					
U.S.S.R.(*a*)(*b*)	260	280	300	320	340
Australia	299	334	328	316	308
United States of America	315	302	239	228	220
Mexico	196	211	199	188	188
Canada	169	162	167	167	169
Peru	127	135	132	113	127
Estimated World Total	*2,200*	*2,300*	*2,300*	*2,300*	*2,400*
SILVER ('000 fine oz.).					
Mexico	43,078	47,150	47,592	44,075	44,526
Canada	28,432	28,823	31,163	31,924	32,328
United States of America	38,948	38,165	34,111	31,194	30,766
Peru	22,973	24,845	25,918	27,225	30,309
U.S.S.R.(*a*)	25,000	25,000	25,000	25,000	25,000
Australia	14,617	15,811	16,340	15,161	15,200
Japan	6,167	6,544	6,552	6,651	6,910
Bolivia	7,543	5,375	6,051	4,504	4,887
Germany, Eastern(*a*)	4,500	4,500	4,500	4,500	4,500
Congo	3,794	3,045	3,794	4,758	3,990
Estimated World Total	*201,000*	*205,000*	*210,000*	*204,000*	*207,000*
ZINC ('000 tons).					
United States of America	484	475	368	380	389
Canada	377	369	380	354	362
U.S.S.R.(*a*)(*b*)	270	300	325	330	340
Australia	278	292	263	249	290
Mexico	245	237	221	260	267
Japan	121	134	141	140	154
Poland	149	129	121	127	142
Peru	172	152	133	141	133
Estimated World Total	*3,100*	*3,100*	*3,000*	*3,000*	*3,100*

(*a*) Estimated. (*b*) Smelter production.

6. **Prices of Lead, Silver and Zinc.**—The following table shows average prices of lead, silver and zinc in Australia and on the London Metal Exchange during the years 1957 to 1961.

PRICES OF LEAD, SILVER AND ZINC.

Particulars.		1957.	1958.	1959.	1960.	1961.
Australian Prices, in Australian currency—						
Lead, per ton(*a*) ..	£	117	87	100	100	99
Silver, per fine oz.(*b*)	*s. d.*	8 3	8 0	8 2	8 3	8 4
Zinc, per ton(*c*) ..	£	104	91	105	113	102
London Metal Exchange Prices, in sterling—						
Lead, per ton ..	£	97	73	72	72	65
Silver, per fine oz.	*s. d.*	6 7	6 4	6 7	6 7	6 8
Zinc, per ton ..	£	82	65	80	88	78

(*a*) Average market price was used prior to 23rd December, 1958. On that date, the minimum price was fixed at £100 per ton. This was reduced to £95 per ton on 14th November, 1961. (*b*) Silver prices shown represent export parity calculated from London Metal Exchange prices. (*c*) Average market price was used prior to 1st January, 1958, and subsequent to 30th June, 1959. On 1st January, 1958, a minimum price was fixed at £90 and this minimum was raised to £100 on 22nd December, 1958. The minimum price was abolished on 1st July, 1959.

7. **Employment in Lead, Silver and Zinc Mining.**—Particulars of the number of persons employed in mining for these metals are shown in paras. 4 (ii) and (iii), pages 1051–2.

§ 6. Copper.

1. **Historical.**—Copper was first discovered in Australia in 1842, at Kapunda in South Australia and in the Northampton district of Western Australia. The subsequent large-scale mining of the South Australian deposits contributed significantly to that State's development, but now only very small quantities are mined in South Australia.

The mining of copper commenced in New South Wales in 1847, near Rockley. Copper was first recognized in the Cobar district in 1869, and large-scale mining continued at Cobar until 1952. Other fields were opened at Mount Hope in 1878, Nymagee in 1880 and Captain's Flat in 1882, but none of these is now producing, the last centre to close down being Captain's Flat which ceased operations in 1962.

The first important discovery of copper in Queensland was made in 1862, when a rich lode was found near Clermont. Copper was discovered in the Herberton mineral field in 1879 and at Mount Morgan in 1882. The copper ore body at Mount Isa was not recognized as an outcrop when the lead-zinc ore body was discovered in 1923, and was discovered as a result of underground development.

Copper mining was first undertaken at Mount Isa during the 1939–45 War, but it was not until the erection of a copper smelter at that centre that large-scale production commenced. The Mount Isa mine is today Australia's largest producer of copper.

In Tasmania, the Mount Lyell deposit was discovered in 1886.

2. **Present Methods of Mining and Treatment.**—Most of the large copper ore bodies contain the mineral chalcopyrite, an iron-copper sulphide. Copper ore is mined by open-cut methods at Mount Morgan and Mount Lyell and by underground methods at Mount Isa and Ravensthorpe (Western Australia). Oxidized copper ore is mined at Mount Isa and at numerous other localities, mainly in Western Australia.

It is the practice for the sulphide ore to be finely ground and for the chalcopyrite contained in it to be recovered by flotation. At Mount Lyell and Mount Morgan, the tailings from the copper flotation are subjected to a further flotation and a pyrite concentrate is produced. The oxidized ore mined at Mount Isa is not concentrated and is fed direct to the smelters.

3. **Mine Production.**—The following table shows for 1960 the copper content of all minerals produced in the several States and the Northern Territory.

COPPER: CONTENT OF ORES AND CONCENTRATES PRODUCED, 1960.
(Tons.)

Mineral in which Contained.	N.S.W.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	N.T.	Aust.
Copper Ore, Concentrate, etc.	898	..	82,163	5	1,656	10,798	9,764	105,284
Gold Concentrate	..	..	..	..	5	..	..	5
Lead Concentrate	2,134	..	590	..	..	86	..	2,810
Lead-Copper Concentrate	..	..	..	..	..	598	..	598
Zinc Concentrate	540	..	..	..	..	198	..	738
Total	3,572	..	82,753	5	1,661	11,680	9,764	109,435

The following were the principal sources of copper during 1960.

(i) *New South Wales.* Most of the copper produced in this State was contained in lead concentrate milled at Broken Hill. At Captain's Flat, nearly all the copper was contained in copper concentrate. During 1960, the search for ore along the Cobar line of lode and in the surrounding districts was actively continued. The prospecting methods employed included geological mapping, geophysical work, geochemistry and diamond drilling. Deep diamond drilling was carried out and the de-watering of underground workings commenced. Prospecting work consisted largely of "follow-up" work on magnetic anomalies by geological investigations and by ground geophysical methods.

(ii) *Victoria.* There was no copper ore mined in Victoria during 1960.

(iii) *Queensland.* Mount Isa was the most important copper producing centre in Australia, its 1960 output being 66 per cent. of the Australian total. The copper produced at Mount Isa is contained in copper sulphide concentrate, oxidized copper ore and lead concentrate. Copper concentrate produced at Mount Morgan contained most of the remainder.

(iv) *South Australia.* Only a small quantity of copper ore for fertilizer was produced during 1960.

(v) *Western Australia.* More than one half of the copper mined was contained in copper concentrate produced at Ravensthorpe. The remainder was contained in copper ore won at various localities in the State for fertilizer manufacture.

(vi) *Tasmania.* Most of the State's production was at Mount Lyell, where copper was contained in copper concentrate, ore and precipitate. Lead-copper concentrate, lead concentrate and zinc concentrate milled at Rosebery made up the remainder of Tasmania's production.

(vii) *Northern Territory.* Copper concentrate from Tennant Creek contained most of the Territory's output of copper. The remainder was contained in copper concentrate and precipitate produced at Rum Jungle.

The table hereunder shows the quantities of copper contained in minerals produced in the several States and the Northern Territory during the years 1956 to 1960.

COPPER: CONTENT OF ORES AND CONCENTRATES PRODUCED.
(Tons.)

State or Territory.	1956.	1957.	1958.	1959.	1960.
New South Wales	4,289	4,382	4,023	3,728	3,572
Victoria	..	..	..	14	..
Queensland	35,708	35,786	50,511	66,798	82,753
South Australia	1	2	1	16	5
Western Australia	740	788	1,107	2,197	1,661
Tasmania	8,807	10,984	11,413	12,244	11,680
Northern Territory	5,002	7,313	8,660	9,953	9,764
Australia	54,547	59,255	75,715	94,950	109,435

4. **Smelter and Refinery Production of Copper.**—Most of the copper concentrate milled in Australia is smelted locally, blister copper being produced at Mount Isa, Mount Morgan, Mount Lyell and Port Kembla.

Blister copper smelted at Mount Isa is railed to Townsville for electrolytic refining at the refinery which commenced production there in 1959. Mount Lyell blister copper is electrolytically refined at Mount Lyell and the bulk is re-melted and cast into primary shapes at Port Kembla. Mount Morgan blister copper is shipped to Port Kembla, where together with blister produced at Port Kembla, it is refined. Most Port Kembla copper is electrolytically refined, although fire refining, which is a cheaper process and undertaken when there are no other metals to be recovered, is used to a lesser extent. Copper from some copper drosses and speisses, by-products of lead refining operations at Port Pirie, is also extracted at Port Kembla.

At Port Kembla, gold and silver contained in electrolytic refining tank house slimes from Mount Lyell, Townsville, and Port Kembla are recovered.

In the following table, details are given of the production of blister copper, and the production and sales of refined copper for the years 1956 to 1960.

METALLIC COPPER: PRODUCTION AND SALES, AUSTRALIA.

(Tons.)

Particulars.	1956.	1957.	1958.	1959.	1960.
Blister Copper—					
Production(*a*)(*b*) ..	49,030	50,403	64,608	68,494	71,037
Refined Copper(*c*)—					
Production(*a*)	29,307	32,880	43,276	51,593	70,652
Sold to Australian Consumers(*d*)	29,038	34,114	43,035	43,072	70,481
Sold for Export(*d*) ..	650	..	..	..	..

(*a*) Source: Bureau of Mineral Resources. (*b*) Production for refining in Australia or overseas.
(*c*) Refined from domestic primary copper. (*d*) Source: Australian Mines and Metals Association.

5. **Production in Principal Countries.**—The following table shows the mine production of copper for the years 1956 to 1960 in the principal producing countries, as published by the Minerals Resources Division of the United Kingdom Overseas Geological Surveys, and their estimate of total world production in those years.

COPPER: MINE PRODUCTION IN PRINCIPAL COUNTRIES.

('000 tons.)

Country.	1956.	1957.	1958.	1959.	1960.
United States of America ..	986	970	874	736	964
Rhodesia and Nyasaland ..	399	432	401	545	581
Chile	482	478	460	538	524
U.S.S.R.(*a*)	400	400	430	430	450
Canada	317	321	308	353	391
Congo(*b*)	246	238	234	278	296
Peru	46	56	53	47	180
Australia	**55**	**59**	**76**	**95**	**109**
Japan	77	80	80	84	88
Mexico	54	60	64	56	59
South Africa	46	46	49	50	45
Philippines	27	40	46	49	43
Estimated World Total ..	*3,400*	*3,500*	*3,400*	*3,600*	*4,100*

(*a*) Estimated. (*b*) Smelter production.

6. Prices.—Details of the average market price for the years 1957 to 1961 are given in terms of Australian currency and sterling in the following table.

AVERAGE PRICE OF ELECTROLYTIC COPPER IN AUSTRALIA AND THE UNITED KINGDOM.

(£ per ton.)

Country.	1957.	1958.	1959.	1960.	1961.
Australia — in Australian currency(a)	341	284	312	324	307
United Kingdom—in sterling	220	193	235	239	228

(a) *Ex* works Port Kembla.

7. Employment in Copper Mining.—Particulars of the numbers of persons engaged in the mining of copper and copper-gold ores are shown in paras. 4 (ii) and (iii), pages 1051–2.

8. Assistance to the Copper-mining Industry.—(i) *Copper Bounty.* The Copper Bounty Act was enacted in 1958, following a Tariff Board inquiry and recommendation, to provide assistance to the industry partly by duty and partly by bounty. The provisions of the Act were reviewed in 1960, and it will continue in its present form until 31st December, 1963. The bounty is payable on copper sold on the Australian market, and provides in effect payment at the rate of £1 for each £1 by which the Australian price falls short of £340, with a maximum of £35 a ton, or, in the case of producers of 50 tons per annum or more, such lesser bounty as will give a return of 10 per cent. on assessed capital employed in the production of copper. The bounty reduced the net effective price of copper to Australian consumers from £340 to £305. A duty is imposed on imported copper when the Australian equivalent of the London Metal Exchange price falls below £290 (£Stg.232), increasing by £1 for each £1 that the Australian equivalent falls below £290. Including freight and other charges, the landed cost is thus expected to be maintained at about £305 so long as the Australian equivalent of the London Metal Exchange price is not in excess of £290.

(ii) *Income Taxation Concession.* One-fifth of the net income from copper mining is exempt from taxation in the hands of the producer. If the producer is a company, this concession also applies to such income when paid to the shareholders as dividends.

§ 7. Tin.

1. Historical.—Although specimens of tin had been found in New South Wales as early as 1851, it was not until tin stone was discovered near Inverell in 1872 that mining operations commenced. The New England area is still the most important producing area in New South Wales.

The first notable discovery of tin in Queensland occurred in 1872, when rich deposits of stream tin were found in the country to the south of Warwick, but these alluvial deposits soon became exhausted. In 1879, important discoveries were made in the Herbert River district and rich fields, including that at Herberton, were opened up.

Tin was first discovered in Western Australia in 1888, and since then has been found in several widely separated localities in the State. More than half of the production to date has come from the Greenbushes Mineral Field, and most of the remainder from the Pilbara goldfield.

Tin mining in Tasmania dates from the year 1871, when the Mount Bischoff mine was discovered. Soon afterwards, rich deposits were located in the north-east of the State and near St. Helens. In 1875, tin was discovered at Mount Heemskirk.

2. Present Methods of Mining and Treatment.—All tin produced in Australia is contained in tin concentrate, which is usually of the mineral cassiterite (tin oxide). The greater proportion of the production is obtained from alluvial workings as a gravity concentrate. In the lode deposits, tin is usually not associated with other recoverable minerals. However,

at two mines in Tasmania tin is associated with wolfram and sulphide minerals. At these mines, a gravity concentrate of tin, wolfram and sulphide minerals is obtained and from this the wolfram is separated by electromagnetic means. The tin and sulphide minerals are separated by flotation, the sulphides being floated off and the tin remaining as tailings.

3. **Mine Production.**—The following table sets out the tin content of tin concentrate produced in Australia during the years 1956 to 1960. No tin is recorded from minerals other than tin concentrate.

TIN: CONTENT OF TIN CONCENTRATES PRODUCED.

(Tons.)

State.	1956.	1957.	1958.	1959.	1960.
New South Wales	269	211	239	174	223
Victoria	..	(a)	..	..	..
Queensland	(b) 630	772	1,019	(b) 1,104	(b) 885
Western Australia	240	182	94	174	190
Tasmania	938	777	883	890	884
Northern Territory	1	10	2	9	20
Australia	**2,078**	**1,952**	**2,237**	**2,351**	**2,202**

(a) Less than half a ton. (b) Estimated.

The following were the principal sources of production in 1960.

(i) *New South Wales.* Virtually the whole of the State's production was from alluvial deposits. The New England region, mainly around Tingha, produced over 55 per cent. of the total production.

(ii) *Victoria.* No tin was produced in Victoria.

(iii) *Queensland.* Most of the tin concentrate produced in Queensland was from the Herberton field, principally alluvial tin concentrate being produced. Tin concentrate was also produced in the Chillagoe, Kangaroo Hills and Cooktown districts.

(iv) *South Australia.* No tin was produced in South Australia.

(v) *Western Australia.* Nearly all the tin concentrate produced in Western Australia was lode tin won from the Pilbara field.

(vi) *Tasmania.* Most of the tin concentrate produced in Tasmania is won in the north-east part of the State, from both lode and alluvial deposits. The largest amount of tin concentrate produced in Australia during 1960 came from a lode deposit in north-east Tasmania, and wolfram concentrate, as well as tin concentrate, was produced.

(vii) *Northern Territory.* Almost the whole of the Territory's output of tin came from a single mine at Mount Harris.

4. **Smelter and Refinery Production.**—Except for occasional small parcels of concentrate shipped to oversea smelters, all local production is treated by the two tin smelters located in Sydney. The combined capacity of the two smelters is well in excess of the domestic supply of concentrates and there seems little prospect of this capacity being fully utilized in the foreseeable future unless concentrates could be economically imported and smelted.

The production of refined tin in Australia from locally produced tin concentrate during recent years, as recorded by the Bureau of Mineral Resources, was as follows:—1957, 1,806 tons; 1958, 2,121 tons; 1959, 2,226 tons; 1960, 2,254 tons; and 1961, 2,599 tons.

5. **Production in Principal Countries.**—World production of tin reached its maximum in 1941 when 241,400 tons were recorded. Australia's contribution to the world's tin production is about 1 per cent.

The production of tin ore (metal content) as published by the Mineral Resources Division of the United Kingdom Overseas Geological Surveys, for the principal producing countries in 1959 and 1960, was as follows.

TIN : PRODUCTION IN PRINCIPAL COUNTRIES.

(Tons.)

Country.	Production.		Country.	Production.	
	1959.	1960.		1959.	1960.
Malaya, Federation of	37,521	51,979	Australia	2,351	2,202
China(*a*)(*b*) ..	21,000	24,000	Burma(*c*)	1,400	1,440
Indonesia	21,613	22,594	South Africa ..	1,272	1,276
Bolivia	23,811	19,404	United Kingdom ..	1,189	1,172
Thailand	9,684	12,080	Japan	998	842
Congo(*b*)	10,332	10,118	*Estimated World Total(d)* ..	*141,000*	*160,000*
Nigeria	5,491	7,677			

(*a*) Estimated smelter production. (*b*) Estimated by the International Tin Council. (*c*) Estimated. (*d*) Excludes U.S.S.R., Czechoslovakia and Vietnam.

6. **Prices.**—Details of the movement in average market prices of tin for the years 1957 to 1961 are given in terms of Australian currency and sterling in the following table.

AVERAGE PRICE OF TIN IN AUSTRALIA AND THE UNITED KINGDOM.

(£ per ton.)

Country.	1957.	1958.	1959.	1960.	1961.
Australia — in Australian currency	992	995	1,058	1,042	1,170
United Kingdom—in sterling	755	735	786	794	895

7. **Employment in Tin Mining.**—The number of persons employed in tin mining is shown in paras. 4 (*ii*) and (*iii*), pages 1051–2.

§ 8. Iron.

1. **Historical.**—Iron ore was first mined in New South Wales to supply raw material for the ironworks that were established near Mittagong in 1852. Iron ore for the ironworks established later at Lithgow was drawn from Carcoar, near Bathurst.

In South Australia, the iron ore deposits of the Middleback Ranges, near Whyalla, were first mined by the Broken Hill Proprietary Co. Ltd. in 1900 to provide a flux for lead smelting operations at Port Pirie. When that company opened its Newcastle steelworks in 1915, it greatly expanded ore production from the Middleback Ranges and most of the Australian steel industry's requirements of iron ore still come from this source.

Regular shipments of iron ore from Yampi Sound, north of Derby in Western Australia, to the steelworks at Port Kembla commenced in 1951. Iron ore for the iron smelter at Wundowie, which commenced operations in 1948, has in recent years been provided entirely from the deposits at Koolyanobbing, near Southern Cross. The Koolyanobbing deposits will be worked on a very much larger scale eventually and will supply the ore for an iron and steel industry to be established at Kwinana, south of Perth. A blast furnace is expected to be in operation in 1968.

In December, 1960, the Commonwealth Government announced a partial relaxation of the embargo on the export of iron ore which had been in force since 1938. Exports are now permitted from some deposits on a controlled basis.

Following this decision, tenders were called for the mining and export of iron ore from two known deposits in Western Australia, Tallering Creek and Mount Goldsworthy. The modification of the export embargo has greatly increased exploration for iron ore. Of particular importance was the announcement late in 1961 of the discovery of extensive deposits in the Pilbara district, in the north-west of Western Australia. An extensive testing programme is envisaged to determine the size and grade of these deposits.

Other deposits under examination include Constance Range (Queensland), Scott River (Western Australia) and Savage River (Tasmania).

Besides the large quantities of iron ore that are mined for metal extraction purposes, smaller quantities of iron oxide are mined for other purposes, such as gas purification, cement manufacture, coal washing and fluxing.

2. **Methods of Mining and Treatment.**—All iron ore and iron oxide is won by opencut mining. The ore is selectively mined, crushed and screened to provide a standard assay and size for blast furnace use. No concentration is carried out. The iron ore from Yampi Sound, however, is powdery and friable and has to be sintered, or agglomerated, before making up the furnace charge.

3. **Mine Production of Iron Ore.**—Iron oxide deposits exist in all States and in the Northern Territory, but at present iron oxide for metal extraction purposes, termed iron ore in this chapter, is produced in two States only. The following table shows the estimated iron content of iron ore produced during the years 1956 to 1960.

IRON : ESTIMATED IRON CONTENT OF IRON ORE PRODUCED.

(Tons.)

State.	1956.	1957.	1958.	1959.	1960.
South Australia	2,324,825	2,199,981	2,173,922	2,218,846	2,227,551
Western Australia	211,215	262,519	365,275	480,769	586,404
Australia	**2,536,040**	**2,462,500**	**2,539,197**	**2,699,615**	**2,813,955**

The producing centres during 1960 were as follows.

(i) *South Australia.* During 1960, 3,427,001 tons of iron ore were drawn from the Iron Monarch and Iron Baron deposits in the Middleback Ranges. Selected foundry grade ore was diverted as required to the Whyalla blast furnace, but the greater part was shipped to Newcastle and Port Kembla for smelting.

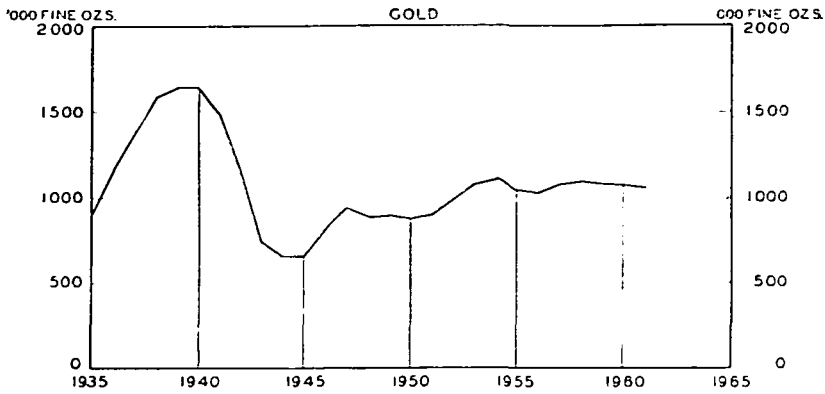
(ii) *Western Australia.* During the year, 837,147 tons of ore were shipped from Yampi Sound, north of Derby, to New South Wales for sintering and smelting. A quantity of 91,316 tons was mined at Koolyanobbing, near Southern Cross, for pig iron production at Wundowie.

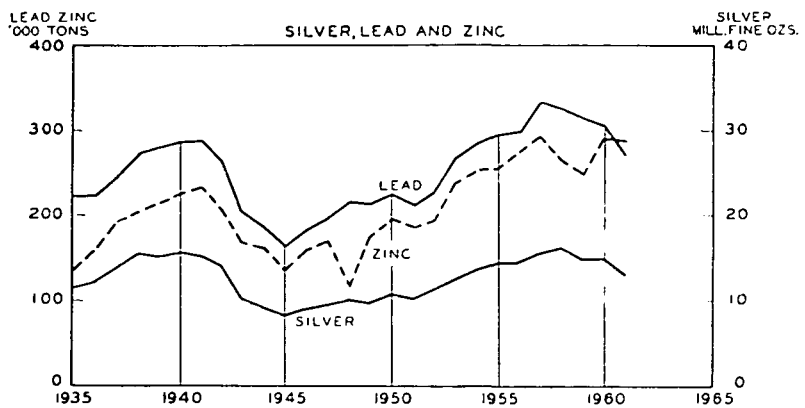
4. **Mine Production of Iron Oxide.**—Production of iron oxide, excluding that used for metal extraction (iron ore) and mineral pigments, in the several States during 1960, according to end use, is shown in the following table.

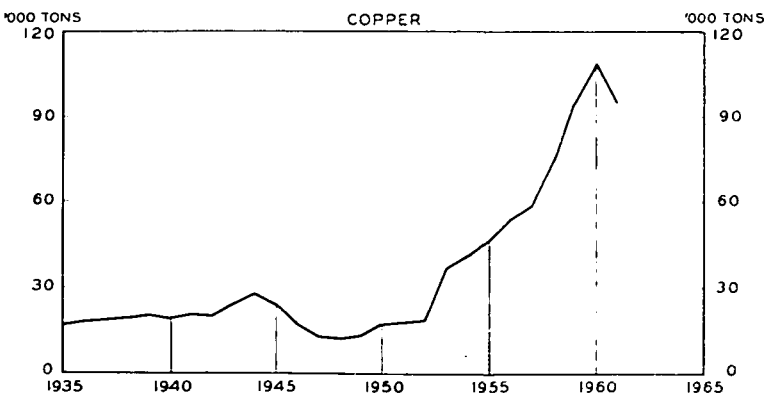
MINE PRODUCTION OF PRINCIPAL METALS

(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1935 TO 1961



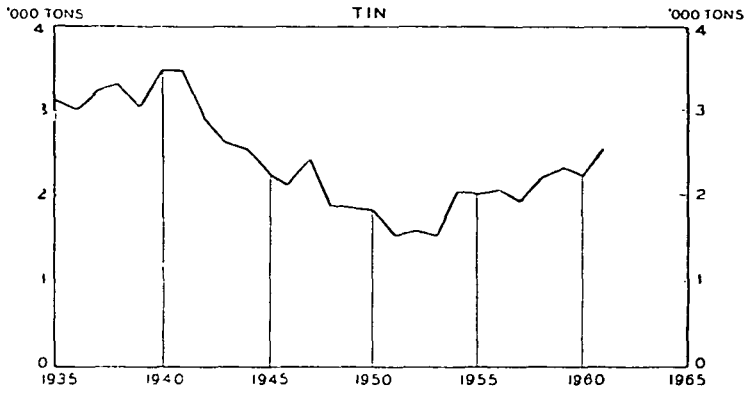


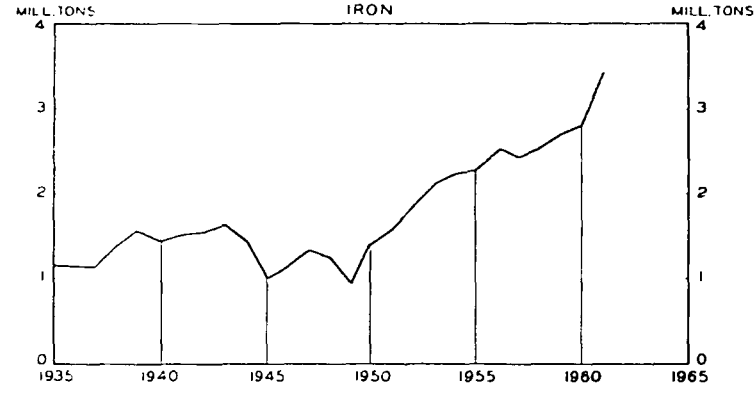


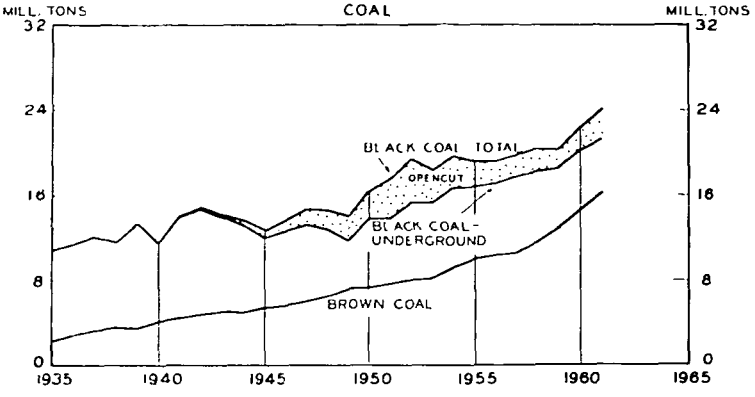
MINE PRODUCTION OF PRINCIPAL METALS AND PRODUCTION OF COAL

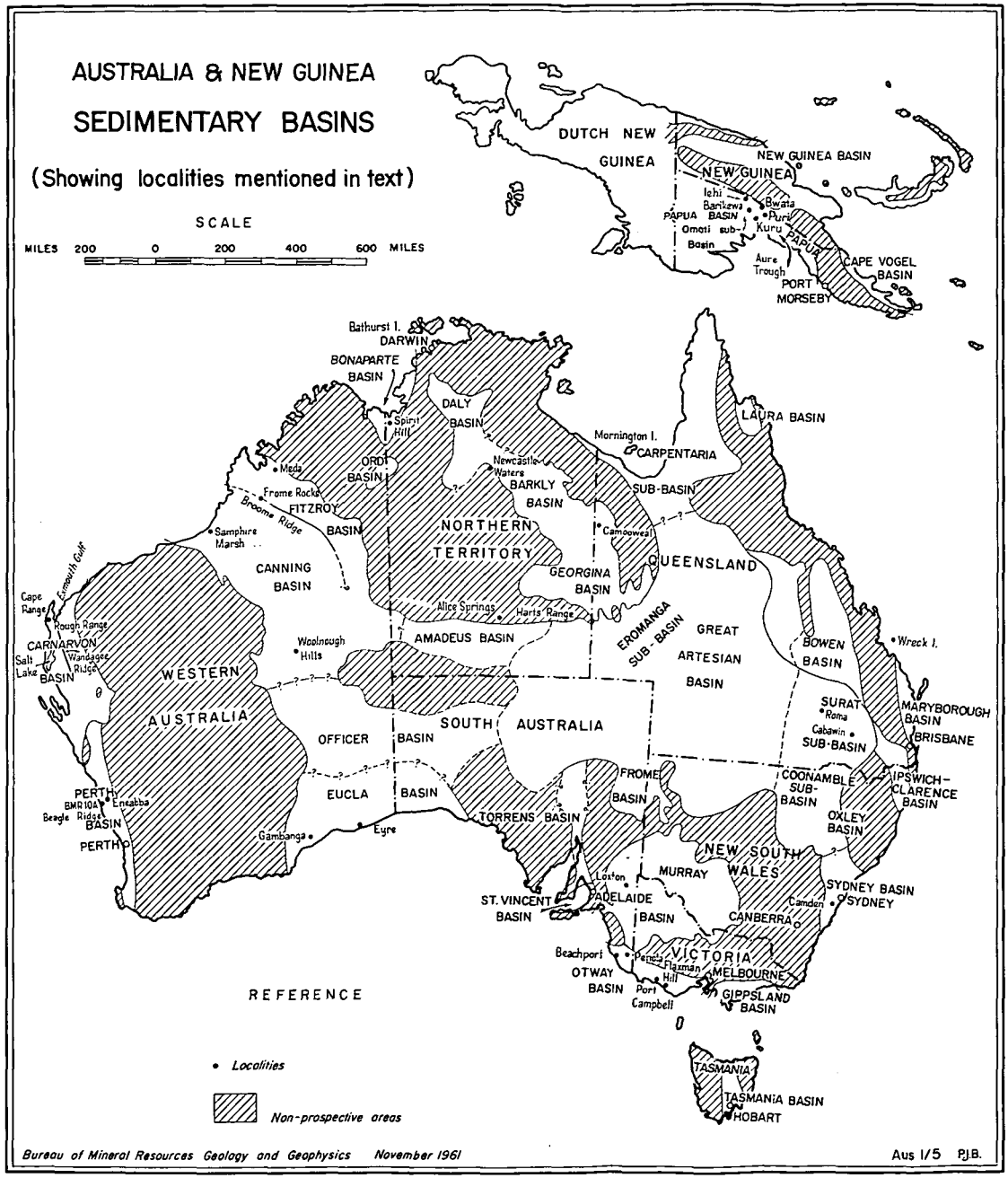
(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1935 TO 1961








AUSTRALIA & NEW GUINEA
SEDIMENTARY BASINS
(Showing localities mentioned in text)
SCALE
MILES 200 0 200 400 600 MILES
DUTCH NEW GUINEA
NEW GUINEA BASIN
NEW GUINEA
Ieihi
Barikewa
Bwata
PAPUA BASIN
Puri
Omati sub-Basin
Kuru
PAPUA
Aure Trough
CAPE VOGEL BASIN
PORT MORSEBY
Bathurst I.
DARWIN
BONAPARTE BASIN
DALY BASIN
Spirit Hill
LAURA BASIN
Mornington I.
CARPENTARIA
Meda
ORDI BASIN
Newcastle Waters
BARKLY BASIN
SUB-BASIN
Frome Rocks
Broome Ridge
FITZROY BASIN
Samphire Marsh
NORTHERN TERRITORY
Camooweal
QUEENSLAND
CANNING BASIN
GEORGINA BASIN
Cape Range
Exmouth Gulf
Alice Springs
Harts Range
Rough Range
CARNARVON
Salt Lake BASIN
Wandagee Ridge
AMADEUS BASIN
EROMANGA SUB-BASIN
GREAT ARTESIAN BASIN
BOWEN BASIN
Wreck I.
Woolnough Hills
WESTERN AUSTRALIA
SURAT
Roma
Cabawin SUB-BASIN
MARYBOROUGH BASIN
BRISBANE
SOUTH AUSTRALIA
OFFICER BASIN
FROME BASIN
COONAMBLE SUB-BASIN
IPSWICH-CLARENCE BASIN
PERTH
BMR 10A
Beagle Ridge
Eneabba
BASIN
PERTH
EUCLA BASIN
TORRENS BASIN
OXLEY BASIN
Gambanga
Eyre
NEW SOUTH WALES
MURRAY
Loxton
ST. VINCENT BASIN
ADELAIDE
SYDNEY BASIN
SYDNEY
Camden
CANBERRA
Beachport
VICTORIA
Penola
Flaxman Hill
MELBOURNE
OTWAY BASIN
Port Campbell
GIPPSLAND BASIN
REFERENCE
Localities
Non-prospective areas
TASMANIA
TASMANIA BASIN
HOBART
Bureau of Mineral Resources Geology and Geophysics November 1961
Aus 1/5 PJB.

IRON OXIDE PRODUCTION, 1960.
(Tons.)

Use.	New South Wales.	Victoria.	Queensland.	South Australia.	Tasmania.	Australia.
For gas purification ..	1,589	1,153	..	..	228	2,970
For cement manufacture	10,748	..	1,759	..	3,269	15,776
For coal washing ..	386	..	..	..	..	386
For fluxing	..	..	..	9,600	..	9,600
Total	**12,723**	**1,153**	**1,759**	**9,600**	**3,497**	**28,732**

The principal sources of iron oxide production during 1960 were as follows.

(i) *New South Wales.* Quantities of iron oxide for gas purification were obtained from deposits near Port Macquarie, while that used for cement manufacture was mined from the Lithgow, Mudgee and Rylstone mining divisions. Magnetite, used in coal washing, was produced in the Copmanhurst mining division and also from beach sand deposits near Murwillumbah.

(ii) *Victoria.* Limonite ore used for gas purification was mined at Buchan.

(iii) *Queensland.* Iron oxide produced for cement manufacture was mined near Townsville.

(iv) *South Australia.* A quantity of 9,600 tons drawn from the Middleback Ranges was dispatched to Port Pirie for use as a flux in lead smelting operations.

(v) *Tasmania.* Iron oxide for gas purification and cement manufacture was mined in the vicinity of Penguin.

Particulars of Australian production of iron oxide for the years 1956 to 1960, according to end use, are shown in the following table.

IRON OXIDE PRODUCTION: AUSTRALIA.
(Tons.)

Use.	1956.	1957.	1958.	1959.	1960.
For gas purification.. ..	6,479	5,338	2,864	4,355	2,970
For cement manufacture ..	9,126	9,759	6,093	9,485	15,776
For coal washing	..	4	25	30	386
For fluxing	10,440	4,650	8,100	9,600	9,600
Total	**26,045**	**19,751**	**17,082**	**23,470**	**28,732**

5. **Iron and Steel Production.**—The production of pig-iron and steel ingots in Australia, of which New South Wales is the main producing State, is shown in the following table for each of the years ended 31st May, 1952 to 1961.

PIG-IRON AND INGOT STEEL: PRODUCTION, AUSTRALIA.
(Tons.)

Year ended 31st May.	Pig-iron. (*a*)	Steel Ingots. (*b*)	Year ended 31st May.	Pig-iron. (*a*)	Steel Ingots. (*b*)
1952	1,430,027	1,521,386	1957	2,098,352	2,773,995
1953	1,691,693	1,801,028	1958	2,283,925	3,037,705
1954	1,826,711	2,116,813	1959	2,293,709	3,203,584
1955	1,868,841	2,208,708	1960	2,655,237	3,519,719
1956	1,910,521	2,320,289	1961	3,001,800	3,748,037

(*a*) Includes pig-iron for castings; excludes ferro-alloys. (*b*) Includes recovery from scrap.

In 1961, ten blast furnaces were operating in Australia; four at Port Kembla and three at Newcastle in New South Wales, two at Wundowie, Western Australia, and one at Whyalla, South Australia. During 1961, ingot steel was produced from 28 open-hearth furnaces (17 at Newcastle and 11 at Port Kembla) and from 11 electric furnaces (5 at Newcastle, 2 at Melbourne, 1 at Whyalla, 2 at Port Kembla and 1 at Bell Bay).

6. **Production of Iron and Steel in Principal Countries.**—Particulars of the production in the principal countries and the estimated world total production during the calendar years 1959 and 1960, according to figures published by the Mineral Resources Division of the United Kingdom Overseas Geological Surveys, are shown in the next table.

IRON AND STEEL: PRODUCTION IN PRINCIPAL COUNTRIES.

('000 Tons.)

Country.	Pig-iron and Ferro-alloys.		Steel Ingots and Castings.	
	1959.	1960.	1959.	1960.
United States of America ..	55,516	61,220	83,434	88,644
U.S.S.R.	42,293	46,019	59,003	64,261
Germany, Federal Republic ..	18,103	25,332	25,414	33,562
United Kingdom	12,583	15,763	20,186	24,305
Japan	9,791	12,197	16,366	21,789
China	20,200	27,100	13,140	18,160
France	12,275	13,922	14,978	17,008
Italy	2,157	2,780	6,655	8,099
Belgium	5,871	6,449	6,330	7,070
Czechoslovakia	4,177	4,621	6,039	6,661
Poland	4,305	4,491	6,062	6,575
Canada	3,856	3,943	5,269	5,169
Luxembourg	3,357	3,726	3,605	4,019
Saar	3,169	(*a*)	3,536	(*a*)
Australia	**2,507**	**2,876**	**3,395**	**3,694**
Germany, Eastern	1,868	1,963	3,156	3,283
India	3,144	4,197	2,429	3,234
Sweden	1,481	1,606	2,795	3,165
Austria	1,808	2,196	2,472	3,113
Estimated World Total ..	*220,000*	*255,000*	*299,400*	*340,100*

(*a*) Included with Germany (Federal Republic).

§ 9. Mineral Sands.

1. **Historical.**—In recent years, the growing world demand for rutile as a coating for electric welding rods and as a source of titanium metal, and for ilmenite in the production of titanium pigments, has brought about a rapid expansion of Australian mineral sands mining. Australia is the largest producer of rutile and zircon in the world, and nearly all this production comes from the mineral sands deposits along the beaches of the east coast. The ilmenite produced on the east coast has proved unsuitable for titanium oxide pigment manufacture, and most of the production is discarded. However, ilmenite produced from mineral sands mined in Western Australia since 1956 has a much lower chromic oxide content than east coast ilmenite, and is therefore suitable for pigment production.

The first commercial development of the mineral sands deposits commenced at Byron Bay in New South Wales in 1934, when a mixed zircon-rutile-ilmenite concentrate was prepared. Large scale production of zircon-rutile concentrate commenced in Queensland in 1941 when electromagnetic separators were installed to separate the ilmenite. In 1943, after the installation of electrostatic separators, a rutile concentrate was produced. The Commonwealth Government banned the export of mixed concentrates in 1944, and all east coast operators now produce separate concentrates of rutile, zircon and ilmenite. In addition, a few companies produce a high-grade monazite concentrate.

Following the record post-war output of rutile in 1957, production was on a reduced scale during the period 1958–60, mainly because of greatly reduced prices offering on world markets. However, during the second half of 1961 the price of rutile improved and production increased. Strengthening of the rutile market was due in part to the rationalization of the Australian industry and also to increased demand for rutile.

2. **Present Methods of Mining and Treatment.**—Mineral bearing sands are usually recovered from sand dunes, but deposits occurring below sea level are recovered by suction dredges. The mineral sands and beach sand (quartz) are gravity concentrated, either by shaking tables or by spiral concentrators, resulting in the complete elimination of quartz and leaving a mixed concentrate of heavy minerals. Magnetic ilmenite and monazite are separated by electromagnetic methods and are then separately recovered, using increasing magnetic intensities. The remaining zircon and rutile are separated mainly by the use of electrostatic separators.

3. **Mine Production.**—(i) *Titanium Dioxide.* The following table shows the quantities of titanium dioxide contained in rutile and ilmenite concentrates produced during the years 1956 to 1960.

TITANIUM DIOXIDE: CONTENT OF CONCENTRATES PRODUCED.

(Tons.)

State.	1956.	1957.	1958.	1959.	1960.
CONTAINED IN RUTILE CONCENTRATE.					
New South Wales	62,470	83,363	44,915	44,792	52,262
Queensland	30,772	41,500	35,755	34,736	33,260
Western Australia	..	..	285	96	493
Australia	**93,242**	**124,863**	**80,955**	**79,624**	**86,015**
CONTAINED IN ILMENITE CONCENTRATE.					
New South Wales	481	485	59	111	537
Queensland	..	78	..	..	21
Western Australia	1,779	38,325	38,219	45,566	58,171
Australia	**2,260**	**38,888**	**38,278**	**45,677**	**58,729**

(ii) *Zircon.* The quantities of zircon mineral contained in zircon concentrate produced during the years 1956 to 1960 are shown in the table below.

ZIRCON: CONTENT OF ZIRCON CONCENTRATE PRODUCED.

(Tons.)

State.	1956.	1957.	1958.	1959.	1960.
New South Wales	50,135	58,747	32,230	71,156	65,764
Queensland	21,634	28,956	26,412	34,504	31,752
Western Australia	..	..	103	6,692	(*a*) 3,978
Australia	**71,769**	**87,703**	**58,745**	**112,352**	**101,494**

(*a*) Estimated.

(iii) *Other Products.* During 1960, small quantities of monazite concentrate, magnetite and garnet concentrate were also recovered from mineral sands.

(iv) *Sources of Production.* The principal sources of mineral sands treated during 1961 were as follows.

(*a*) *New South Wales and Queensland.* The main deposits of mineral sands occur along the eastern Australian coast from Wyong in New South Wales to Curtis Island, Queensland. At present, the principal mining operations are located between Lake Munmorah and Newcastle in the south and between Evans Head and North Stradbroke Island in the north.

(*b*) *Western Australia.* The chief deposits of mineral sands occur on the south-west coast between Bunbury and Wonnerup. During 1961, the bulk of production was from the Copel-Yoganup area.

4. **Employment in Mineral Sands Mining.**—Particulars of the number of persons employed in mineral sands mining are shown in paras. 4 (ii) and (iii), pages 1051–2.

§ 10. Aluminium.

1. **Mine Production.**—The source of aluminium is bauxite. Until recent years, the only bauxite production in Australia was from small deposits in Queensland, New South Wales and Victoria. Production from these deposits has been used mainly by the chemical and steel industries.

Large deposits of bauxite exist at Weipa (North Queensland), Gove (Northern Territory) and Darling Range (Western Australia). The deposits at Weipa and the Darling Range are now being developed and trial shipments from both deposits have been sent to Japan for aluminium smelting. The deposit at Gove is being developed for the production of alumina (plant capacity 360,000 tons annually) at that centre and also for the export of bauxite. The Weipa alumina plant will supply the requirements of an aluminium smelter (plant capacity 120,000 tons annually) to be installed at Invercargill (New Zealand). At Kwinana (Western Australia), an alumina plant (capacity 200,000 tons annually) is to be constructed to use Darling Range bauxite. The alumina will be shipped to Geelong (Victoria) for the production of metal. In addition, some alumina is likely to be exported from Kwinana. The alumina content of bauxite produced in Australia during the years 1956 to 1960 is shown in the following table.

ALUMINA : CONTENT OF BAUXITE PRODUCED.
(Tons.)

State.	1956.	1957.	1958.	1959.	1960.
New South Wales	1,578	1,354	633	1,648	1,386
Victoria	2,600	1,910	2,304	1,991	2,306
Queensland (*a*)	440	494	596	..	14,442
Western Australia (*a*) ..	..	..	..	3,275	13,259
Australia	**4,618**	**3,758**	**3,533**	**6,914**	(*b*) **31,393**

(*a*) Estimated. (*b*) Partly estimated.

2. **Refinery Production.**—There is a refinery for the production of alumina and refined aluminium at Bell Bay on the River Tamar in Northern Tasmania. The location of this refinery was determined by the availability of large supplies of hydro-electric power. Production of alumina commenced in February, 1955, and of refined aluminium in September, 1955. Work is in hand to expand the Bell Bay plant to a capacity of 28,000 tons in 1962 and ultimately to 48,000 tons in 1964. A new smelter with an ultimate capacity of 40,000 tons is to be constructed at Geelong (Victoria). The plant is expected to come into production in 1963. The following table shows the production of alumina and refined aluminium in Australia during the years 1957 to 1961.

ALUMINA AND REFINED ALUMINIUM : PRODUCTION, AUSTRALIA.
(Tons.)

Refinery Product.	1957.	1958.	1959.	1960.	1961.
Alumina	20,116	22,490	26,900	29,801	29,468
Refined Aluminium ..	10,624	10,869	11,370	11,655	13,204

Source: Bureau of Mineral Resources.

§ 11. Uranium.

Uranium concentrate has been produced in Australia since 1954, but particulars of the quantity of U_3O_8 concentrate produced and its value are not available for publication. All U_3O_8 concentrate is exported overseas. During 1961, the principal producing centres were as follows.

(i) *Queensland.* Uranium ore was mined by opencut methods at Mary Kathleen, 33 miles east of Mount Isa.

(ii) *South Australia.* Uranium ore was mined by underground methods at Radium Hill, 289 miles north-east of Adelaide. A concentrate of heavy minerals was produced at the mine and this was railed to a treatment plant at Port Pirie for the chemical extraction of U_3O_8 concentrate. The Radium Hill mine closed down in December, 1961, and the Port Pirie plant ceased production of uranium oxide late in February, 1962.

(iii) *Northern Territory.* At Rum Jungle, uranium-copper and copper ores were treated to produce U_3O_8 concentrate, copper concentrate and copper precipitate. Mining operations ceased at Rum Jungle in November, 1958, but sufficient ore was stockpiled to permit the continuation of full-scale production of uranium concentrate for some years. At the recently discovered Rum Jungle Creek South deposit, removal of overburden is well advanced and full-scale extraction of ore is due to commence in 1962.

During 1961, ore was mined in the South Alligator River area. Two companies opened treatment plants at Moline and Rockhole Creek during the year. Operations at the latter plant ceased at the end of 1961.

Income from uranium mining is exempt from taxation in the hands of Australian producers. If the producer is an Australian company, such income is exempt from taxation in the hands of the shareholders when paid as dividends.

§ 12. Other Metallic Minerals.

1. **Tungsten.**—In recent years, Tasmania has been the principal State producing tungsten ores, scheelite being mined on King Island in Bass Strait and wolfram being mined in association with tin ores in the north-east part of the State. Because of low world prices, scheelite production on King Island ceased in August, 1958, but production was recommenced on a limited scale in 1960.

Particulars of the production of tungstic oxide contained in scheelite and wolfram concentrates produced during the years 1956 to 1960 are shown in the following table.

TUNGSTIC OXIDE (WO_3): CONTENT OF CONCENTRATES PRODUCED.
(Tons.)

State.	1956.	1957.	1958.	1959.	1960.
CONTAINED IN SCHEELITE CONCENTRATE.					
New South Wales	2	1	1	(a)	(a)
Queensland	3	1	..	..	..
Tasmania	985	948	477	..	291
Australia	**990**	**950**	**478**	**(a)**	**291**
CONTAINED IN WOLFRAM CONCENTRATE.					
New South Wales	2	(a)	..	..	..
Queensland	46	19	5	..	..
Tasmania	443	391	360	645	804
Northern Territory	101	49	7	8	16
Australia	**592**	**459**	**372**	**652**	**820**

(a) Less than half a ton.

2. **Manganese.**—In recent years, Western Australia has been the principal State producing manganese ore, mined mainly from the Pilbara goldfield.

The following table shows the manganese content of metallurgical grade and the manganese dioxide content of battery and other grades of manganese ore produced during the years 1956 to 1960.

MANGANESE : CONTENT OF MANGANESE ORE PRODUCED.

(Tons.)

Year.	Metallurgical Grade. In terms of Manganese (Mn) Content.				Battery and Other Grades. In terms of Manganese Dioxide (MnO_2) Content.			
	N.S.W.	Q'land. (a)	W. Aust.	Australia.	N.S.W.	W. Aust.	N. Terr.	Australia.
1956 ..	436	140	25,280	25,856	371	179	914	1,464
1957 ..	391	557	33,956	34,904	385	186	668	1,239
1958 ..	516	3,181	21,926	25,623	511	195	2,113	2,819
1959 ..	620	4,350	35,996	40,966	907	162	1,406	2,475
1960 ..	342	1,670	26,561	(b) 28,585	623	9	940	(c) 1,617

(a) Estimated. (b) Includes Victoria (12 tons). (c) Includes South Australia (45 tons).

The quantity of manganese dioxide recovered, in 1960, from zinc concentrates produced at Broken Hill and Rosebery amounted to 3,847 tons, of which 452 tons were sold.

3. **Other.**—Production in 1960 (1959 shown in parentheses) of other metallic minerals was as follows.

Antimony. The antimony content of antimony-bearing minerals produced was 786 tons (1,280 tons). Of this amount, 632 tons (652 tons) were in lead concentrate and 154 tons (628 tons) in 256 tons (1,022 tons) of antimony ore and concentrate.

Beryllium. Production of beryllium ore was 190 tons (317 tons), which came mainly from Western Australia where the Pilbara and Gascoyne goldfields were the main producing areas. The beryllium oxide content of the ore was 2,221 units of 22.4 lb. (3,587 units).

Chromite. Production of chromite was 529 tons (120 tons) with an estimated chromic oxide content of 265 tons (60 tons). This production came from Rockhampton, in Queensland.

Tantalite-Columbite. The production of tantalite-columbite concentrate was 23,677 lb. (18,950 lb.) and the whole of this output came from Western Australia. The tantalum pentoxide and columbium pentoxide content of the concentrates was 11,500 lb. (8,499 lb.).

Other. Fifteen tons of lithium ore containing 1 ton of lithium oxide were produced in New South Wales during 1960. This was the first recorded post-war production of lithium. In addition, 7 oz. of platinum concentrate containing 4 oz. of platinum were obtained in New South Wales as a by-product of gold refining.

§ 13. Coal.

1. **Historical.**—Coal was probably the first of Australia's mineral products to be discovered, being reported from the neighbourhood of Newcastle in 1796. In the following year, outcrop coal was discovered at Coalcliff, 40 miles south of Sydney, and at the entrance to the Hunter River in the Newcastle district. By 1799, outcrop coal was being exported overseas from the latter field. All production was from the Newcastle district until 1857, when the first coal was produced from the southern field. The estimated production in 1830 was 4,000 tons and this increased to 30,000 tons in 1840, 70,000 tons in 1850, and 370,000 tons in 1860. In 1864, the first coal was discovered in the Greta-Cessnock-Maitland field which has since become the principal Australian source of gas coal.

The discovery of coal in Victoria dates from the year 1825, when the mineral was reported to have been found at Cape Paterson, but only a small quantity of coal was mined in Victoria prior to the opening of the State-owned mine at Wonthaggi in 1909. Present

day Victorian production of black coal is obtained almost exclusively from this mine. Brown coal was discovered in Victoria at Lal Lal in 1857 and in the Latrobe Valley in 1874. Mining operations were first undertaken in 1889, but it was not until after the 1914–18 War that large-scale mining began.

In Queensland, coal was first discovered near Ipswich in 1827 and the first colliery was established there in 1846. At Blair Athol, 240 miles west of Rockhampton, coal was discovered in 1864. This field is unique in that the field's total reserves of 200 million tons are available for opencut mining in a seam attaining a thickness of over 90 feet, the greatest thickness of black coal yet found in Australia.

The deposits of black coal at Leigh Creek, 377 miles north of Adelaide, were discovered in 1888 during dam-sinking operations. Small quantities of coal were mined in 1907 and 1917, but it was not until 1944 that extensive opencut mining operations began.

In Western Australia, coal was first discovered on the Irwin River in 1846, but the discovery of the Collie field in 1883 proved to be of far greater importance. This field is located 120 miles south of Perth and commercial mining began there in 1898.

There appear to be no reliable records of the earliest discoveries of coal in Tasmania. Coal was mined on the Tasman Peninsula to provide fuel for penal settlements in the vicinity and for Hobart, and mining continued there until about 1877. In 1824, coal was discovered at South Cape Bay near the most southerly part of the island. The most important deposit is the Mount Nicholas-Fingal-Dalmayne (St. Marys) field in the north-east part of the State.

The mining of black coal on a large scale by opencut methods first began in Australia at Blair Athol in Queensland, where in 1937, the first year of production, 18,494 tons (0.2 per cent. of total Australian black coal production for that year) were produced. Opencut mining of black coal was introduced in New South Wales in 1940, in Western Australia in 1943, in South Australia in 1944, and in Tasmania in 1950. The output from opencuts reached a maximum of 21.1 per cent. of total production in 1952, but in recent years this has been at a lower level (9.6 per cent. in 1960).

Plans have been announced recently for the construction of coal-loading facilities costing £2.5 million at the inner harbour at Port Kembla. The work is the first stage of a plan to expand coal loading facilities at Port Kembla, Newcastle and Balmain in anticipation of greatly increased coal export trade.

A joint company has recently been formed to develop the Kianga-Moura coalfield in central Queensland. Fifteen million pounds will be spent on developing the field and lifting production to 2 million tons of coal a year. Firm orders have already been received from the Japanese steel industry for 3.4 million tons of coal to be delivered during the next seven years.

2. **Mine Production of Black Coal.**—Production of black coal according to rank in the several States during the years 1956 to 1960 is set out in the following table. Th tonnages produced by underground mining and opencut mining are also shown.

BLACK COAL : PRODUCTION.
(Tons.)

Particulars.	1956.	1957.	1958.	1959.	1960.
NEW SOUTH WALES.					
Bituminous	14,792,853	15,376,240	15,840,550	15,712,440	17,736,994
Sub-bituminous ..	17,312	13,996	10,398	..	..
Total	**14,810,165**	**15,390,236**	**15,850,948**	**15,712,440**	**17,736,994**
Underground mines ..	13,999,615	14,662,155	15,130,633	15,278,162	16,981,561
Opencut mines ..	810,550	728,081	720,315	434,278	755,433
VICTORIA.					
Total(*a*) ..	**118,827**	**111,569**	**108,359**	**90,438**	**76,972**

NOTE.—*See* next page for footnotes.

BLACK COAL: PRODUCTION—*continued.*

(Tons.)

Particulars.	1956.	1957.	1958.	1959.	1960.
QUEENSLAND.					
Semi-anthracite ..	79,316	68,873	55,190	51,849	47,762
Bituminous	2,472,692	2,475,079	2,392,435	2,476,479	2,531,581
Sub-bituminous ..	182,651	157,625	132,748	66,059	70,769
Total	**2,734,659**	**2,701,577**	**2,580,373**	**2,594,387**	**2,650,112**
Underground mines ..	2,103,641	2,170,979	2,098,030	2,142,302	2,269,564
Opencut mines ..	631,018	530,598	482,343	452,085	380,548
SOUTH AUSTRALIA.					
Total(*b*) ..	**481,463**	**608,913**	**755,022**	**690,374**	**884,819**
WESTERN AUSTRALIA.					
Total(*c*) ..	**830,007**	**838,661**	**870,882**	**911,435**	**922,393**
Underground mines ..	621,467	689,882	779,394	800,856	798,185
Opencut mines ..	208,540	148,779	91,488	110,579	124,208
TASMANIA.					
Semi-anthracite ..	1,827	1,847	2,006	2,217	2,333
Bituminous	296,886	266,293	274,262	297,151	295,337
Total	**298,713**	**268,140**	**276,268**	**299,368**	**297,670**
Underground mines ..	280,332	253,108	260,100	281,310	281,662
Opencut mines ..	18,381	15,032	16,168	18,058	16,008
AUSTRALIA.					
Semi-anthracite ..	81,143	70,720	57,196	54,066	50,095
Bituminous	17,681,258	18,229,181	18,615,606	18,576,508	20,640,884
Sub-bituminous ..	1,511,433	1,619,195	1,769,050	1,667,868	1,877,981
Total	**19,273,834**	**19,919,096**	**20,441,852**	**20,298,442**	**22,568,960**
Underground mines ..	17,123,882	17,887,693	18,376,516	18,593,068	20,407,944
Opencut mines ..	2,149,952	2,031,403	2,065,336	1,705,374	2,161,016

(*a*) Bituminous coal from underground mines. (*b*) Sub-bituminous coal from an opencut mine.
(*c*) Sub-bituminous coal.

The principal producing centres during 1960 were as follows.

(i) *New South Wales.* The principal deposits worked were in the vicinity of Newcastle, Cessnock and Singleton (northern field), Lithgow (western field) and Wollongong (southern field). Tonnages mined in 1960 were: northern field, 10,234,000 tons; southern field, 5,735,000 tons and western field, 1,578,000 tons. All opencut coal was from the northern field.

The coal fields of New South Wales, predominantly bituminous, are the most important in Australia, in respect of the magnitude, quality and accessibility of reserves and the extent to which the deposits are being worked. Coal from the various seams differs in properties, coal from the Greta seam worked in the vicinity of Cessnock being particularly suitable for gas making, while coal from the Victoria tunnel, Dudley, Young Wallsend and Borehole seams, all of which are mined near Newcastle, have coking properties and are used in the steelworks. Coking coal is also obtained from the Bulli seam which is mined near Wollongong and in the Burragorang Valley. A multi-purpose coal is available in the Singleton area and steaming coals are mined around Newcastle, Lithgow, Cessnock and Wollongong.

(ii) *Victoria.* Production of black coal in Victoria was restricted to the Gippsland district. The State Coal Mine at Wonthaggi was the main producer, and the remaining production came from small privately-owned mines.

(iii) *Queensland.* The principal producing centres were Ipswich, 1,628,633 tons; Bowen, 411,821 tons; Clermont, 170,606 tons; and Mount Morgan, 126,736 tons. Opencut coal was mined on the Bowen, Clermont and Mount Morgan fields and the total coal won by this means was 14 per cent. of total production.

(iv) *South Australia.* Coal was mined only at Leigh Creek, 377 miles north of Adelaide.

(v) *Western Australia.* The only coal deposits which have been developed on a commercial scale are at Collie in the south-west of the State and all production during 1960 was from this source.

(vi) *Tasmania.* Most of the coal produced was won in the north-east of the State, the principal producing centres being St. Mary's, 130,172 tons; Fingal, 96,131 tons; and Avoca, 57,748 tons.

3. **Mine Production of Brown Coal.**—Brown coal is mined only in Victoria and production in recent years has been as follows:—1956, 10,559,801 tons; 1957, 10,740,989 tons; 1958, 11,643,629 tons; 1959, 13,034,605 tons; and 1960, 14,967,202 tons. In the past ten years, the output of brown coal has nearly doubled.

4. **Australia's Coal Reserves.**—The latest available estimate of the measured and indicated coal reserves of Australia is that prepared by the Coal and Lignites Panel of the Power Survey Sectional Committee of the Standards Association of Australia, and is shown in the following table. It should be noted that reserves can only be included in the "measured and indicated" categories when sufficient exploratory and testing work has been completed.

ESTIMATED COAL RESERVES OF AUSTRALIA.
(Million Tons.)

State.	Bituminous Coal.(a)	Sub-bituminous Coal.	Brown Coal. (Lignite).
New South Wales	8,650	800	..
Victoria	12	..	56,100
Queensland	749	..	..
South Australia	..	144	230
Western Australia	..	274	..
Tasmania	240	..	..
Australia	**9,651**	**1,218**	**56,330**

(a) Includes reserves of a small quantity of semi-anthracitic coal.

5. **Production in Principal Countries.**—The following table shows the production of the principal countries in 1959 and 1960 as published by the Mineral Resources Division of the United Kingdom Overseas Geological Surveys.

COAL : PRODUCTION IN PRINCIPAL COUNTRIES.
('000 Tons.)

Country.	Black Coal.		Brown Coal and Lignite.	
	1959.	1960.	1959.	1960.
China	342,300	413,000	..	..
United States of America	383,834	385,340	2,482	2,452
U.S.S.R.	359,600	367,000	138,900	140,000
United Kingdom	206,111	193,609	..	..
Germany, Federal Republic of	125,407	141,843	92,193	94,634
Poland	97,500	102,000	9,200	9,200
France	56,696	55,076	2,143	2,240
India	(a) 47,000	(a) 51,810	(b)	(b)
Japan	44,977	48,792	1,446	1,466
South Africa	35,876	37,571	..	..
Czechoslovakia	24,727	25,800	52,855	57,481
Australia	**20,298**	**22,569**	**13,035**	**14,967**
Belgium	22,397	22,111	..	..
Saar	15,972	(c)	..	..
Spain	13,327	13,566	2,069	1,734
Netherlands	11,789	12,301	196	4
Korea (North)	8,714	10,452	..	..
Canada	7,749	7,893	1,739	1,938
Turkey	6,421	6,207	3,605	3,357
Korea (South)	4,071	5,266	..	..
Formosa	3,507	3,899	..	..
New Zealand	2,639	2,852	170	160
Hungary	2,691	2,802	22,256	23,302
Colombia	2,500	2,700	..	..
Germany, Eastern	2,796	2,678	211,391	221,904
Estimated World Total	*1,860,000*	*1,727,000*	*620,000*	*863,000*

(a) Includes lignite. (b) Included with black coal. (c) Included with Germany (Federal Republic).

6. **Consumption of Coal in Australia.**—(i) *Black Coal.* Details of the production of black coal in Australia and its disposal are shown in the following table for the years 1956–57 to 1960–61.

BLACK COAL : PRODUCTION AND CONSUMPTION.
('000 Tons.)

Particulars.	1956–57.	1957–58.	1958–59.	1959–60.	1960–61.
Production(a)	19,711	20,362	20,459	21,223	22,979
Imports	6	9	8	8	7
Total	**19,717**	**20,371**	**20,467**	**21,231**	**22,986**
Consumption as Fuel—					
Electricity Generation	6,363	6,941	7,131	7,398	7,420
Factories	2,977	2,991	3,122	3,167	3,102
Railway Locomotives(b)	2,690	2,217	2,051	2,002	1,847
Bunker Coal(c)	233	229	203	169	136
Total	*12,263*	*12,378*	*12,507*	*12,736*	*12,505*
Consumption as Raw Material—					
Gas works	1,946	1,779	1,761	1,744	1,726
Coke works	3,665	3,841	3,846	4,216	4,910
Total	*5,611*	*5,620*	*5,607*	*5,960*	*6,636*
Exports (Oversea)	545	836	645	1,088	1,888
Mine Washery Refuse and Dump Losses(d)	274	495	660	982	1,054
Balance—Unrecorded consumption, other purposes(e)	1,024	1,042	1,048	465	903
Grand Total	**19,717**	**20,371**	**20,467**	**21,231**	**22,986**

(a) Includes miners' and colliery coal. (b) Government railways only. (c) Figures refer only to New South Wales consumption by oversea, interstate and intrastate vessels. (d) Prior to 1959–60, figures refer to New South Wales only. Figures for 1959–60 and 1960–61 include Tasmania. (e) Includes net change in stocks.

After the 1939–45 War, it was found necessary to augment local supplies of black coal in Australia by increasing imports. The quantity imported reached a post-war peak of 597,866 tons in 1950–51, but has since declined as production has expanded considerably. Since 1952–53, exports have exceeded imports by a wide margin; in 1960–61, exports of black coal were 1,888,415 tons and imports were 6,629 tons. These imports were of black coal for special purposes only.

(ii) *Brown Coal.* The table following shows the production and consumption of brown coal and the production of briquettes in Victoria for the years 1956–57 to 1960–61.

BROWN COAL: PRODUCTION AND CONSUMPTION, VICTORIA.
('000 Tons.)

Year.	Production.	Consumption as Fuel.			Consumption as Raw Material in Briquette Manufacture.	Briquettes Manufactured.
		Electricity Generation.	Briquette Factory.	Other Factories. (*a*)		
1956–57	10,772	6,943	806	1,309	1,613	618
1957–58	10,866	7,020	810	1,297	1,619	626
1958–59	12,243	8,470	819	1,293	1,639	643
1959–60	14,101	9,300	1,198	1,248	2,396	975
1960–61(*b*)	15,723	8,759	1,991	957	3,984	1,807

(*a*) Recorded consumption. (*b*) Subject to revision.

The State Electricity Commission of Victoria started commercial production of brown coal briquettes at Yallourn in February, 1925. Output for the financial year 1924–25 was 36,500 tons. This had increased to 141,044 tons in 1928–29 and to 642,590 tons in 1958–59. With the commencement of production in the Commission's new works at Morwell, output of briquettes (Yallourn and Morwell combined) rose to 974,670 tons in 1959–60 and to 1,806,619 tons in 1960–61, which was the first complete year of full output at Morwell.

In December, 1956, the Lurgi high pressure brown coal gasification plant at Morwell was opened by the Gas and Fuel Corporation of Victoria. This plant operates on briquettes supplied by belt conveyor from the State Electricity Commission's Morwell works, and produces town gas which is sent to Melbourne through 103 miles of pipeline.

7. Exports.—The quantities and values of the oversea exports of Australian coal and of bunker coal for oversea vessels for the five years 1956–57 to 1960–61 are shown in the following table. These shipments were made mainly from New South Wales.

COAL: OVERSEA EXPORTS AND BUNKER, AUSTRALIA.

Year.	Oversea Exports.(*a*)		Bunker Coal for Oversea Vessels.	
	Quantity.	Value.	Quantity.	Value.
	Tons.	£	Tons.	£
1956–57	545,101	2,196,044	9,065	44,116
1957–58	836,336	3,390,628	11,608	50,656
1958–59	645,249	2,676,042	8,187	37,808
1959–60	1,087,844	4,326,810	8,117	25,380
1960–61	1,888,415	7,682,223	179	1,716

(*a*) Excludes bunker coal.

New South Wales, in addition to meeting requirements within the State, supplies considerable quantities of coal to other States and for export overseas. Of the total of 18,243,000 tons produced in 1960–61, 1,624,000 tons (8.9 per cent.) were exported interstate and 1,888,000 tons (10.3 per cent.) were exported overseas. The demand for bunker coal continues to decline and in 1960–61 a total of 136,000 tons (0.7 per cent.) of New South Wales production was supplied for interstate, intrastate and oversea vessels.

8. **Value at the Mine in New South Wales.**—Particulars of the average values at the mine (or at screens or mine washeries where these are at a distance from the mine) of saleable coal for each district and for New South Wales as a whole are shown in the following table for the years 1956 to 1960. Saleable coal excludes miners' coal, coal consumed at the mines, and refuse, etc., removed by the use of hand picking belts or at mine washeries. In calculating these values, most coal won by producer consumers is also excluded, and in respect of stocks of coal held at grass by the Commonwealth Government only actual sales have been taken into account. No deduction has been made in respect of excise duty operative from 1st November, 1949.

AVERAGE SELLING VALUE AT THE MINE PER TON OF SALEABLE COAL: NEW SOUTH WALES.

(s. d.)

Year.	Northern District.	Southern District.	Western District.	Average for State.
1956..	59 3	58 1	55 1	58 6
1957..	58 3	55 7	50 7	56 9
1958..	56 1	55 0	47 5	54 10
1959..	52 5	54 4	47 6	52 7
1960..	51 11	55 11	48 1	52 8

9. **Values in New South Wales, United Kingdom and the United States of America.**—The following table shows, for the years 1956 to 1960, average values of coal produced in New South Wales, Great Britain and the United States of America. The figures give an indication of changes in average value or price within each country but they do not necessarily show the relative levels as between the countries concerned.

PRODUCTION VALUES OF COAL PER TON: NEW SOUTH WALES, UNITED KINGDOM AND UNITED STATES OF AMERICA.

Country.	1956.	1957.	1958.	1959.	1960.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*
New South Wales—Bituminous(*a*)	58 6	56 9	54 10	52 7	52 8
United Kingdom—Deep mined(*b*)	77 0	82 1	85 7	83 5½	86 1½
United States of America—	$	$	$	$	$
Bituminous and lignite(*c*) ..	4.82	5.08	4.86	4.77	4.69

(*a*) Average selling value at the mine per ton of 2,240 lb.; the figures relate to saleable coal and include excise duty. (*b*) Average value in sterling at the mine per ton of 2,240 lb. (*c*) Average value in United States currency at the mine per ton of 2,000 lb.

10. **Employment in Coal-mines.**—The number of persons employed, both above and below ground, in coal-mines in each State for each of the years 1956 to 1960 is shown in the following table.

COAL-MINES: PERSONS EMPLOYED.(*a*)

Year.	New South Wales.	Victoria.		Queensland.	South Australia.	Western Australia.	Tasmania.	Australia.
		Black.	Brown.					
1956	17,918	610	1,566	3,568	260	1,190	349	25,461
1957	16,622	561	1,579	3,493	223	1,145	301	23,924
1958	15,463	516	1,540	3,295	230	999	292	22,335
1959	13,445	401	1,519	3,172	251	1,095	314	20,197
1960	13,163	407	1,399	3,231	257	1,042	313	19,812

(*a*) Average number of persons employed (including working proprietors) during whole year.

The year of maximum employment was 1926 when 31,774 persons were engaged in the coal-mines of Australia. Shortly after that year, the industrial depression and a prolonged stoppage of work on one of the principal fields of New South Wales during 1929 and 1930 seriously affected the figures of employment. After 1933, there was a gradual increase up to a level of about 23,000 which was maintained during the war years. There was a further increase after the war to 28,303 in 1952, but since then the number in employment has fallen again. In 1960, it was 19,812.

In New South Wales, during 1960, 15,687,000 tons of coal or 92.4 per cent. of the total output of underground coal, were loaded by machinery as compared with 1,101,000 tons (9.8 per cent.) in 1939, 3,089,000 tons (32.9 per cent.) in 1949, and 13,483,000 tons (88.2 per cent.) in 1959. Similar details for other States are not available, but machinery is used to a considerable extent in Western Australian mines and to a lesser extent in Queensland.

11. **Production of Black Coal per Man-shift.**—(i) *Underground Mines.* The following table shows particulars of estimated black coal output per man-shift worked, (*a*) at the coal face, and (*b*) by all employees, in respect of underground mines for each State concerned and for Australia for the years 1956 to 1960. These estimates have been calculated by the Joint Coal Board from data collected fortnightly in respect of coal production and the number of man-shifts actually worked. In South Australia, black coal is won only by opencut mining.

PRODUCTION OF BLACK COAL PER MAN-SHIFT: UNDERGROUND MINES.

(Tons.)

Year.	N.S.W.	Vic.	Q'land.	W. Aust.	Tas.	Australia.
PRODUCTION PER MAN-SHIFT WORKED AT COAL FACE.						
1956	11.43	2.05	6.79	5.14	7.04	9.77
1957	13.19	2.01	7.13	5.88	7.60	11.02
1958	14.48	2.04	7.28	6.67	8.01	11.96
1959	18.07	2.10	7.53	7.60	7.34	14.13
1960	20.64	2.16	8.37	8.12	7.64	16.08
PRODUCTION PER MAN-SHIFT WORKED BY ALL EMPLOYEES.						
1956	3.55	0.83	2.65	2.35	3.41	3.28
1957	3.99	0.85	2.82	2.77	3.76	3.65
1958	4.35	0.89	2.90	3.02	3.91	3.95
1959	4.90	0.93	2.95	3.35	3.72	4.37
1960	5.39	0.94	3.19	3.62	3.87	4.81

(ii) *Opencut Mines.* In the next table, the Joint Coal Board's estimates of production of black coal per man-shift worked by all employees in opencut mines are shown for the years 1956 to 1960. There are no opencuts producing black coal in Victoria.

PRODUCTION OF BLACK COAL PER MAN-SHIFT: OPENCUT MINES.

(Tons.)

Year.	N.S.W.	Q'land.	S. Aust.	W. Aust.	Tas.	Australia.
1956	10.36	13.06	6.72	6.37	8.56	9.19
1957	11.11	12.17	9.89	6.04	7.68	10.25
1958	11.31	13.63	11.46	6.78	10.42	11.47
1959	12.47	12.50	10.36	7.64	10.47	11.08
1960	22.15	10.96	12.46	8.01	9.38	13.79

12. **Joint Coal Board.**—For details of the powers and functions of this Board, which has functioned since 1947, *see* page 887 of Official Year Book No. 39.

§ 14. Coke and Other By-products from Coal.

1. **Coke.**—The production of metallurgical coke in Australia was limited to about 250,000 tons per annum prior to the 1914–18 War. This was below local requirements and necessitated an annual import of about 27,000 tons. By 1920, production had risen to more than 500,000 tons, by 1938–39 to 1,164,873 tons, and in 1960–61 it reached the record level of 2,738,505 tons. Imports exceeded exports prior to 1952–53, but in 1952–53 and later years there has been a net export surplus. In 1960–61, exports amounted to 81,075 tons while imports were 9,768 tons. Most of the tonnage imported is petroleum coke for use in the production of aluminium.

In addition to metallurgical coke referred to above (which is produced by specialized coke works), considerable quantities of coke are produced in gas works as a by-product of the manufacture of gas. Production in gas works in 1960–61 was 764,626 tons. To date, there has been no production of petroleum coke at Australian oil refineries.

In order to avoid duplication with coal values, the figures for coke have not been included in the general tables of mineral production in the early part of this chapter.

In the following table, particulars of the production of coke in coke works and gas works in Australia are shown for the years 1956–57 to 1960–61. The figures exclude output of coke breeze, which amounted to 316,549 tons in 1959–60 and 376,123 tons in 1960–61.

COKE PRODUCTION: AUSTRALIA.

(Tons.)

Industry.	1956–57.	1957–58.	1958–59.	1959–60.	1960–61.
Coke Works	2,234,458	2,295,737	2,210,621	2,376,097	2,738,505
Gas Works	954,756	831,615	815,464	758,668	764,626
Total	**3,189,214**	**3,127,352**	**3,026,085**	**3,134,765**	**3,503,131**

2. **Other By-products from Coal.**—In addition to coke, other products are obtained from the treatment of coal by coke and gas works. Some of the main items produced, principally in coke and gas works, during 1960–61 (1959–60 in parentheses) were: crude tar, 57,132,117 gallons (51,962,066 gallons); refined tar, 29,672,825 gallons (29,647,990 gallons); and ammonium sulphate, 98,988 tons (104,861 tons).

§ 15. Oil Exploration in Australia.

1. **Introduction.**—The discovery of oil in commercial quantities in Australia has been the objective of oil exploration companies for many years. Recent discoveries in Queensland could indicate that this country is on the verge of proving commercial oilfields.

A comprehensive survey of current developments was presented in a special article prepared by the Bureau of Mineral Resorces, Geology and Geophysics, Department of National Development and published in the December, 1961, issue of *The Australian Mineral Industry*. With minor modifications it is reproduced below.

2. **General.**—Within the land areas of Australia and Papua-New Guinea, the twenty-seven sedimentary basins cover 1,480,000 square miles of the total area of 3,519,000 square miles. The individual basins range in area from 4,000 to 510,000 square miles (*see* map on page 1079), and contain marine and continental sedimentary rocks ranging in maximum thickness from 1,000 to about 50,000 feet and including rocks of all ages from Proterozoic to Pliocene.

At present, seventy-two tenement holders have an aggregate tenement area of 2,200,000 square miles, including off-shore areas. Tenement areas range from four acres to 292,646 square miles. One joint-venture group holds a total of 381,250 square miles. Many of these large areas were granted when there was very little interest in Australian oil exploration and an absence of any general belief in the probability of finding commercial oil. Since then, a number of impressive shows of oil have established the presence of hydrocarbons in many parts of Australia and have given rise to a steady increase in the number of companies engaged in oil exploration.

Basic regional exploration is still only partly complete, and very little detailed investigation has been undertaken. The regional outcrop geology has been established in the New Guinea, Papua, Maryborough, Ipswich-Clarence, Sydney, St. Vincent, Carnarvon, Canning (including Fitzroy), Bonaparte, and Georgina Basins. Reconnaissance aeromagnetic surveys (flight lines at two-mile spacing) cover one-eighth of the Carpentaria Basin, half of the Bowen Basin, two-fifths of the Surat Basin, one-third of the Ipswich-Clarence Basin, the whole of the Perth and Carnarvon Basins, one-third of the Canning Basin, the whole of the Bonaparte Basin and about one-quarter of the Papua Basin. Reconnaissance gravity surveys (one station per 100 square miles) cover about one-third of the Papua Basin, one-fifth of the Carpentaria Basin, one-sixth of the Maryborough Basin, two-fifths of the Bowen Basin, one-third of the Surat Basin, one-fifteenth of the rest of the Great Artesian Basin, one-fifth of the Sydney Basin, the whole of the Gippsland Basin, half of the Murray Basin, half of the St. Vincent Basin, the whole of the Perth Basin, four-fifths of the Carnarvon Basin, two-thirds of the Fitzroy Basin and one-quarter of the rest of the Canning Basin, half of the Bonaparte Basin, and two-fifths of the Georgina Basin. Detailed gravity surveys (one station per ten square miles) have been completed only in the north-western part of the Canning Basin, the north-western part of the Carnarvon Basin and the northern part of the Perth Basin.

Regional seismic surveys and some detailed surveys have been started in the Papua, Surat, Maryborough, Great Artesian, Sydney, Gippsland, Otway, St. Vincent, Perth, Carnarvon, Canning and Bonaparte Basins. A few reconnaissance seismic traverses have been run in the Carpentaria, Bowen, Murray, Amadeus and Georgina Basins.

Stratigraphic drilling has begun in the Papua, Carpentaria, Bowen, Surat, Great Artesian, Maryborough, Ipswich-Clarence, Sydney, Gippsland, Otway, Murray, Eucla, Perth, Carnarvon, Canning and Bonaparte Basins, but only about 1,300,000 feet has been drilled in all (about one foot per square mile of the area of the sedimentary basins).

Expenditure on exploration is a useful guide to the level of activity. Since 1900 about £80 million has been spent in the whole of Australia and Papua-New Guinea—£37 million in Papua-New Guinea; £14 million in Queensland; £1.6 million in New South Wales; £4 million in Victoria; £2.7 million in South Australia; and £20 million in Western Australia. About £10 million only was spent before the 1939–45 War, mainly in Papua and Queensland. Since the War, expenditure has been concentrated in Papua (£28 million), Western Australia (£16 million) and Queensland (£13 million).

3. Government Assistance.—The role of Government in oil exploration has been to provide technical and financial assistance. On the technical side, the Bureau of Mineral Resources, Geology and Geophysics carries out geological and geophysical surveys and drilling to obtsin regional data on the sedimentary basins, and undertakes laboratory investigations. The State Mines Departments control tenements and also carry out field surveys and laboratory investigations. The Division of National Mapping provides aerial photographs, photo-maps and base maps to form the basis for geological and geophysical surveys.

In addition to taxation concessions to oil exploration companies and their shareholders, since 1957, the Commonwealth Government has been subsidizing exploration for oil; £2,486,092 had been paid in subsidies for stratigraphic drilling, geophysical surveys and bore-hole logging* to June, 1961. In October, 1961, the Petroleum Search Subsidy Act 1959 was amended to include structure drilling and test drilling under subsidy, to provide for payment of subsidy for drilling on a footage basis and to extend the period of operation of the Act to June, 1964. An amount of £2,700,000 was appropriated for subsidy payments in the year 1961–62.

* The surveying of the physical characteristics of the strata in a bore.

The Subsidy Acts have been designed to increase the total amount of exploration, to encourage companies to enter the field, and to ensure that subsidized exploration is adequately planned, carried out and reported upon, and that the results are generally made available within a short time. Although discoveries of oil would be the most significant immediate results of this policy, the very great improvement in the quality of the exploration work being carried out and its permanent documentation might in the long term prove more important in the success of the exploration effort on a national scale. In order to make the results of subsidized operations available, agreements have specified that the data be made available (and/or published) twelve months after the completion of field work; agreements made under the amended Act will reduce this period to six months.

The Bureau of Mineral Resources, which supervises the technical aspects of the Subsidy Act, insists on a certain minimum standard in operations; in most cases this is higher than previous Australian standards and consistent with oversea exploration practice. For example, before 1958, very few bores were adequately logged and tested; the Bureau's insistence on logging and testing has led to the introduction of several logging units that formerly were not available in Australia. It is expected that the current improvement will continue until Australian exploration is up to the best oversea standards.

A Sedimentary Basins Study Group is being established within the Bureau of Mineral Resources to collect all available data on the sedimentary basins, to collate and compile these data and to publish review maps and reports. The data obtained in subsidized operations will provide a basis on which work can begin, but it is hoped to enlist the co-operation of State Mines Departments and of exploration companies to ensure that all data that have been obtained may be used. Much data that normally are not included in reports, such as detailed outcrop sections, basic gravity data, details of experimental seismic work and copies of seismic records, will be sought.

A Core and Cuttings Laboratory has been established in Canberra, where representative cores and cuttings from all subsidized bores and as many others as can be obtained will be available for examination. Facilities will be provided for visiting geologists to examine the material.

4. **Status of Exploration.**—Several promising oil discoveries have been made—at Rough Range and Meda (Western Australia), Port Campbell (Victoria), Cabawin (Queensland) and Puri (Papua)—but none of these proved commercial. Oil was discovered at Moonie (Queensland) in December, 1961. Production testing in February, 1962, produced flows at rates ranging from 184 to 1,920 barrels a day. Wells are being drilled to assess the size and productive capacity of the Moonie field. Because of the capitalization required to bring the oil to the sea-board it cannot yet be stated that this discovery will be commercial in the sense of covering costs and making profits, and this will not be known until enough wells have been drilled to establish reserves and the optimum total production rate. Gas has been found in many places; the most important shows are at Kura, Bwata, Barikewa and Iehi in Papua (all or any of which may be commercial if a suitable market can be developed); at Roma (Queensland), where the gas is being used in the local electricity generating powerhouse; at Cabawin and Glendullock (Queensland); in the Camden area near Sydney (New South Wales); and at Port Campbell and Flaxman's Hill (Victoria). These discoveries lend additional support to the opinion that oil should be present in Australia's sedimentary basins in commercial quantities.

Domestic risk capital is more readily available than previously for well-organized exploration companies, and many experienced oversea companies are for the first time taking part in, or examining the possibility of taking part in, exploration for oil in Australia. These oversea groups have brought not only funds but also equipment and experienced personnel to assist in exploration.

The main problem is still the establishment of the regional geology of the basins in precise and reliable terms, so that regional structure, formation thicknesses and rock types can be determined and the geological history established. From this the history of movement of hydrocarbons may be indicated and the more prospective areas of the basin selected for detailed exploration.

The information obtained from drilling could be improved to provide more data of potential significance, for example sonic logs* to help in interpretation of seismic records (or velocity surveys where sonic logging is not available); pressure-temperature information from all tests regardless of the nature of the formation fluid (from this the hydrodynamic characters of each sand can be determined and these may indicate areas where prospects of petroleum accumulation are good); water analyses from formation tests; more porosity and permeability determinations on cores; more cores from permeable formations; more stratigraphic control; logging of organic content and of carbonate content of cuttings.

5. Basins.—The Papua Basin which for years was the area of most intensive exploration in the Australian region is at present being less actively explored. The prospects of the basin have been enhanced by the discovery of wet gas in the Miocene and of dry and wet gas in the Cretaceous. The unconformity between the Mesozoic and the Tertiary and the thrust fault established at Puri introduce problems in exploration, but neither the Cretaceous nor the Miocene has been explored completely. The Omati Basin has sedimentary peculiarities that have not been explained and much more exploration is justified in this area.

Following the entry of several experienced American companies into the State, Queensland has been the locale of greatest exploration activity for several years. Marine Permian sediments containing oil and gas have been found in the Surat Basin, but so far the sub-surface extensions of the Lower Palaeozoic of the Georgina Basin have not been determined. The Mornington Island bores have further restricted the prospective area of the Carpentaria Basin, but examination of the Gulf is required.

The discovery of oil and gas at Cabawin and oil at Moonie in the southward sub-surface extension of the Bowen Basin has increased the prospects of this basin considerably; the search is now for areas of adequate sand development in or in contact with the Permian marine source rocks. It is evident that the Bowen Basin is a structural basin including only the western part of the original basin of sedimentation.

The emphasis within the Great Artesian Basin has been on the exploration of the pre-Mesozoic rocks; very little attention has been given to the salt-water sands within the marine Cretaceous, although these must be rated as definitely promising. The discovery of Lower Palaeozoic marine sediments at Mootwingee on the margin of the Great Artesian Basin increases the probability that the Lower Palaeozoic sequence will be found in the sub-surface of the Basin. Data on the structure of the basin and of pre-Mesozoic basins underlying it are gradually being obtained. The discovery in bores of red-bed sequences below the Mesozoic has reduced the prospects of the pre-Mesozoic basins in the east-central area of the basin. The age of these sequences is not well established.

The Wreck Island bore on the western margin of the northern off-shore extension of the Maryborough Basin revealed marine Tertiary sediments overlying basement. This discovery has not yet been followed up. In the Sydney Basin, marine fossils have been found in the Narrabeen; structural drilling targets, to help in the search for extensions of the Camden gas sands, have been found. A shallow stratigraphic bore at Wentworth (New South Wales) has revealed Permian sediments underlying the Tertiary in the Murray Basin. In the Gippsland Basin, marine Cretaceous sediments were found by re-examination by the Geological Survey of Victoria of material from the Hollands Landing bore. Little new work has been done lately on the St. Vincent and Torrens Basins, but a bore is planned for the Adelaide area.

Significant shows of wet gas and condensate have been found in the Otway Basin. The latest bore to test this area, Flaxmans Hill No. 1, struck wet gas, but on test it produced insufficient quantities for development. The problem is now to locate areas of adequate sand development in contact with the source beds. Submarine seepages of heavy crude petroleum have been located off the coast of south-eastern South Australia. Apart from their adding to the positive indications of petroleum in the basin, these seepages are also important in that they suggest that, whatever its origin, this petroleum is migrating through the Tertiary formations and may, in favourable locations, form pools in the permeable Tertiary sands.

The stratigraphic bores at Eyre and Gambanga in the Eucla Basin revealed shallow basement; although this confirms the thinness of the prospective sediments in these areas, it does not effectively change the prospects of this basin, which have always been regarded as low and related to the possibility of a thicker prospective sequence seawards.

* Sonic logs record the sound velocity characteristics of the strata.

The occurrence of marine Triassic sediments and traces of oil in the Permian in stratigraphic bores drilled at Beagle Ridge and the confirmation of the presence of basement rocks in the Beagle Ridge have provided additional prospective sediments to those already known in the Perth Basin, and have afforded evidence of large structural relief in the basement. The Beagle Ridge and its flank would appear to be one of the more important prospective areas in the Basin. The first deep stratigraphic bore in the central area of the Perth Basin has been drilled at Eneabba, 150 miles north of Perth.

In the Carnarvon Basin, additional seismic work in the Rough Range area apparently has not produced a structural drilling target. Seismic surveys are proposed over the Wandagee basement ridge and in the Salt Lake area, where there are numerous anticlines in Tertiary and Cretaceous sediments, and may presage the exploration of the prospective Palaeozoic sediments. Stratigraphic bores have shown traces of petroleum in both the Sakmarian Lyons Group and the Artinskian Byro Group and of marine sediments and permeable sands in both.

The Canning Basin is now known to include the deep Fitzroy Basin and at least two shallower basins in the south. The deep basin may be repeated at the east margin of the Canning Basin beyond a structurally high saddle at the south-eastern end of the Fitzroy Basin. This deep basin may continue southward to join with the north-western extension of the Officer Basin. The hinge areas on either side of these deep basins and the basement ridges between the shallower basins offer attractive areas for exploration, since Lower Palaeozoic sediments of good permeability have been proved on the Broome Ridge and marine shales in the Samphire Marsh bore. The occurrence of salt intrusions at Frome Rocks No. 1 bore and at Woolnough Hills suggest that salt-dome structure may be found in the Palaeozoic with or without expression in the Mesozoic. Although the pre-Permian has been the main exploration target, oil shows have been obtained in the Permian, and it remains a prospect in areas where contemporaneous structures are intact.

The Spirit Hill bore revealed good source rocks in the Carboniferous of the Bonaparte Basin, but the distribution of the various sequences has yet to be established. Recent marine seismic work in the Gulf may help to establish this and to give useful information on the regional structure.

A regional gravity traverse has suggested a moderately deep Palaeozoic basin in the area east of Newcastle Waters in the Barkly Basin, and geological surveys near Camooweal suggest the possibility of the contemporaneity of the Camooweal Dolomite and the petroliferous Middle Cambrian. Geological, seismic and drilling exploration now programmed by the Bureau of Mineral Resources may change the prospects of this basin very markedly.

Regional surveys of the Georgina Basin have indicated a marine sequence, dominantly carbonate, of moderate thickness and some structural relief. Sediments appear mainly to be of shelf type, but the palaeogeography of the basin of deposition has not been established.

It has also been established that the Amadeus Basin is a structural basin with sediments mainly of shelf type, dominantly of sand and shale. It is suggested that the Georgina and Amadeus Basins are the structural remnants of a single large basin of deposition in which the Amadeus Basin represents the proximal shelf, the Georgina Basin the distal shelf or rim, and the Precambrian gneiss of the Harts Range area the location of the deep basin. The Precambrian gneiss shows strong evidence of deep burial and north-south compression at a stage much later than the high-grade metamorphism. The main problem in these two basins is to determine their structural and sedimentational histories so that possible migration directions of oil in relation to the development of structures may be assessed.

6. **Results.**—The net result to date is that there have been some encouraging discoveries, which are partially disappointing because they have not been commercial. But there has also been, over the past few years, a very significant improvement in the quality as well as the amount of exploration work done, and this has resulted in a very large increase in the understanding of the geology of the sedimentary basins. This in turn has enhanced the prospect of finding oil in commercial quantities.

7. **Footage Drilled in the Search for Oil.**—The following table, while not connected with the article above, shows details of footage drilled in the search for oil in the Commonwealth of Australia and the Territories of Papua and New Guinea during the years 1957 to 1961.

FOOTAGE DRILLED IN THE SEARCH FOR OIL.

Source: Bureau of Mineral Resources.(*a*)

(Feet.)

State or Territory.	1957.	1958.	1959.	1960.	1961.
New South Wales	8,729	16,357	17,422	6,169	7,779
Victoria	12,244	2,439	8,395	14,682	22,439
Queensland	15,343	5,081	30,328	54,841	74,931
South Australia	13,995	6,239	12,637	..	8,945
Western Australia	26,961	30,383	36,020	17,193	13,712
Northern Territory	..	..	2,458	1,373	1,024
Australia	**77,272**	**60,499**	**107,260**	**94,258**	**128,830**
Territories of Papua and New Guinea	25,636	29,350	13,389	10,042	..

(*a*) Based on figures obtained from State Departments of Mines and the Northern Territory Mines Branch.

§ 16. Sulphur.

1. **Mine Production of Sulphur.**—There is no production of elemental sulphur (brimstone) in Australia. However, while sulphur is itself non-metallic, considerable quantities are contained in certain metallic minerals produced.

It should be noted that large quantities of the lead and zinc concentrates produced are exported and the sulphur they contain is not available for utilization in Australia.

The following table shows the sulphur content of the metallic minerals produced during 1960 from which sulphur was subsequently recovered.

SULPHUR: CONTENT OF METALLIC MINERALS PRODUCED, 1960.

(Tons.)

Mineral in which contained.	N.S.W.	Q'land.	S. Aust.	W. Aust.	Tas.	Australia.
Lead Concentrate	46,715	..	..	(*a*) 316	(*a*) 2,071	49,102
Lead-copper Concentrate ..	..	..	..	..	(*a*) 952	(*a*) 952
Pyrite Concentrate	15,637	9,580	(*a*) 31,717	24,240	33,375	114,549
Zinc Concentrate..	142,006	(*a*) 15,032	..	..	18,359	175,397
Total ..	**204,358**	(*b*) **24,612**	(*a*) **31,717**	**24,556**	**54,757**	**340,000**

(*a*) Estimated. (*b*) Partly estimated.

The principal producing centres during 1960 were as follows.

(i) *New South Wales.* All the sulphur produced in New South Wales was contained in lead and zinc concentrates produced at Broken Hill and in lead, zinc and pyrite concentrates produced at Captain's Flat.

(ii) *Queensland.* In Queensland, sulphur was contained in zinc concentrate milled at Mount Isa and in pyrite concentrate produced at Mount Morgan. No sulphur was recovered in Australia from the zinc concentrate.

(iii) *South Australia.* A pyrite concentrate containing sulphur was produced from ore mined at Nairne, 22 miles east of Adelaide.

(iv) *Western Australia.* Sulphur was recovered from pyrite concentrates produced at Norseman and at Kalgoorlie. Although both these concentrates are auriferous, gold was recovered only from that produced at Kalgoorlie.

(v) *Tasmania.* A pyrite concentrate was recovered at Mount Lyell after the prior separation of the copper sulphide mineral. Recoverable sulphur was also contained in lead, lead-copper and zinc concentrates milled at Rosebery, but only that contained in zinc concentrate was recovered in Australia.

The following table shows for the years 1956 to 1960 the sulphur content of minerals from which sulphur was subsequently recovered.

SULPHUR: CONTENT OF METALLIC MINERALS PRODUCED.

(Tons.)

State.	1956.	1957.	1958.	1959.	1960.
New South Wales	187,087	207,604	197,736	188,892	204,358
Queensland(*a*)	15,103	24,544	14,647	17,464	24,612
South Australia (*b*).. ..	31,248	32,721	32,129	27,616	31,717
Western Australia	25,295	25,420	22,635	24,473	24,556
Tasmania	47,339	52,185	55,472	52,100	54,757
Australia	**306,072**	**342,474**	**322,619**	**310,545**	**340,000**

(*a*) Partly estimated. (*b*) Estimated.

2. Production of Sulphuric Acid.—The principal use of sulphur is in the manufacture of sulphuric acid, which is produced in all States and in the Northern Territory. Most of this is used for fertilizer manufacture, although small quantities are used in the rubber and chemical industries and in the preparation of uranium concentrates. Sulphur contained in lead concentrate is used for acid manufacture at Port Pirie and sulphur in zinc concentrates is used at Risdon. Pyrite concentrate is used as a source of sulphur for acid manufacture at Cockle Creek, near Newcastle, and at Port Kembla in New South Wales, and at Melbourne, Brisbane, Adelaide, Perth and Fremantle. However, about half the sulphuric acid produced in Australia is made from imported elemental sulphur. The next table shows, for the years 1957 to 1961, the Australian production of sulphuric acid and the quantity of sulphur in the acid produced from various sources.

SULPHUR USED IN SULPHURIC ACID PRODUCTION: AUSTRALIA.

(Tons.)

Item.	1957.	1958.	1959.	1960.	1961.
Production of Sulphuric Acid (Mono)	*971,976*	*1,009,064*	*1,000,458*	*1,109,751*	*1,137,501*
Sulphur in Sulphuric Acid (Mono) produced from— ..					
Sulphur (Elemental)(*a*) ..	156,413	162,881	153,195	179,752	182,554
Zinc Concentrate ..	35,025	38,524	39,933	42,946	52,423
Lead Concentrate ..	18,272	21,339	19,619	21,573	22,440
Pyrite	100,111	99,216	103,596	104,406	100,520
Spent Oxide	4,744	4,301	3,655	3,814	2,277
Other Materials ..	3,271	3,702	7,151	10,396	11,749
Total Sulphur Content..	*317,836*	*329,963*	*327,149*	*362,887*	*371,963*

(*a*) All imported.

§ 17. Non-metallic Minerals.

1. Asbestos.—Production of asbestos in Australia has been confined mainly to crocidolite which is found principally in the Hammersley Ranges in Western Australia, about 200 miles south-east of Roebourne. Production from this centre, which has reserves estimated at two million tons, has expanded greatly in recent years. The only deposits of chrysotile, located mainly at Nunyerry in Western Australia and at Baryulgil in New South Wales, are relatively small and widely scattered.

The production of chrysotile and crocidolite in Australia during the five years 1956 to 1960 is shown in the following table.

PRODUCTION OF ASBESTOS.

(Short Tons of 2,000 lb.)

Year.	Chrysotile.			Crocidolite.
	New South Wales.	Western Australia.	Australia.	Australia.(a)
1956	697	852	1,549	8,160
1957	676	1,556	2,232	12,438
1958	712	1,543	2,255	13,313
1959	726	707	1,433	16,442
1960	1,072	69	1,141	14,472

(a) Produced in Western Australia only.

2. Clays.—Statistics of clay production in Australia are not entirely satisfactory, mainly because of differences between States in the classification of the various types of clays. In addition, the statistics are incomplete as some clays are outside the normal administrative control of some State Mines Departments. In the following table, the recorded production of the main types of clays produced in each State of Australia is shown for the year 1960.

PRODUCTION OF CLAYS, 1960.

(Tons.)

Type.	New South Wales.	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.	Australia.
Bentonite and Bentonitic Clay ..	17	..	173	..	382	..	572
Brick Clay and Shale	2,077,518	a1,258,275	334,584	407,840	(a)310,342	157,245	4,545,804
Cement Clay and Shale	177,624	(b)	(b)	18,090	13,015	(b)	(c)208,729
Damouritic Clay ..	..	..	..	559	..	..	559
Fireclay, n.e.i. ..	88,872	14,498	12,571	21,009	20,347	..	157,297
Fuller's Earth ..	90	..	..	..	..	..	90
Kaolin	37,973	5,938	37	3,283	..	964	48,195
Stoneware Clay ..	75,353	..	30	53,442	..	..	128,825
Tile Clay.. ..	121,576	(b)	(b)	(b)	(b)	3,750	(c)125,326
Other Clays ..	6,036	191,299	(b)	(b)	(b)	13,064	(c)210,399

(a) Estimated. (b) Not available. (c) Incomplete.

3. Gypsum.—There are very extensive deposits of gypsum in Australia, but only the more accessible and easily worked deposits have been exploited. These deposits lie in four main regions, (a) in New South Wales stretching from around Griffith to near Broken Hill, (b) in the north-west corner of Victoria, the south-west corner of New South Wales and adjoining parts of South Australia, (c) in South Australia on both sides of St. Vincent Gulf and extending to Lake MacDonnell in the west, and (d) between Perth and Kalgoorlie in Western Australia. The South Australian deposits are the most important and more than half the total Australian production of gypsum in 1960 came from that State, where the main centres of production are Stenhouse Bay on Yorke Peninsula and Lake MacDonnell.

The building industry is the main user of the gypsum produced in Australia. The greatest part is used in the manufacture of plaster and most of the remainder in cement manufacture. A small amount is also used as fertilizer. A considerable quantity is exported, mainly to New Zealand for use in the plaster industry.

The production of gypsum in Australia is set out in the following table for the five years 1956 to 1960.

PRODUCTION OF GYPSUM.
(Tons.)

Year.	New South Wales.	Victoria.	South Australia.	Western Australia.	Australia.
1956	94,203	78,895	263,136	27,121	463,355
1957	101,491	68,647	274,945	33,353	478,436
1958	90,664	72,010	306,749	35,515	504,938
1959	101,143	81,101	296,816	37,731	516,791
1960	95,514	100,386	340,762	44,216	580,878

4. **Limestone.**—Limestone is quarried in all States, being used mainly for the manufacture of cement. Other uses are in agriculture, in the steel industry as a metallurgical flux, and in the chemical industry.

The recorded statistics of limestone production in each State of Australia for the years 1956 to 1960 are shown in the following table. Details of limestone produced for use as building or road material are not included.

PRODUCTION OF LIMESTONE(*a*).
('000 Tons.)

Year.	New South Wales.	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.	Australia.
1956 ..	1,700	813	(*b*)	1,076	(*b*)	179	4,264
1957 ..	1,897	846	(*b*)	1,135	(*b*)	205	4,572
1958 ..	2,061	859	(*b*)	1,220	(*b*)	235	5,324
1959 ..	2,056	1,120	(*b*)	1,017	(*b*)	230	5,305
1960 ..	2,400	1,157	(*b*)	1,064	(*b*)	215	5,669

(*a*) Includes shell and coral. (*b*) Not available for publication, included in total for Australia.

5. **Magnesite.**—The major sources of magnesite at present are deposits at Fifield, Thuddungra and Lake Cargelligo in central New South Wales. Most of the output of magnesite in Australia is used for refractory purposes, particularly in the steel industry, and small amounts are used in chemical, paper, glass, rubber, and ceramic industries. Particulars of the production of magnesite in each State for the years 1956 to 1960 are set out in the table below.

PRODUCTION OF MAGNESITE.
(Tons.)

Year.	New South Wales.	Queensland.	South Australia.	Western Australia.	Australia.
1956	63,050	..	831	804	64,685
1957	83,271	..	202	..	83,473
1958	69,030	20	341	..	69,391
1959	59,777	..	790	19	60,586
1960	61,668	..	498	..	62,166

6. **Mica.**—Almost all Australian production of muscovite mica comes from the Northern Territory, though small quantities of inferior grades have been obtained from most of the States. The centre of mica production in the Northern Territory is the Harts Range area, about 130 miles north-east of Alice Springs, where mining has been carried on intermittently since 1892, and the Plenty River field, 50 miles north-east of Harts Range.

Prior to 31st December, 1960, the Commonwealth Mica Pool, details of which are given on page 1094 of Official Year Book No. 46, purchased all mica which was in accordance with certain specifications. From that date, this agency ceased buying locally-produced mica and will discontinue selling the product as soon as practicable.

Local production of block mica has declined steadily and in 1960 it had fallen to 9,500 lb. which was the lowest since 1925.

The following table shows the quantity of muscovite mica produced in Australia during the five years 1956 to 1960.

MUSCOVITE MICA PRODUCTION.

(lb.)

Particulars.	1956.	1957.	1958.	1959.	1960.
New South Wales—					
Scrap	..	..	15,680	7,000	..
Queensland—					
Scrap	..	..	21,728	..	..
Northern Territory—					
Trimmed	28,837	36,713	42,479	44,665	9,500
Crude and Film	..	..	35,840	170,000	649,600
Scrap	..	40,600	..	..	..

7. Salt.—Salt is obtained in Australia by evaporation of saline lakes and clay pans. Production satisfies local requirements and provides a considerable surplus for export. Recorded production in South Australia (the chief producing State) is shown in the following table for the years 1956 to 1960. Estimates of total Australian production are also shown.

SALT PRODUCTION.

('000 Tons.)

Particulars.	1956.	1957.	1958.	1959.	1960.
South Australia	332	339	336	358	359
Estimated Australian Total ..	409	428	430	468	463

8. Other Non-metallic Minerals.—(i) *General.* Many other non-metallic minerals are produced in Australia in considerable quantities, and are listed separately in the following paragraphs.

(ii) *Barite.* The principal centre producing first-grade barite is at Oraparinna in the North Flinders Range in South Australia. The production of barite in Australia during 1960 was 11,417 tons, of which 11,357 tons came from South Australia and 60 tons from New South Wales.

(iii) *Diatomite.* Production of diatomite is carried on mainly in the eastern States of Australia. In 1960, 4,659 tons were produced, of which New South Wales produced 3,941 tons, mainly at Coonabarabran and Barraba. The remaining 718 tons were produced in Victoria, principally at Lillicur.

(iv) *Dolomite.* Up to 1950, New South Wales was the main producer of dolomite, but in that year a large deposit at Ardrossan in South Australia, which now produces over 90 per cent. of the total output, was opened up. In 1960, South Australia produced 182,290 tons; New South Wales, 3,357 tons; Tasmania, 2,678 tons; Queensland, 2,139 tons; and Western Australia, 404 tons, making an Australian total of 190,868 tons.

(v) *Felspar.* The main demand for felspar comes from the glass and ceramic industries. Most of the Australian production of felspar comes from New South Wales, which produced 5,325 tons of the Australian total of 8,414 tons in 1960. Of the remainder, 1,942 tons came from Western Australia and 1,147 tons from South Australia.

(vi) *Gemstones.* (*a*) *Opals.* Most of the opals won in recent years came from the Coober Pedy and Andamooka fields in South Australia which produced opals worth £598,000 in 1960. Other production in 1960 was from Lightning Ridge in New South Wales, valued at £40,000.

(*b*) *Sapphires.* In 1960, sapphires produced in the Inverell District of New South Wales were valued at £3,000 and production from the Anakie Field in Central Queensland was valued at £2,000.

(vii) *Phosphate Rock.* In the course of a search for deposits of uranium ore near Rum Jungle in 1961, the Bureau of Mineral Resources discovered high-grade phosphate rock deposits in the area. At this stage the size and potential of this discovery are not known. However, a programme is being conducted to make a preliminary assessment of the extent and grade of the new deposits.

(viii) *Silica.* The production of silica is not recorded in Victoria and production recorded in all other States may not be complete. The output of silica, which includes glass sand, quartz, quartzite, sand, sandstone, and silicious abrasives, but does not include production for use as building or road material, was 165,447 tons in New South Wales; 15,882 tons in Queensland; 14,615 tons in South Australia; 8,925 tons in Western Australia; and 5,231 tons in Tasmania; making a total of 210,100 tons recorded for those States during 1960.

(ix) *Sillimanite.* In 1960, 1,524 tons of sillimanite were produced in Australia, all of which came from South Australia.

(x) *Talc.* The Australian output of talc (including steatite) was 15,670 tons in 1960. South Australia produced 9,064 tons, Western Australia 5,470 tons, and New South Wales 1,136 tons.

(xi) *Other.* Other non-metallic minerals produced in Australia in small quantities during 1960 were fluorspar, garnet concentrate, glauconite, industrial diamonds, foundry loam, mineral pigments, pebbles for grinding, perlite, pyrophyllite, and serpentine.

§ 18. Oversea Trade in Minerals and Mineral Products.

Particulars of the quantity and value of the principal mineral and mineral product items imported into and exported from Australia during the years 1958 to 1960 are shown in the following table.

IMPORTS AND EXPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS: AUSTRALIA.

Item.	Unit of Quantity.	Quantity.			Value. (£A 000.)		
		1958.	1959.	1960.	1958.	1959.	1960.
IMPORTS.							
Aluminium, Refined—							
Ingots	ton	14,813	19,268	26,432	3,356	3,883	6,448
Plates, Sheets and Strips	,,	2,317	2,555	5,770	1,026	1,068	2,432
Foil	,,	2,409	2,788	3,909	1,711	1,803	2,560
Asbestos	short ton	38,888	38,330	41,002	2,493	2,502	2,508
Gold, Unrefined Bullion	fine oz.	160,232	136,674	143,852	2,502	2,136	2,235
Iron and Steel—							
Bars and Rods	ton	24,798	9,035	54,075	2,750	1,940	4,597
Ferro-alloys	,,	13,335	23,989	41,612	1,486	1,859	3,391
Plate and Sheet (Plain)	,,	15,918	9,119	258,539	3,354	2,919	16,852
Tinplate	,,	66,059	50,348	63,741	6,699	4,774	6,039
Petroleum Oils—							
Crude	'000 gals.	2,441,916	2,603,377	2,699,251	67,778	69,347	67,743
Enriched Crude	,,	95,302	35,559	237,336	4,079	802	6,923
Kerosene	,,	97,403	109,649	102,965	5,337	6,002	5,368
Lubricating Oil	,,	41,665	49,619	49,832	5,759	6,582	6,809
Spirit	,,	207,500	243,910	238,083	14,566	13,228	13,247
Phosphate Rock	'000 tons	1,501	1,327	1,491	3,894	3,689	4,075
Sulphur	ton	202,421	170,770	221,778	2,254	1,855	2,285
Titanium Oxide	,,	6,996	5,472	5,054	1,482	1,016	971

IMPORTS AND EXPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS: AUSTRALIA—*continued.*

Item.	Unit of Quantity.	Quantity.			Value. (£A'000 f.o.b.).		
		1958.	1959.	1960.	1958.	1959.	1960.
EXPORTS.(a)							
Asbestos	short ton	10,433	12,974	8,299	933	1,225	784
Coal	ton	823,925	794,190	1,577,140	3,408	3,178	6,327
Copper, Blister	,,	14,471	16,225	502	3,156	4,375	162
Gold, Refined	fine oz.	128,550	128,052	2,513,583	2,111	2,007	39,275
Iron and Steel—							
Bars and Rods	ton	28,588	39,198	52,633	1,420	1,895	2,585
Plate and Sheet, Plain	,,	85,444	141,313	60,728	5,169	8,468	4,251
Plate and Sheet, Galvanized	,,	58,938	58,488	57,792	4,911	4,975	4,988
Scrap	,,	156,978	182,985	205,747	2,800	3,404	3,431
Lead—							
Ore and Concentrate(b)	,,	83,984	90,797	74,696	4,776	5,034	4,172
Lead-Silver Bullion	,,	58,068	53,021	49,653	6,104	5,498	5,268
Pig	,,	155,730	138,448	125,265	13,729	12,025	10,970
Petroleum Oils—							
Spirit	'000 gals.	80,171	32,682	35,289	4,814	2,140	2,588
Diesel Oil	,,	43,081	93,008	179,490	2,511	5,305	10,232
Residual and Furnace Oil	,,	202,052	146,869	174,804	9,131	6,484	7,320
Rutile Concentrate	ton	75,615	80,938	93,706	4,630	3,609	4,064
Silver, Refined	'000 fine oz.	4,876	3,001	2,800	1,911	1,224	1,150
Zinc—							
Ore and Concentrate	ton	261,279	193,254	321,930	2,749	2,472	5,395
Refinery Type Shapes	,,	37,938	41,606	27,443	3,165	3,962	3,066

(a) Includes re-exports. (b) Includes lead-copper concentrate.

Considerable quantities of metallic ores, concentrates, slags and residues are exported from Australia for refining overseas. The following table shows the quantities of such items exported during 1960 and their principal metallic content as estimated by assay.

PRINCIPAL METALLIC CONTENTS OF SPECIFIED ORES AND CONCENTRATES, ETC., EXPORTED FROM AUSTRALIA DURING 1960.

Ores and Concentrates, etc.	Quantity Exported.	Metallic Contents—Estimated from Assay.						
		Copper.	Gold.	Lead.	Silver.	Tin.	Tungstic Oxide.	Zinc.
	ton.	ton.	fine oz.	ton.	fine oz.	ton.	ton.	ton.
Copper—								
Ore and Concentrate	137,897	34,408	9,632	..	305,883	..	..	..
Copper—Lead Dross and Speiss	5,333	941	..	3,223	218,883	..	..	..
Other Slags and Residues	139	76	..	1	..	1	..	5
Blister	502	498	..	..	..	..	..	..
Lead—								
Ore and Concentrate(a)	74,696	785	16,171	49,129	1,811,018	..	..	5,356
Slags and Residues	808	..	..	335	..	1	..	..
Lead-Silver Bullion	49,653	..	..	49,305	3,972,260	..	..	..
Tungsten—								
Scheelite Ore and Concentrate	505	..	..	..	..	..	351	..
Wolfram Ore and Concentrate	913	..	..	..	..	..	655	..
Zinc—								
Ore and Concentrate	321,930	..	..	2,239	93,056	..	..	168,200
Slags and Residues	6,443	..	..	..	..	..	..	4,530
Total Metallic Contents	..	36,708	25,803	104,232	6,401,100	2	1,006	178,091

(a) Includes lead-copper concentrate.

§ 19. Government Aid to Mining, and Mineral Control.

1. **Aid to Mining.**—(i) *Commonwealth.* (*a*) *Assistance to the Gold Mining Industry.* For particulars, *see* para. 9, page 1064.

(*b*) *Assistance to the Copper Mining Industry.* For particulars, *see* para. 8, page 1073.

(*c*) *Assistance to Producers of Sulphuric Acid and Iron Pyrites.* As a result of Tariff Board recommendations, the Sulphuric Acid Bounty Act was extended for a period of five years from 1st July, 1960. Arising from these same recommendations, the Pyrites Bounty Act 1960 was enacted on 15th December, 1960, to be operative for a period of five years from that date. The Acts provide for bounties to be paid to producers of iron pyrites and sulphuric acid.

(*d*) *Income Taxation Concessions.* For particulars of income taxation concessions to the gold, copper and uranium mining industries, *see* pages 1065, 1073 and 1085 respectively. Further information is given in a booklet entitled *Income Tax for the Mining Industry*, issued by the Commissioner of Taxation.

(*e*) *Search for Oil.* The Commonwealth Government has encouraged the search for oil in Australia, Papua and New Guinea and considerable sums have been spent during recent years in geological and geophysical surveys and in drilling operations.

The Bureau of Mineral Resources, in close co-operation with the Mines Departments of the States, has continued regional geological and geophysical surveys throughout the Commonwealth. In 1957, the Commonwealth introduced the Petroleum Search Subsidy Act 1957, whereby stratigraphic drilling operations were subsidised to the extent of 50 per cent. of cost. The Petroleum Search Subsidy Act of 1959 widened the scope of operations for which subsidy was offered to include all types of geophysical surveys and off-structure drilling operations. Another amendment in 1961 further widened the scope of the 1959 act to provide subsidy for test drilling and detailed structure drilling operations. It also provided for the calculation of drilling subsidies on a footage basis as an alternative to the total cost basis. To the end of 1961, actual payments of subsidy totalling more than £3 million had been made in accordance with the terms of the Subsidy Acts and it is anticipated that this amount will be greatly increased during the next three years because of the recent impetus in oil search activities. For further particulars of Government assistance in oil exploration, *see* § 15.—Oil Exploration in Australia, page 1095.

(*f*) *Rewards for Discovery of Uranium Ore.* The Commonwealth Government's offer to pay rewards up to a maximum of £25,000 for the discovery of any one deposit of uranium ore was withdrawn on 31st March, 1961.

(*g*) *Mica Pool.* The Commonwealth Mica Pool ceased purchasing mica on 31st December, 1960, and the Committee of Management was abolished on the same day. The Pool will continue to sell mica while stocks last.

(*h*) *Bureau of Mineral Resources, Geology and Geophysics.* The Bureau of Mineral Resources, Geology and Geophysics has sections dealing with geology, geophysics, mining engineering, petroleum technology and mineral economics. The geological section provides geologists to conduct all surveys required in Commonwealth Territories, and makes detailed and regional surveys in conjunction with or by arrangement with the State Mines Departments, surveys of possible oil-fields in Australia and New Guinea, surveys of mines for which financial assistance is sought, and investigations of deposits of radio-active minerals. The geophysical section conducts investigations throughout Australia and New Guinea connected with the search for metalliferous radio-active and other mineral deposits; investigations connected with exploration for coal, oil and water; regional magnetic and gravity surveys; engineering and military geophysics; and the operation of geophysical (magnetic and seismic) observatories. The Bureau works in close co-operation with the Mines Departments of the States. It has assumed full responsibility for geological and geophysical surveys in Commonwealth Territories, but suitable arrangements have been made to ensure that the local Administrations have the necessary technical advice directly available to them.

(*i*) *Ore-dressing and Mineragraphic Investigations.* These investigations are conducted by the Commonwealth Scientific and Industrial Research Organization as required by the industry. Ore-dressing investigations are carried out at the Ore-Dressing Laboratory, situated in the Department of Mining, University of Melbourne, and at the Ore-Dressing Laboratory, Kalgoorlie, situated at the School of Mines. The Mineragraphic Investigations Section is located in the Geology Department, University of Melbourne.

These two groups of laboratories perform complementary services—the Mineragraphic Investigations Section assesses microscopically the state of dispersion and the mineral association of ore bodies, while the Ore-Dressing Laboratories investigate the composition of ores and provide advice on suitable methods for their full-scale treatment. Much of this research is carried out on a co-operative research basis with the mining industry.

(*f*) *Department of Territories.* For particulars of the Northern Territory Administration, *see* paragraph (*h*) under section (ii) *States* following.

(ii) *States.* (*a*) *General.* In addition to free assays and determinations of rocks and minerals carried out for prospectors by the Mines Departments of the States and Territories, technical officers of these departments provide advice to the mining and allied industries where required, carry out field examinations of mining prospects, advise on exploration and development, select sites for water supply, and in general give a free technical service to the mining industry.

(*b*) *New South Wales.* State aid to assist metalliferous mining may consist of grants to assist the prospecting and/or mining for gold and minerals, and for the purchase, removal and installation of mining plant or equipment. A quantity of mechanical equipment is also available in several localities for hire at reasonable rentals to prospectors and small mine operators, and District Inspectors have geiger counters and scheelite detectors which are loaned to approved persons.

(*c*) *Victoria.* Loans may be granted to assist prospecting and development or the purchase of machinery for gold mining. The Mines Department has stamp batteries in different parts of the State to crush ore for prospectors at nominal rates. Small mining companies may avail themselves of these facilities. Drilling with diamond, rotary and percussion drills is carried out by the Mines Department for mining companies and for general mineral exploration. A survey of the State's underground water reserves is in progress, in conjunction with the opening up of town water supplies from underground sources.

(*d*) *Queensland.* Various forms of assistance to mining are made available by the Queensland Department of Development and Mines. Grants are made from the Consolidated Revenue Fund for use on construction and maintenance of roads in mining areas. Advances are made from the Gold Mining Encouragement Fund for mining development work. This assistance is restricted to gold mines and advances are repayable from proceeds of the mine, if any. From the Assistance to Metalliferous Mining Fund, plant, such as jackhammers, compressors and pumps, is purchased and maintained. Such plant is made available on hire, the rental payments being credited back to the fund. Prospecting assistance is made available in approved cases, the rates being £2 10s. a week for a single man and £3 10s. a week for a married man with dependants. This is not repayable. From the Advances to Mining Fund, assistance by way of subsidy is advanced for mine development. This is repayable from proceeds of the mine. The Department also maintains a treatment works for tin ores, etc., at Irvinebank, an assay office at Cloncurry, and diamond-drilling plants in several parts of the State. The Venus State mill at Charters Towers is available for the treatment of gold-bearing ores.

(*e*) *South Australia.* The Department of Mines provides the following services and facilities to the mineral industry:—(i) Hire of boring plant and mining equipment, boring and testing of mineral deposits, financial subsidies in approved cases for prospecting and mining development, development of sub-surface water supplies for farming, pastoral, irrigation and mining purposes, and purchase of basic metal ores from prospectors; (ii) geological examination of mineral deposits, water supply, dam foundation and drainage problems, guidance on mining legislation, and publication and issue of geological bulletins and maps. It also provides, through the Australian Mineral Development Laboratories, chemical and metallurgical, analytical and assay investigation, testing and treatment of ores and minerals, petrographic, mineragraphic and radiometric determinations. Pilot scale metallurgical and chemical treatment plants are maintained and operated for the development of mineral extraction processes.

(*f*) *Western Australia.* Assistance is given to prospectors to the extent of £5 a week south of the 26th parallel of latitude, and of £6 a week north of that parallel; also provision is made for the supply of some tools required for prospecting.

There are twenty State batteries operating intermittently throughout the goldfields for the treatment of ore from prospectors and small mine-owners, at a nominal charge. A cartage subsidy is also granted to such operators sending ore to State batteries for treatment.

Provision is made for loans to mine-owners who require assistance to develop mines. The Government also has a drilling scheme, financing mine-owners on a £1 for £1 basis.

(*g*) *Tasmania.* The Department of Mines provides financial assistance to mining lessees for the purchase of plant and machinery, for sinking, repairing or de-watering of shafts, for construction of dams and water races, for testing and proving a deposit of any mining product, for developmental work and for diamond and other types of drilling. The Department has available for hire percussion and diamond drills for exploration, as well as a complete plant for small shaft sinking and tunnelling. Other assistance is rendered to the industry by geological and engineering advice and through ore-dressing research into metallurgical recoveries and the selection and design of treatment plant.

(*h*) *Northern Territory.* To encourage the development of the mining industry, the Northern Territory Administration has erected four Government batteries for the treatment of miners' ores. Only two of these, at Tennant Creek and Mount Wells near Burrundie, are now in operation. The re-opening of the other two batteries will depend on the revival of small scale wolfram and tin mining in Hatches Creek and Maranboy where these batteries are located.

The crushing charges are subsidized by Government grants. In addition, the Administration provides cartage subsidies and financial advances to encourage miners to carry out developmental work. Roads and water supply services are provided and maintained for mines under active development throughout the Territory.

2. **Controls on Minerals and Metals.**—Export controls are maintained over certain minerals and metals. These controls are enforced by means of the Customs (Prohibited Exports) Regulations as amended from time to time by Statutory Rules. To export these materials, it is necessary to obtain a clearance from the following Commonwealth Departments:—

(i) Department of National Development—Mineral sands in all forms (including concentrates) containing zircon, rutile or ilmenite; lithium ores and concentrates; beryllium ores and concentrates; manganese ores; iron ores, beneficiated iron ores and iron concentrates;
(ii) Department of Trade—Iron, steel and ferrous alloys;
(iii) Department of Primary Industry—Phosphate rock, phosphate and superphosphate and fertilizers containing phosphate or superphosphate;
(iv) Australian Atomic Energy Commission—All radio-active minerals, metals and compounds, including uranium and thorium in all forms; lithium metal and alloys; beryllium metal, alloys and compounds; zirconium metal, alloys and compounds.

Further information concerning the Atomic Energy Commission appears in Chapter XV.—Education and Research.