

CHAPTER 26

MINERAL INDUSTRY

Further detailed statistics and information on the subjects dealt with in this chapter are contained in the annual printed bulletin *The Australian Mineral Industry—Annual Review* and other publications issued by the Bureau of Mineral Resources, Geology and Geophysics, which also issues, in conjunction with this Bureau, a quarterly publication, *The Australian Mineral Industry* (10.17), comprising two parts—Part 1—Quarterly Review and Part 2—Quarterly Statistics. The annual statistical bulletins *Mining Establishments, Summary of Operations* (10.55), *Mining Establishments* (10.60), *Mineral Production* (10.51), *Mineral Exploration* (10.41), and *Overseas Participation in Australian Mining Industry* (10.42) of this Bureau contain economic statistics of the industry prepared and published as soon as possible after the data have been compiled. A monthly statistical bulletin *Minerals and Mineral Products* (10.19) is issued also, and other current statistics on mining or mine products are contained in the *Quarterly Summary of Australian Statistics* (1.3), the *Monthly Review of Business Statistics* (1.4), the *Digest of Current Economic Statistics* (1.5), and the *Monthly Bulletin of Production Statistics* (12.14).

All quantity data in this chapter are quoted in imperial units throughout the text and metric units within statistical tables except where otherwise indicated.

GENERAL

Geology

General geology

Most of the western and central part of the Australian continent consists of basement rocks of Precambrian age. Younger Palaeozoic rocks, mostly of geosynclinal origin, form a discontinuous belt several hundred miles wide extending from north Queensland to Tasmania. Mesozoic platform sediments form a broad zone separating the Palaeozoic and Precambrian rocks and extending from the Gulf of Carpentaria to central New South Wales. Cainozoic rocks occur mainly in Victoria, south-western New South Wales and southern South Australia, and as residual basalt cappings over extensive areas of the Palaeozoic rocks of eastern Australia.

Economic geology

Minerals of economic significance occur widely throughout the Precambrian and Palaeozoic rocks of the continent. Palaeozoic mineralisation is perhaps more varied, but the Palaeozoic deposits now being worked are in general smaller than those found in Precambrian rocks. Most of Australia's metallic mineral deposits occur within two broad regions, a region of Precambrian rocks in the west and central areas of the continent and a region of younger Palaeozoic rocks in the east.

The major deposits of metallic ore minerals, including those of iron, lead, zinc, silver, copper, uranium, nickel, and gold, are contained in the Precambrian rocks of the Australian shield. Smaller deposits of ores of tin, tungsten, tantalum, beryllium, manganese, cobalt, and mica are also contained in these rocks.

The mineralised Palaeozoic rocks contain major deposits of gold, now mostly worked out, and a few large copper and lead-zinc-silver ore occurrences. Smaller amounts of ores of tin, tungsten, molybdenum, bismuth, antimony, and ores of other metals also occur in these rocks.

Outside these two main categories, however, there are some metallic mineral deposits of considerable economic importance which were formed during the Tertiary Period. These include bauxite (the ore of aluminium) which occurs as a surface capping over rocks of various ages. Extensive deposits of bauxite occur at Weipa on Cape York peninsula in north Queensland, at Gove on the north-eastern tip of the Northern Territory, in the Darling Range in Western Australia, and near Kalumburu in the north-west of Western Australia. These deposits are the result of a long period of weathering and reworking.

Other important deposits which are the results of weathering are the lateritic nickel deposits at Greenvale and Rockhampton in Queensland, and in the Kalgoorlie and Wingellina areas of Western Australia. Mineral sands, another important exception, contain rutile and ilmenite (ores of titanium), zircon (zirconium ore), monazite (thorium ore), and other minerals, and are particularly well developed on the central and northern New South Wales coast, southern Queensland and south-western Western Australia. The deposits of the eastern States are considered to be final derivatives of Mesozoic rocks. The Western Australian deposits are thought to be derivatives of the Precambrian granites of the Australian shield.

Occurrences of fuel minerals (coal, oil and natural gas) are characteristically located in former sedimentary basins. Large areas of Australia are covered by these basins, and more than twenty major sedimentary basins have been identified on the Australian mainland. In addition, sedimentary basins are known to exist in off-shore areas adjacent to the Australian coast. The individual basins range in area from 4,000 to 680,000 square miles and contain marine and continental sedimentary rocks ranging in maximum thickness from 1,000 to about 30,000 feet and including rocks of all ages from Proterozoic to Tertiary.

The main Australian deposits of black coal are in eastern Queensland and New South Wales. Most are Permian in age, and they predominantly have a bituminous rank; both coking and non-coking types occur. The extensive brown coal deposits of Victoria were formed during the Tertiary Period and are used to produce electricity for that State.

Crude oil and natural gas have been found in a number of sedimentary basins. In the Bowen-Surat Basin, Queensland, commercial deposits of oil exist at the Moonie, Alton, Bennett and Major fields, and commercial deposits of natural gas exist in the Roma, Surat and Rolleston areas. Gas from the Roma area is used to supply Brisbane. Gas reserves are present in the Adavale Basin at Gilmore, and in a dozen or so accumulations in the Cooper Basin which extends from South Australia into Queensland and the Northern Territory. In general the oil reservoir rocks in Queensland are of Lower Jurassic age, and the gas reservoir rocks are of Mesozoic and Permian age. In the Gippsland Basin, off-shore from Victoria in Bass Strait, oil in commercial quantities was discovered in the Kingfish, Halibut, Tuna, Barracouta and the Mackerel field and commercial natural gas in the Marlin, Barracouta, Snapper and Tuna fields. Cretaceous and Tertiary strata are the reservoir rocks. Eastern Victoria and Melbourne are now supplied with gas from Marlin and Barracouta fields. Oil is being piped from Kingfish, Halibut and Barracouta. In the Cooper Basin, South Australia, commercial deposits of natural gas were discovered at Gidgealpa, Moomba, Daralingie, Toolachee, Merrimelia, Della, Strzelecki, Mudrangie, Moorari, Coonatie, Fly Lake, Big Lake, Dullingari, Brumby, Kanowana and Burke and gas and oil at Tirrawarra, Moorari, Fly Lake and Broilga. The reservoir rocks are of Permian age and plans to supply Sydney and some large towns in New South Wales with gas from the Cooper Basin in 1974 are well advanced. In the Carnarvon Basin, Western Australia, commercial crude oil mainly in the Cretaceous formations, and also to a lesser degree in the Jurassic, is being produced from Barrow Island. Off-shore, on the northwest continental shelf, major gas deposits have been discovered at Scott Reef, Rankin, Goodwyn, Angel, North Rankin and Eaglehawk; oil was discovered at Rankin, Legendre, Madeleine, Eaglehawk and Goodwyn which are at present non-commercial. Further south, onshore in the Perth Basin, natural gas in commercially significant quantities was discovered in the Yardarino, Gingin, Dongara, Mondarra and Walyering areas, the reservoir rocks being of Lower Jurassic, Lower Triassic and Permian ages. Perth is now supplied with natural gas from the Dongara, Mondarra and Gingin fields and this will also be piped to the large towns. In the off-shore Bonaparte Gulf Basin high pressure natural gas was encountered at the Petrel and Tern prospects. In the Amadeus Basin, Northern Territory, natural gas was discovered in commercial quantities in formations of Ordovician age at Mereenie and Palm Valley. These are not yet being exploited but several proposals are under consideration. The gas accumulation in the Mereenie Anticline is underlain by the oil column in the same Pacoota Sandstone reservoir.

The most important non-metallic minerals are asbestos, clays, sand and gravel, limestone, gypsum, and silica. Salt won by evaporation of sea water is another important product.

Opals are found in the flat-lying sedimentary beds of the Great Artesian Basin in Queensland, New South Wales and South Australia and were formed during the Tertiary Period.

A table showing most of the larger mineral deposits now being mined in Australia according to the age of the geological formation in which they are found is shown in Year Book No. 53, page 1062.

Mineral resources

Australia is self-sufficient in most minerals of economic importance and much more than self-sufficient in some. The following table summarises, in a general way, known reserves and production of the principal metals and minerals in relation to Australian consumption of these commodities and present export availability. Many qualifications are necessary to a simple summary of this kind, and the table should be read in conjunction with the following detailed notes on principal minerals.

RESERVES OF MINERALS: AUSTRALIA

(Source: Bureau of Mineral Resources, Geology and Geophysics)

<i>Production</i>	<i>Reserves adequate</i>	<i>Reserves uncertain</i>	<i>Reserves negligible</i>
Production sufficient for domestic demand and exports	Asbestos (chrysotile) Barite Bauxite Bismuth Cadmium Coal (black) Copper Gold Gypsum Iron ore Lead Manganese ore (metallurgical) Mineral sands(a) Natural gas Nickel Opal Salt Silver Tin Tungsten Zinc	Antimony Beryl Glass sands Talc Tantalite	
Production sufficient for domestic demand	Clays (except light grade china clay) Coal (brown) Dolomite Felspar Limestone	Sillimanite	
Production not sufficient for domestic demand	Lithium minerals Phosphate rock Sulphides (as source of sulphur)	Abrasives Arsenic Bentonite China clay Chromite Cobalt Crude oil Diatomite Fluorite Magnesite Manganese ore (chemical) Mercury Mineral pigments Molybdenum Platinum	
Production nil	Magnesium Potassium salts Vanadium	Asbestos (crocidolite) Diamonds Graphite Vermiculite	Borates Nitrates Sulphur

(a) Ilmenite, monazite, rutile, zircon.

Individual minerals

Bauxite. As a result of discoveries at Weipa, Queensland, Gove, Northern Territory, and in the Darling Range and Kimberley area in Western Australia, Australia's reserves of bauxite are known to be very large, perhaps the largest in the world. Total reserves in the Weipa area are believed to be in excess of 3,000 million tons, while proved reserves at Gove are reported to contain 250 million tons of bauxite. In the Darling Range, reserves of economic grade bauxite are estimated to be about 1,000 million tons spread over several locations. Another significant deposit of over 200 million tons has been proved in the Mitchell Plateau area in the Kimberley District of Western Australia.

Coal. Australia has coal resources of all types adequate to provide for future domestic requirements and a substantial export surplus. Australia's coal reserves are concentrated mainly in the mainland eastern States. The bituminous coal is located mainly in New South Wales and Queensland; Victoria has very substantial brown coal reserves in the Latrobe Valley. The value of coal production is second only to iron ore, as is the value of coal exports. An inventory of Australian coal resources at December 1970 was published in September 1971 by the Bureau of Mineral Resources in the *Australian Mineral Industry—Quarterly Review* vol. 23, no. 4.

Copper. The principal deposit of this metal is at Mount Isa, Queensland where ore reserves were estimated at 140 million tons in 1972. Other important deposits are situated at Cobar, New South Wales, Mount Morgan and Gunpowder, Queensland. Mount Lyell, Tasmania, Kanmantoo, South Australia, Tennant Creek, Northern Territory and Tarago, New South Wales.

Crude oil. Recent exploration and development activity indicates that Australia has significant reserves of crude oil and that additional reserves may be discovered in the near future as exploration activity finds further drilling prospects, particularly in the off-shore areas. The Moonie and Alton fields in Queensland, and the Barrow Island field in Western Australia have been producing since 1964, 1966 and 1966 respectively. The Barracouta, Halibut and Kingfish fields in the Gippsland Shelf area off-shore from Victoria commenced production in 1969, 1970 and 1971 respectively. At the end of 1972, proved reserves in Australia were estimated to be 1,536 million barrels and the recent discoveries indicate the possibility of an upward revision of this figure in the near future.

Gold. Australia's gold resources are heavily concentrated in Western Australia, mainly in the Kalgoorlie-Coolgardie area, but small deposits of gold-bearing ore occur in all States. In addition, gold is commonly obtained as a by-product of other mining activities, particularly copper mining. Economic gold ore reserves at Kalgoorlie were estimated at 4.8 million tons in late 1972.

Iron ore. Very extensive deposits of iron ore have been discovered, establishing Australia as one of the most important iron ore provinces in the world. The largest deposits are located in the Hamersley and Ophthalmia Ranges in the Pilbara region of north-west Western Australia. Other commercially important deposits of iron ore are situated in the Savage River area of Tasmania, in the Middleback Ranges of South Australia, in the Mount Goldsworthy, Yampi Sound, Koolyanobbing, and Weld Range areas in Western Australia, and at Frances Creek in the Northern Territory. These deposits are adequate to supply the estimated needs of the Australian iron and steel industry far into the future, as well as providing a large export availability. Total Australian reserves with an iron content greater than 55 per cent are estimated to be at least 20,000 million tons.

Lead-zinc. Australia has been a major producer of lead and zinc since the discovery of ore at Broken Hill, New South Wales in 1883. Measured reserves of lead-zinc ore at Broken Hill are currently 6 million tons assaying 11.7 per cent lead and 9.8 per cent zinc; 6.7 million tons assaying 9.3 per cent lead, of which 6.2 million tons also assays 14 per cent zinc and, 4.5 million tons assaying 13.1 per cent lead and 10 per cent zinc. Reserves at another major producing mine, Mount Isa in Queensland, are 56 million tons assaying 7 per cent lead and 6 per cent zinc. Preparations are now being made to start production from a new mine, the Hilton, near Mount Isa with reserves of 35.0 million tons of ore, assaying 8 per cent lead and 10 per cent zinc. The capacity of the mine at Rosebery in Tasmania (reserves of 9.5 million tons, 6 per cent lead and 17 per cent zinc) is being increased. Development of the McArthur River deposit in Northern Territory (reserves of 200 million tons, 4 per cent lead and 9 per cent zinc) is dependent on the solution of complex metallurgical problems. A deposit discovered near Tarago, near Goulburn, N.S.W. will commence production in 1976; reserves are estimated at 7 million tons assaying 3.3 per cent lead, 9.4 per cent zinc and 2.9 per cent copper. Lead and zinc concentrates are being produced with copper concentrates at Cobar, New South Wales.

Manganese. Australia's known reserves of manganese, which is highly important for the iron and steel industry, are in excess of domestic requirements, and exports have continued at a high level. The principal deposits currently being worked are in the Pilbara area of Western Australia and on Groote Eylandt in the Gulf of Carpentaria. Reserves on Groote Eylandt are substantial and supplied 90 per cent of Australian production in 1971.

Mineral sands. Ores of titanium (rutile and ilmenite), zirconium (zircon) and thorium (monazite) occur in mineral sands over extensive areas of the north and central coasts of New South Wales, the

south and central coasts of Queensland, and the south-western coast of Western Australia and at Eneabba, 170 miles north of Perth. Resources are large by world standards and easily workable. Australia's reserves of rutile and zircon represent a large proportion of the world's reserves of these minerals. In 1971 Australia was responsible for about 95 per cent of the world's supplies of rutile, 87 per cent of zircon, 50 per cent of monazite and 25 per cent of ilmenite.

Natural gas. Significant discoveries of natural gas have been made throughout Australia, the most notable being the Barracouta, Marlin, and Snapper fields; Gippsland shelf combined reserves are 10 million million cubic feet. About 20 fields in the Cooper Basin in South Australia have total recoverable reserves in excess of 3.4 million million cubic feet, and numerous small fields in the Roma, Surat and Rolleston areas in Queensland have combined reserves of 212 thousand million cubic feet. Commercial production is being undertaken from the Barracouta, Marlin, Gidgealpa, Moomba, Dongara, Mondarra and Roma fields. Reserves in the Dongara, Mondarra, Walyering, Gingin and Yardarino gasfields in Western Australia are about 500 thousand million cubic feet. Total daily gas production at the end of 1972 was of the order of 314 million cubic feet. Reserves of 1.6 million million cubic feet at Mereenie and Palm Valley in the Northern Territory are not yet being exploited. Large reserves of natural gas discovered on the north west continental shelf at Petrel, Scott Reef, North Rankin, Rankin, Angel, Goodwyn and Eaglehawk are estimated to contain in excess of 20 million million cubic feet. At the end of 1972, the total reserves of natural gas in Australia were estimated at about 40 million million cubic feet.

Natural gas liquids. The production of natural gas liquids in association with natural gas is becoming an important facet of Australian petroleum production. Natural gas liquids, also known as condensate, are produced in association with gas from the Barracouta, Marlin, Gidgealpa, Moomba and Dongara/Mondarra fields and to a lesser degree at Roma. Natural gas liquids from Barracouta and Marlin are separated from the gas at the Longford gas and crude oil stabilisation plant and piped to Westernport Bay for shipment to local and export markets. A liquids pipeline from the Gidgealpa-Moomba gasfield to Adelaide is planned. The liquids produced at Roma, because of their small quantity, are mainly used as a fuel on the producing fields. The condensate content of Northwest Shelf gas is generally higher than that of other Australian gas. At the end of 1972, reserves of natural gas liquids in Australia, were estimated to be in excess of 620 million barrels.

Nickel. In the Kalgoorlie-Widgiemooltha area of Western Australia more than 21 nickel sulphide ore bodies have been found since the original discovery of nickel ores was made at Kambalda in 1966. Total ore reserves in the Kalgoorlie area are more than 27 million tons, averaging 3.0 per cent nickel. Other large but low-grade ore bodies have been found between Leonora and Wiluna; the largest of these is Mount Keith where ore reserves are estimated to be 330 million tons averaging 0.6 per cent nickel. In the Leonora-Wiluna area at Agnew the ore body is estimated to contain at least 33 million tons of ore averaging 2.2 per cent nickel.

A nickel refinery has been built at Kwinana, Western Australia, with an annual capacity of 15,000 tons which is expected to be expanded to 20,000 tons. A smelter built at Kalgoorlie with an annual capacity of 200,000 tons of nickel concentrate commenced operation in 1973.

Lateritic nickel deposits have been discovered at Greenvale in Queensland where production is expected to commence in 1974. Other large, but at present uneconomic, deposits of this type have been found at Wingellina, near the border of South Australia and Western Australia, at the Ora Banda district north-west of Kalgoorlie and at Marlborough in Queensland.

Phosphate. Accelerated search for phosphate rock commencing in late 1964 resulted in the discovery of major deposits in north-west Queensland and in the Northern Territory with reserves exceeding 2,600 million tons. It is unlikely that these will be developed in the immediate future.

Tin. The main deposits of tin now being exploited are in the Herberton field inland from Cairns, Queensland; north-west and north-east Tasmania; in the Pilbara region and in the south-west of Western Australia; and at Gibsonvale, Ardlethan and in the New England area, in New South Wales. As the result of exploration and expansion of known deposits in recent years, Australia is now a net exporter of this metal.

Tungsten. The main deposits of tungsten ores are in north-eastern Tasmania (wolfram) and on King Island (scheelite). Australia's own requirements are small, and production is principally for export. Australian production of tungsten concentrates could be doubled by the mid-1970's when the planned increases in production at King Island take effect.

Uranium. Export from Nabarlek (Northern Territory) and Mary Kathleen (Queensland) of 3,340 short tons of uranium oxide has been arranged for delivery between 1975 and 1985, and 1,000 short tons from Nabarlek from 1976-1983. During 1972, four large deposits of uranium ore have been discovered in the East Alligator River area of the Northern Territory. Preliminary estimates suggest that two of the deposits could each contain more than the total of previously known uranium reserves in Australia. Further work is being carried out at Nabarlek, Koongarra (Jim Jim), Ranger 1 and

Jabiluka; preliminary estimates suggest that at least 115,000 short tons of uranium oxide will be proven in these deposits. Export contracts for uranium oxide from Ranger 1 are for 1,300 short tons from 1977-1982, and 2,000 short tons from 1977-1986. Discovery of a large deposit at Yeelirrie near Wiluna, Western Australia was announced in 1971; reserves are estimated at the equivalent of 50,000 short tons of uranium oxide. Other important areas of exploration are Mount Painter and Lake Frome in South Australia, South Alligator River in the Northern Territory and the Westmoreland and Mount Isa areas of Queensland.

Administration

All mineral rights in Australia are vested in the Crown except on land which was granted before the Crown began to reserve mineral rights. In practice these private mineral rights are important only in the New South Wales coalfields. In the States, rights are held by the State Governments and in the Territories of the Commonwealth these rights are vested in the Commonwealth Government. The Commonwealth Government is able also to influence over-all development and production activity in the mineral industry by virtue of its statutory powers with respect to international trade, customs and excise, taxation, and loan raisings. Certain specially formed bodies such as the Joint Coal Board and the Australian Atomic Energy Commission have been given administrative responsibility in defined areas.

Control of mining

Each State or Territory in the Commonwealth has its own mining Acts or Ordinances and regulations governing the prospecting for and working of mineral deposits. Before the commencement of the Acts mentioned in the next paragraph these Acts, etc., were similar in principle, but different in detail. They all made provision for miner's rights to prospect and for small mining leases for mineral production. The principles embodied in these Acts, etc., were established many years ago when mining operations were generally small scale and labour-intensive. Although amendments had been enacted to modernise the legislation, it was generally inadequate for the large scale capital-intensive operations often involved with modern mineral development. For this reason a large enterprise may take the course of acquiring mining titles by negotiation with the appropriate Minister for Mines and having the agreed terms and conditions embodied in an Act of the State Parliament. This method of acquisition has been used in several cases where the leasing company undertook an obligation (such as the erection of a large treatment works) in return for leases over large areas for a long period, and has become more common in recent years (e.g. iron ore in Western Australia, coal and bauxite in Queensland, bauxite in the Northern Territory).

Two States have passed and brought into operation new mining acts, i.e. *The Queensland Mining Act of 1968 to 1971* which commenced on 1 January 1972 and *The South Australian Mining Act, 1971* which commenced on 3 July 1972. These Acts are simpler and more suited to modern conditions than the mining acts which they replaced. Western Australia and New South Wales introduced Bills for new mining acts into their respective Parliaments in 1972 but these bills had not been passed at the end of 1972.

AREAS OCCUPIED UNDER MINING ACTS AND ORDINANCES^(a)
STATES AND NORTHERN TERRITORY, 31 DECEMBER 1968 TO 1972
(^{'000 acres})

Year	N.S.W.(b)	Vic.	Qld(c)	S.A.(b)	W.A.	Tas.	N.T.(b)	Total
1968	1,146	596	2,618	99	705	66	43	5,273
1969	1,397	608	2,607	97	1,471	54	93	6,327
1970	1,495	2,301	3,568	121	5,512	60	97	13,154
1971	1,148	1,231	3,926	130	7,820	62	101	14,418
1972	1,620	329	3,471	145	4,254	64	119	10,002

(a) Excludes areas held under special arrangements; see following text. (b) At 30 June. (c) Excludes lands held under miners' rights and dredging claims.

Control of exploration

This section refers in general to the exploration for all types of mineral deposits in Australia. Additional information relating to the search for petroleum is set out in the following section.

As a result of the introduction of large-scale modern prospecting methods (particularly air-borne prospecting), the small prospecting areas referred to in the previous section were found to be unsuitable in some instances, and steps have been taken in the States and Territories to ensure the availability of large areas for prospecting by interested persons. Large areas may be made available by provision within the Mining Acts or Ordinances for the issue of authorities to prospect over an area defined by a written agreement which also sets out provisions as to the amount of money to be spent, methods of prospecting, tenure of the agreement, etc.

The tenure of such areas is limited, usually to one or two years only, and, if renewed for a further period, is only over an area selected from the larger area as a result of work done during the life of the initial agreement. It does not give the holder any rights over, or authorities to prospect on, land already held under a mining title within the agreed area. Unless specifically stated in an agreement, the discovery of minerals, whether inside or outside an area covered by an authority to prospect, gives the discoverer no legal rights except the right to apply for a mining lease over the area in which the discovery was made. Suitable prospects are converted to mining tenements by making application for lease under the appropriate mining Act.

Control of petroleum exploration

On-shore. In Australia all petroleum is the property of the Crown. Consequently, full control of petroleum mining rights is vested in the Government or Administration of each State or Territory. Any company, organisation or individual proposing to undertake petroleum exploration or development must first satisfy the Government concerned that the necessary financial and technological resources are available to carry out the operation.

There are three main types of petroleum titles:

- (a) the permit, covering initial geological, geophysical and exploration drilling;
- (b) the licence (in Victoria only), which covers detailed surveys and drilling; and
- (c) the lease, which covers development operations and production.

Further details of the petroleum legislation are given in Year Book No. 55, pages 996-7. The States of Western Australia and South Australia recently issued some revisions to their on-shore legislation, for details of which direct reference should be made to the State concerned.

Off-shore. The *Petroleum (Submerged Lands) Act 1967-1968* is the instrument whereby the control and safeguarding of the exploration and exploitation of petroleum resources on the territorial sea-bed and on the continental shelf are assured. Complementary legislation has been passed by each State Government and by the Federal Government.

The legislation provides for a two-stage system of titles: the exploration permit, which covers all forms of exploration including drilling, and the production licence, which covers development and exploration. Royalty is generally shared between State and Federal Governments on a 60 : 40 basis; however, overriding royalty is payable to the State under certain conditions. Mineral royalty receipts of governments under these Acts are included in the table on page 919. For full details of the off-shore legislation, see Year Book No. 55, pages 997-8.

The table following shows details of areas occupied under both on-shore and off-shore petroleum exploration and development titles at 31 December 1970, 1971 and 1972.

AREAS OCCUPIED UNDER PETROLEUM EXPLORATION AND DEVELOPMENT TITLES: STATES AND NORTHERN TERRITORY, 31 DECEMBER 1970 TO 1972

Year	N.S.W.	Vic.	Qld	S.A.(a)	W.A.	Tas.	N.T.(a)	Total
ON-SHORE AREAS (square miles)								
1970 . .	87,886	25,308	506,118	233,526	n.a.(b)	639	61,769	n.a.
1971 . .	75,732	18,491	397,484	219,966	n.a.(b)	230	57,734	n.a.
1972 . .	33,486	19,862	337,074	218,992	n.a.(b)	..	57,734	n.a.
OFF-SHORE AREAS (5 minute blocks) (c)								
1970 . .	643	1,189	2,918	3,425	8,808	2,314	3,626	22,923
1971 . .	782	1,178	2,918	3,089	8,727	1,703	3,534	21,931
1972 . .	503	1,178	2,918	3,089	10,171	1,498	3,535	22,892

(a) At 30 June. (b) Available only in terms of 5 minute blocks of which there were 5,517 at 31 December 1970, 6,510 at 31 December 1971 and 8,036 at 31 December 1972. (c) Area bounded by 5 minutes of latitude and 5 minutes of longitude; figures include partial blocks.

Mineral royalties

The collection by governments of royalties for the production of minerals within their area of authority is an internationally accepted practice. In Australia the responsibility for mineral royalties is largely a State concern, and all States currently collect some form of mineral royalty payments. In the past most States have relied on an established system of standard rates which were uniform for all producers of any particular mineral in the State concerned. These charges were either a fixed monetary amount per ton (e.g. 5c per ton on gypsum mined in New South Wales) or an *ad valorem* royalty (e.g. 1.5 per cent of gross value of gold produced in New South Wales).

In recent years there has been an important basic change in the system of establishing royalty commitments, and it is now quite common for State Governments to negotiate special royalty rates with companies which are seeking mineral leases for large scale developments. These royalty rates may vary, depending on whether production is for export or for domestic processing. The rates for a particular mineral may also vary between producers. Important examples of this type of royalty agreement are the iron ore development agreements in Western Australia and coal development agreements in Queensland. Mineral royalties received by Governments in recent years are shown in the table below.

MINERAL ROYALTY RECEIPTS: GOVERNMENTS, 1967-68 TO 1971-72
($\$$ '000)

	1967-68	1968-69	1969-70	1970-71	1971-72
New South Wales(a)	11,685	9,795	13,558	17,819	10,237
Victoria(b)	663	(c)687	(c)2,736	(c)12,239	(c)16,875
Queensland(a)	1,844	1,688	3,039	5,483	3,805
South Australia	1,037	1,254	1,557	1,798	1,821
Western Australia	6,238	11,001	15,700	22,347	25,247
Tasmania(d)	87	(e)251	(e)424	(e)410	(e)489
Northern Territory	291	283	449	431	634
Commonwealth	9	(c)11	(c)492	(c)5,024	(c)7,567
Total	21,853	24,971	37,953	65,552	66,676

(a) Includes royalty on sand and gravel from Crown lands. (b) Includes royalty on brown coal paid by State Electricity Commission. (c) From 1968-69 includes royalties received under the *Petroleum (Submerged Lands) Act, 1967-68*. (d) Includes rent and fees from mineral lands. (e) From 1968-69 includes royalties on iron ore.

Control of exports

The Commonwealth Government maintains export controls over certain metals, petroleum and petroleum products and all raw and semi-processed minerals. These controls are administered under the authority of the Customs (Prohibited Exports) Regulations as amended from time to time by Statutory Rules. The Commonwealth authorities having jurisdiction over such exports are set out below together with listings of the goods subject to control. A clearance to export is needed in each case.

Department of Minerals and Energy—An amendment to the Customs (Prohibited Exports) Regulations on 22 February 1973 (Statutory Rule No. 39 of 1973) provided that the exportation from Australia of the following goods is prohibited unless approval in writing is issued by the Minister for Minerals and Energy or by an authorised person.

- (a) ores containing copper or tin, whether or not they have been subjected to processing or treatment; mineral or metallic substances produced in the course of processing or treatment of those ores; copper anodes, copper cathodes, copper ingots, copper rods, copper scrap and copper refinery shapes in the form of ingots, wire bars, billets, cakes, rolling blocks or ingot bars; copper alloys in the form of ingots, billets, cakes, rolling blocks or ingot bars and copper alloy scrap; refined tin in the form of ingots or in any other refinery form;
- (b) alumina;
- (c) natural gas, whether liquefied or not, liquefied petroleum gas, and condensate;
- (d) all other minerals including those other minerals that have been subjected to processing or treatment; substances produced in the course of processing or treatment of those other minerals but not including refined products obtained by or from processing or treatment of those other minerals and goods into which products, whether refined or not, obtained by or from processing or treatment of those other minerals have been converted.

The amendment of 22 February 1973 to the regulations extends the export controls which have functioned for some time over a limited number of metals and minerals, including copper and tin

metals and various specified materials containing those metals, iron ore, manganese ore, mineral sands and natural gas, by bringing within the scope of the export controls all minerals either in raw or semi-processed form.

In addition, previously existing regulations controlling the export of metals and minerals of atomic energy significance continue, viz. minerals containing uranium and thorium, uranium, thorium, beryllium and lithium metals, compounds and alloys; hafnium-free zirconium metal, alloys and compounds, nickel metal in certain forms.

Department of Primary Industry—phosphate rock, phosphate and superphosphate, and fertilisers containing phosphate or superphosphate.

Joint Coal Board

The Joint Coal Board was established in 1946 under joint legislation of the Commonwealth and of the State of New South Wales to carry out special administrative functions in regard to the New South Wales black coal mining industry. A summary of these functions is given below.

- (i) To ensure that coal is produced in the State of New South Wales in such quantities and with such regularity as will meet requirements throughout Australia and in trade with other countries;
- (ii) to ensure that the coal resources of the State are conserved, developed, worked and used to the best advantage in the public interest;
- (iii) to ensure that coal produced in the State is distributed and used in such manner, quantities, classes and grades, and at such prices as are calculated best to serve the public interest and secure the economical use of coal and the maintenance of essential services and industrial activities; and
- (iv) to promote the welfare of workers engaged in the coal industry in the State.

Australian Atomic Energy Commission

During 1953, Commonwealth legislation was enacted to set up an Atomic Energy Commission which is responsible, in an overall sense, for the production and utilisation of uranium in Australia. This Act, the *Atomic Energy Act 1953*, superseded the *Atomic Energy (Control of Materials) Act 1946*, but retains a provision of that Act which provides for the control of substances which could be used for production or use of atomic energy.

The functions of the Commission fall under two main headings. Firstly, it is responsible for undertaking and encouraging the search for and mining of uranium and is empowered to co-operate with the appropriate authorities of the States in connection with these and related matters. Secondly it is authorised to develop the practical uses of atomic energy by constructing and operating plant for this purpose, carrying out research and generally fostering the advancement of atomic energy technology. The Commission operates under the direction of the Minister for Minerals and Energy.

Government assistance

The Commonwealth Government and the various State Governments provide assistance to the mineral industry in a variety of ways. The main forms of assistance are discussed below.

Commonwealth Government Assistance

Assistance provided by the Commonwealth Government takes the form of income taxation concessions, subsidies, bounties, and technical assistance mainly through the work of the Bureau of Mineral Resources and the Commonwealth Scientific and Industrial Research Organization. A table showing direct Commonwealth Government payments to sectors of the mineral industry is included on page 923.

Income taxation concessions. One-fifth of the net income derived from mining for prescribed minerals in Australia or Papua New Guinea is exempt from tax. Principal minerals to which this concession applies are as follows: asbestos, bauxite, radio-active ores, rutile and zircon; and ores of copper, nickel and tin.

Income derived from mining principally for gold in Australia or Papua New Guinea is exempt from tax. The exemption is also available in respect of income derived from mining principally for gold and copper if the value of the gold obtained is not less than 40 per cent of the value of the total output.

Dividends paid wholly and exclusively out of exempt mining income are also exempt from tax.

One third of call moneys paid by resident and non-resident investors on non-redeemable shares in a company, whose principal business is mining or prospecting for minerals in Australia or Papua New Guinea, is allowable as a deduction from the investors' assessable income. Where the shares in such a company are issued after 9 May 1968, the deduction is dependent upon the company lodging a declaration that the call moneys have been, or will be, expended exclusively on the search for minerals (including petroleum) obtainable by mining.

Other valuable assistance has been given in the form of certain taxation concessions to encourage the search for petroleum and other minerals. Resident investors are permitted, for tax purposes, to deduct from their assessable income all application, allotment and call moneys paid for shares issued by petroleum exploration companies or companies engaged in prospecting or mining for other minerals obtainable by mining. These deductions are allowable only if the company elects to forgo an equivalent amount of the special deductions for capital expenditure to which it would otherwise be entitled. Many companies engaged in exploring for petroleum and other minerals have elected to pass on this benefit to their shareholders.

Special deductions for capital expenditure incurred in the discovery and mining of petroleum are allowable to a company deriving income from the sale of petroleum, and products of that petroleum, mined by the company in Australia or Papua New Guinea. A company is entitled to these deductions only when it produces Australian petroleum in commercial quantities. The general effect of the deductions is to free the proceeds from the sale of Australian or Papua New Guinean petroleum and its products from tax until all allowable capital expenditure has been fully recouped. Dividends paid wholly and exclusively out of profits so freed from tax are exempt.

Capital expenditure allowable to petroleum exploration companies includes, broadly, the cost of exploratory surveys, drilling and well-head plant, access roads and expenditure on housing and welfare.

A company mining or prospecting for minerals other than petroleum and gold may also be allowed special deductions for capital expenditure. Broadly, allowable capital expenditure includes expenditure on exploration and prospecting, preparation of a site for extractive mining operations, buildings, other improvements and plant necessary for those operations, access roads, certain treatment plant and housing and welfare.

The allowable capital expenditure of a general mining company may be deducted over the life of the mine, or twenty-five years, whichever is the lesser. Alternatively, the mine owner may elect to have the allowable capital expenditure deducted in the year it is incurred or, where appropriations have been made for such expenditure to be incurred in the following year, the deduction may be allowed in the year of the appropriation. Annual deductions for depreciation on mining plant may be allowed in lieu of spreading the cost over the life of the mine. Expenditure on housing and welfare may, at the option of the mine owner, be allowed over the life of the mine, or five years.

Special deductions are allowable for capital expenditure incurred on certain transport facilities used primarily and principally in relation to minerals mined in Australia, for the transport of raw minerals and certain specified products obtained from the processing of such minerals, or for transporting petroleum between the oil or gas field and a refinery or other terminal. The special deduction applies to expenditure incurred on a railway, road, pipe-line or similar transport facility. Allowable expenditure on transport facilities is deductible in equal annual instalments over a period of ten years.

Petroleum search subsidy. In 1957 the Commonwealth Government introduced the *Petroleum Search Subsidy Act 1957* whereby stratigraphic drilling operations were subsidised to the extent of 50 per cent of cost. An amendment in 1959 widened the scope of operations for which subsidy was offered to include all types of geophysical surveys and off-structure drilling.

Subsidy payments under the Act for the years 1968 to 1972 are shown in the table on page 923. Various amendments to the Act and Regulations altered the rate of subsidy and the type of operations to which a subsidy is applicable. On-shore exploration drilling is subsidised at the rate of 30 per cent of approved costs and on-shore geophysical operations at a rate of 50 per cent. All similar off-shore operations are subsidised at a rate dependent upon the Australian financial contribution to the operation, the maximum rate being 30 per cent for operations wholly financed by Australian companies. Details of amendments are given on page 1001 of Year Book No. 55. The 1969 amendment provided for the payment of subsidy for approved operations completed before 30 June 1974. In May 1973 the Minister for Minerals and Energy announced the termination of the subsidy scheme and that operations extending beyond or commencing after 30 June 1974 would not be eligible for subsidy.

Pricing of Australian crude oil. Early in 1965 the Tariff Board conducted a public inquiry to determine an appropriate price for Australian crude oil, having regard to the Commonwealth Government's desire to encourage the search for oil and the consequent need to offer sufficient incentive to exploration companies. At the same time the Government indicated that it was anxious to prevent or minimise increased costs of petroleum products to consumers and to ensure that refineries using Australian crude oil were not detrimentally affected in relation to other refineries.

Evidence was heard from oil exploration, marketing and refining interests, government officials, coal and power interests, and major users of refined petroleum products. The Tariff Board recommended at that time that Moonie crude oil should be valued at \$2.69 a barrel at the nearest refinery centre, which included a variable differential related to the quality of the oil and an incentive of 22.4 cents per barrel. The Government adopted the Tariff Board's recommendations, and raised the incentive margin to 67 Australian cents a barrel; this margin to apply to all Australian crude oil producers.

To ensure that indigenous crude oil is used to the maximum extent in Australian refineries, the Government also adopted the Tariff Board's recommendation to impose penal import duties of 0.8 cents a gallon on crude oil and 2.4 cents a gallon on motor spirit to be paid by the companies which do not take their share of local crude oil. The share of local crude to be taken will be based on the importer's share of total imports of refinery feedstock or refined products or both.

Under these arrangements the price of Moonie crude is \$3.14 a barrel delivered Brisbane; and Barrow Island field when it commenced production in April 1967 was \$3.24 a barrel delivered Kwinana. This pricing structure was to remain operative until 17 September 1970.

However, the discovery of very large crude oil reserves in the Gippsland Shelf fields revealed that this pricing structure could result in the Australian consumer paying more for indigenous petroleum products than for similar products refined from imported crude oils. Following negotiations with the Commonwealth Government the Gippsland Shelf operators agreed to forgo the \$0.67 a barrel incentive, plus a further \$0.05 per barrel. This applied from commencement of production in October 1969 to 17 September 1970. As from 18 September 1970, the price of all Australian crude oils has been based on 'import parity' as at 10 October 1968, the date on which the new arrangements were announced by the Prime Minister in Parliament. This new pricing structure is also for a 5 year period.

Under this agreement the Gippsland crude oil is priced in the following manner:

	<i>per barrel</i>
	\$
Weighted average posted price as at 10 October 1968 of principal crudes imported into Australia	1.62
less weighted average discounts as at 10 October 1968	0.26
	<hr/>
	1.36
plus weighted average overseas freights as at 10 October 1968	0.46
Wharfage and other charges as at 10 October 1968	0.07
	<hr/>
	1.89
less a deduction for coastal freight	0.09
	<hr/>
	1.80
	<hr/>

To this the quality differential of approximately \$0.26 per barrel is added. The quality differential varies according to changes which occur in the quality of the oil produced.

Moonie crude oil on the same basis, for the five-year period will be \$2.15 per barrel f.o.b. Brisbane, since the coastal freight deduction of 9 cents per barrel does not apply.

Barrow Island crude will be the basic \$1.89 per barrel plus a quality differential of 34 cents, giving the total of \$2.23 per barrel f.o.b. Kwinana.

The Government has announced that the absorption of Australian crude oil by Australian refineries will be Government policy until September 1980. The allocations to refining and marketing companies are now based on the sales volume of certain products, and the associated penal duties on imports made by companies not taking up their allocations have been increased to 7.5 cents per gallon on motor spirit, 5 cents per gallon on other refined products and 2 cents per gallon on crude oil.

The Government has also announced that, should the production of Australian crude oil exceed the capacity of the refiners to absorb indigenous crude, the available market will be shared between all producing companies on a formula based on the reserves of each company. Export of the excess crude oil will be permitted.

Assistance to the gold-mining industry. Assistance to the gold-mining industry by subsidy was introduced at a time of rising costs in the industry and fixed official world price for gold. Because many producers were faced with the likelihood of closing down, the Government decided to subsidise marginal producers in Australia and Papua New Guinea. Under the *Gold-Mining Industry Assistance Act* 1954 a producer, the value of whose gold output exceeded 50 per cent of the total value of his mine output, was eligible for assistance, subject to certain conditions, on the production of gold

from 1 July 1954. The assistance scheme has been reviewed on a number of occasions since the Act was originally passed, and some liberalisations have been approved, including increases in the rates of subsidy payable authorised in amendments passed in 1957, 1959, 1965 and 1972.

Under the Act as it now stands the subsidy payable to small producers whose annual deliveries do not exceed 500 fine oz is \$6 per fine oz, irrespective of cost of production. For large producers, subject to certain provisions, the rate of subsidy payable is an amount equal to three-quarters of the excess of the average cost of production over \$27 per fine oz, with a maximum amount of subsidy of \$12 per fine oz. A producer whose deliveries during the year exceed 500 fine oz may elect to be treated as a small producer. In this case the subsidy rate payable per fine oz on total deliveries is \$6 reduced by 1c for each fine oz by which deliveries exceed 500 fine oz. The benefit under this provision terminates when deliveries in a year reach 1,100 fine oz. Where a producer receives an amount in excess of \$31.25 per fine oz as a result of sales on overseas premium markets or otherwise, the subsidy payable is, with effect from 1 January 1972, reduced by fifty per cent of the amount of the excess. Prior to 1 January 1972 subsidy was reduced by seventy-five per cent of the excess.

Payments under the Act will apply to production until 30 June 1975. The amounts paid to gold producers in the various States and Territories of Australia in each of the years 1968 to 1972 are shown in the table below.

Assistance to the producers of sulphuric acid and iron pyrites. The *Sulphuric Acid Bounty Act 1954-1971* and the *Pyrites Bounty Act 1960-1971* expired on 31 May 1972. The Acts provided for payment of bounty on sulphuric acid produced from prescribed Australian materials, and to producers of iron pyrites. Payments under these Acts for the years 1968 to 1972 are shown in the table below.

Payments to producers of phosphate fertilisers. The *Phosphate Fertilisers Bounty Act 1963-1971* provides for a bounty to be paid on superphosphate and ammonium phosphate manufactured and used in Australia as a fertiliser. (This includes approved trace elements, compounds or substances when added to superphosphate). Bounty is payable on the soluble content of phosphorus pentoxide. A standard grade of superphosphate containing between 19.5 and 20.5 per cent soluble content of phosphorus pentoxide qualifies for full bounty of \$12 per ton. Outside this range, bounty is payable at \$60 per ton of contained phosphorus pentoxide. The intention of this Act is to assist consumers of phosphate fertilisers (primary producers). The Act is due to expire on 31 December 1974. Payments under the Act, for the years 1968 to 1972, are set out in the following table.

**COMMONWEALTH GOVERNMENT PAYMENTS TO THE MINERAL INDUSTRY
AND TO THE MANUFACTURING INDUSTRY FOR PRODUCTS OF MINERAL
ORIGIN; AUSTRALIA, 1968 TO 1972**
(\$'000)

Year	<i>Petroleum exploration (a)</i>	<i>Gold mining(b)</i>	<i>Pyrites mining(c)</i>	<i>Sulphuric acid production (d)</i>	<i>Phosphate fertiliser production (e)</i>
1968 . . .	13,805	2,817	..	1,279	24,907
1969 . . .	14,911	1,077	..	988	31,665
1970 . . .	11,237	3,278	90	740	45,820
1971 . . .	8,468	2,162	568	489	40,815
1972 . . .	8,422	1,185	962	527	49,137

(a) *Petroleum Search Subsidy Act 1959-69.* Includes payments in Papua New Guinea; see also the table on page 946. (b) *Gold-Mining Industry Assistance Act 1954-72.* Includes payments in Papua New Guinea. (c) *Pyrites Bounty Act 1960-1971.* This Act expired on 31 May 1972. (d) *Sulphuric Acid Bounty Act 1954-1971.* This Act expired on 31 May 1972. (e) *Phosphate Fertilisers Bounty Act 1963-1971.*

Bureau of Mineral Resources, Geology and Geophysics. The functions of the Bureau are as follows:

- (i) as a primary function, to obtain, study, publish and provide basic geological and geophysical information necessary for the exploration and development of the nation's mineral resources; this to be done where appropriate in co-operation with State and Territorial authorities;
- (ii) to undertake experimental studies and research into geology and geophysics in order to support the function of obtaining basic information;
- (iii) to make basic investigations of the earth's magnetic and gravitational fields and in seismology and vulcanology;

- (iv) to complement the work of the State and Territorial authorities by undertaking geological and geophysical investigations into the occurrence and distribution of underground water;
- (v) to undertake geological and geophysical investigations on behalf of other Commonwealth Departments and authorities including the provision of resident staff by arrangement with the Territories;
- (vi) to obtain basic information on, and review the mineral resources of the Commonwealth and its Territories; to study the various sectors of the mineral industry both in the national and international spheres; to publish and provide information about the mineral industry;
- (vii) to undertake such investigations in mining engineering and petroleum technology as are relevant to (i) and (vi) above;
- (viii) to prepare advice for Government on the mineral industry, including the exploration and development of mineral resources in the national interest;
- (ix) when directed by Government, to administer schemes for the assistance of sectors of the mineral industry and to undertake special mineral projects.

The Bureau comprises five branches under the Director: Operations, Mineral Resources, Geological, Geophysical, and Petroleum Exploration. The Operations Branch consists of three sections, Planning and Co-ordination, Publications and Information, and Administrative. It carries out central office functions, including planning and control of program, assessment of results, co-ordination of activities, liaison, and distribution of information. The Mineral Resources Branch comprises the sections Mineral Economics, Mining Engineering, and Petroleum Technology, and is concerned largely with those aspects of the Bureau's work which involve studies of the mineral industry as a whole, and the preparation of advice and reviews for the Government, industry and the public. The Geological and Geophysical Branches are responsible for the principal field activities of the Bureau, and the operation of observatories, while the Petroleum Exploration Branch is concerned with the administration of the *Petroleum Search Subsidy Act 1959-1969* and the assessment of sedimentary basins in Australia and its Territories. The establishment of the Bureau is 637 officers (at 30 June 1972), of whom 285 were professional. The budget for the financial year 1972-73 was \$17.75 million, of which \$8.6 million was provided for payment under the *Petroleum Search Subsidy Act 1959-1969*.

The Bureau maintains laboratories in Canberra and Darwin which are engaged on geochemical, geochronological and petroleum technological studies and basic research into the design and testing of geophysical equipment. The Bureau also maintains geophysical observatories at Toolangi, Mundaring, Port Moresby, Mawson (Antarctica), and Macquarie Island. The geophysical observatories are engaged in magnetic, ionospheric, and seismic investigations and are base stations for field operations.

State Government assistance

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.

New South Wales. The State Mines Department renders scientific, technical and financial assistance to the mining industry. Grants are made to cover up to half the cost of prospecting and drilling operations. These grants are repayable if sufficient pay minerals are discovered or if certain other conditions are met. Loans at low interest rates may be made to prospectors and miners for the purchase of plant and machinery. A quantity of equipment is also available for hire in several localities. The Department has itself undertaken a program of contract drilling to investigate the existence of mineral deposits in the State (including the testing and proving of coal resources). Expenditure on financial assistance in 1971-72 amounted to \$634,286 including \$214,923 on the Department's own drilling program.

Victoria. The Mines Department conducts geological and mineral surveys and produces geological maps and issues scientific and technical reports thereon. Extensive rotary, percussion and auger drilling operations are carried out and in conjunction with these, sedimentary basin studies are made to evaluate petroleum, mineral and groundwater potential. A comprehensive library and a geological museum are maintained and a core library retains cores and cuttings from drilling operations. The administration of petroleum and pipeline legislation ensures the conduct of all petroleum exploration and production operations by private operators, onshore and offshore, in a safe and effective manner. Technical and drilling assistance and loans or grants are available for mineral exploration and prospecting and for approved development operations. Six stamp batteries provide an ore crushing service to enable test crushings to be made at nominal cost. Information is available on mining law

and mineral statistics. Assays of ores, analytical services, advice on metallurgical treatments, industrial pollution and chemical problems are available together with information on the manufacture, handling and use of explosives. Financial assistance is available to municipalities to reclaim mine-damaged land, in areas where a Reclamation Committee recommends such action.

Queensland. The Department of Mines provides assistance to mining by way of geological services, grants for construction and maintenance of roads in mining areas, repayable advances or subsidies for mine development, hiring of equipment, and assistance to prospectors. The Department maintains a concentration plant for tin ores at Irvinebank, an assay office at Cloncurry, a battery for treatment of gold-bearing ores at Charters Towers, and diamond drilling plants in various parts of the State.

South Australia. The Department of Mines provides the following services and facilities to the mineral industry: (i) drilling and testing of mineral deposits, geophysical investigations, well logging, development of sub-surface water supplies for farming, pastoral, irrigation, and mining purposes; (ii) geological examination of mineral deposits, ground water supplies, dam foundation and drainage problems, and publication and issue of geological bulletins and maps. It also provides, through the Australian Mineral Development Laboratories, facilities for chemical, metallurgical, analytical and assay investigations, testing and treatment of ores and minerals, and petrographic, mineragraphic and radiometric determinations. Pilot scale metallurgical and chemical treatment plants are maintained and operated for the development of mineral extraction processes.

Western Australia. Prospectors receive assistance of either \$15 or \$17.50 a week according to the prospecting locality. North of the 26th parallel and within a defined area south of this, lying largely outside the agricultural areas, assistance is given to the extent of \$17.50 a week. In the remainder of the State prospectors receive \$15 a week. Provision is also made for the supply of some tools required for prospecting. There are seventeen 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 gold and lead ores 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.

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 in the form of geological and engineering advice, through ore-dressing research into metallurgical recoveries, and the selection and design of treatment plant.

Northern Territory. To encourage the development of the mining industry the Department of the Northern Territory operates two batteries for the treatment of ores for miners. The Tennant Creek battery will continue cyaniding the gold in accumulated tailings and is available for crushing. The Mount Wells battery is crushing mainly parcels of tin ores. Small quantities of ore containing gold, silver, lead, copper and wolfram are also crushed from time to time. The crushing charges are subsidised by the Government. In addition the Department of the Northern Territory provides cartage subsidies and financial advances to encourage miners to carry out mining operations. Assistance is also given to the mining industry by drilling encouraging prospects. Roads and water supply services are provided and maintained for mines under active development throughout the Northern Territory.

Research

Research investigations into problems of mining, ore-search, ore-dressing and metallurgy are conducted by Government bodies, by universities, by private enterprise, and by combined efforts of these bodies. A summary of their functions follows.

Australian Atomic Energy Commission

The Australian Atomic Energy Commission conducts research at its laboratories at Lucas Heights in Sydney on the development of nuclear power, including research on nuclear materials and on metals and ceramics used for nuclear power. Research conducted by the Commission is discussed in detail in Year Book No. 55, page 561.

The Australian Mineral Development Laboratories

Contract research and technical consulting for the mineral and associated industries is undertaken by The Australian Mineral Development Laboratories (Amdel), at Adelaide. This organisation is controlled by a council comprising representatives of the mineral industry, the South Australian

Government and the Commonwealth Government. Extensive facilities are available in the fields of analytical chemistry, mineralogy and petrology, chemical metallurgy and mineral engineering, operations research/computer services and materials technology. Both long and short term applied research is carried out and all investigations are conducted on a strictly confidential basis. Services in the field of pollution and environmental control are also available through the recently formed Amdel group Amdel (Aspect).

The Baas Becking Geobiological Research Laboratory

In 1965 the Baas Becking Geobiological Research Laboratory was established in the Bureau of Mineral Resources Building in Canberra, under the joint sponsorship of the Commonwealth Scientific and Industrial Research Organization, the Bureau of Mineral Resources, and the Australian Mineral Industries Research Association (*see* Research by private enterprise, page 927). The broad objective of the research work is to investigate the biological and chemical processes associated with the formation of mineral deposits of the stratiform type.

Emphasis is placed on investigations to establish the relationship of biological factors to the natural physico-chemical environment with particular reference to the possible role of these factors in the formation and transformation of sulphide minerals. Investigations have included the response of micro-organisms to heavy metals; biochemistry and physiology of oxidative and reductive sulphur transformations; role of organisms in the concentration of mineral elements; physico-chemistry of low-temperature mineral synthesis; and mobility of sulphides under the influence of temperature and pressure and the interaction of mineral types.

Bureau of Mineral Resources, Geology and Geophysics

Mineral research by the Bureau of Mineral Resources is concerned with basic problems of mineral emplacement. Special studies are undertaken of: the sedimentary environment of potentially oil-bearing rocks; the genesis of continental and marine phosphate; the fundamental chemistry of metallic ore deposits; the structural, chemical, and stratigraphic contents of ore deposits; and geophysical interpretation by means of model testing.

For details of the functions of the Bureau of Mineral Resources, Geology and Geophysics, *see* page 923.

Commonwealth Scientific and Industrial Research Organization

Mineral research by the Commonwealth Scientific and Industrial Research Organization is undertaken mainly in the Minerals Research Laboratories comprising the Divisions of Mineral Chemistry, Chemical Engineering, Mineralogy, and Mineral Physics. Major laboratories are located at Clayton (Vic.), Port Melbourne, Sydney and Perth. Current research program objectives and sub-program titles are:

- (a) *Exploration*. To improve and develop procedures for locating mineral deposits (surface geochemistry, rock geochemistry, structural analysis, geobiology, remote sensing, fuel deposits).
- (b) *Mineralisation*. To improve methods of recognizing and defining the nature and economic significance of specific types of mineralisation (nickel, chromium, acid igneous deposits, stratiform ores, ore-forming fluids, electromagnetic geophysics, field analysis, mineral structures).
- (c) *Mining and concentration*. To identify, and utilize in practice, those properties of minerals and rocks which will increase the overall efficiency of their mining, concentration and handling (mineral dressing, flotation chemistry, reactivity, non-metallics).
- (d) *Process Metallurgy*. To improve and develop methods for the economic processing of minerals and mineral products (slags, iron ores, nickel ores, ilmenite, metal refining, zinc, lead, structures and bonding, plasmas, carbon reductants, fluidisation).
- (e) *Environment*. To alleviate, or turn to economic advantage, aspects of mining minerals, processing, or minerals utilisation which may be detrimental to the environment (sulphide, electrolysis, combustion, gas cleaning, reactive carbon, sulphide roasting, nutrient cycling).
- (f) *Associated industries*. To apply the skills and expertise of the Mineral Research Laboratories to the improvement and development of industrial processes not necessarily connected with the minerals industry (polymers, pulp and paper, sugar, food).

The minerals industry provides strong support in the form of co-operative research planning, collaborative investigation of specific projects, and financial grants for appropriate developmental work.

National Coal Research Advisory Committee

The functions of the National Coal Research Advisory Committee are to review coal research activity in Australia, to recommend priorities for further activities in this area, and to allocate special Commonwealth funds of \$260,000 per year provided for coal research projects as recommended by the committee. This amount is additional to that expended by C.S.I.R.O. and Commonwealth Departments on coal research. The major beneficiary under this scheme is the Australian Coal Industry Research Laboratories; other beneficiaries are university departments.

From 1965 to 1969 special coal research funds of \$520,000 annually were available to the committee, comprising the Commonwealth contribution of \$260,000 matching an equivalent total contribution from State Governments and coal producing and consuming industries. Beginning with the financial year 1968-69 the States and industry are independently sponsoring coal research and development according to their own individual requirements.

University Research

The various universities in Australia carry out research into various aspects of the mineral industry such as geology, ore mineralogy and genesis, mining techniques, mineral processing, extractive metallurgy, and materials and metals technology.

Research by private enterprise

Most large mining and smelting companies have laboratories dealing with their own individual problems. Private industry formed the Australian Mineral Industries Research Association in 1959 to provide industry with representation in the management of the Australian Mineral Development Laboratories. The Association now finances research work into geology, mining and mineral processing at Universities, C.S.I.R.O. and the Australian Mineral Development Laboratories. Membership of the Association at 30 June 1972 was: full members 57, associate members 20, registered divisions 13. Expenditure on research projects during the year 1971-72 was \$453,308.

International relations

Because Australia is a large supplier of certain minerals to the rest of the world and because the welfare of the domestic industry depends to a large extent on the maintenance of a high level of exports, international relations are of considerable importance to the industry, and the Commonwealth Government takes an active role in international consultations and discussions relating to minerals. The most important international commitments are discussed below.

International Tin Agreement

The First International Tin Agreement (of the post-war period) was in operation for five years from 1 July 1956 to 30 June 1961. This Agreement was subsequently replaced by the Second and Third International Tin Agreements, which came into force on 21 February 1962 and 21 March 1967, respectively. Details of these Agreements are given in Year Book No. 57, pages 911-12.

Australia has signed and ratified the Fourth International Tin Agreement which came into operation on 1 July 1971 for a period of 5 years. Australia joined the Fourth Agreement as a 'producing' (i.e. exporting) member, whereas in the past Agreements Australia's status had been that of a 'consuming' (i.e. importing) member. This stems from the fact that Australia's tin production has increased significantly over recent years making it a net exporter of tin.

The objectives of this Agreement are the same as for its predecessors. Producing countries are required to contribute to a buffer-stock-equivalent in cash or tin up to 20,000 tons of tin metal, which is used to buffer short-term fluctuations in the world market price. In the event of persistent market disequilibrium through causes beyond the ability of the buffer stock mechanism to control, the agreement also provides for the regulation of exports and stocks to stabilise the market. The main provisions of the Fourth Agreement are substantially the same as those of the Third. However, the Buffer Stock Manager, a paid Council employee charged with operating the buffer stock, has been given somewhat greater flexibility in reacting to market situations.

The International Tin Agreement is operated by the International Tin Council, which is made up of the following Governments: *Producers*—Australia, Bolivia, Indonesia, Malaysia, Nigeria (Federal Republic of), Thailand, Zaire (Republic of). *Consumers*—Austria, Belgium-Luxembourg, Bulgaria, Canada, Czechoslovakia, Denmark, France, Germany (Federal Republic of), Hungary, India, Italy, Japan, Korea (Republic of), Netherlands, Poland, Romania, Spain, Turkey, United Kingdom, Union of Soviet Socialist Republics and Yugoslavia. The producing countries hold a total of 1,000 votes, distributed so that each country receives five initial votes and an additional

number corresponding to its percentage as laid down by the Agreement. The consuming countries hold a total of 1,000 votes also distributed so that each country receives five initial votes and an additional number proportionate to tonnages consumed. The allocation of votes in each category is periodically reviewed.

The International Tin Agreement establishes floor and ceiling prices for tin and, by the medium of a buffer stock and remedial trading on the London Metal Exchange, aims at confining the price within these limits. Because of a world over-supply situation of tin, the Council imposed export controls on producer members in January 1973. For the second quarter of 1973 export by all producer countries except Australia was cut by 2.5 per cent of 1972 production and the Australian export was cut by 2.5 per cent of estimated 1972 exports.

International Lead-Zinc Study Group

With the cessation of stockpile buying of lead and zinc by the United States Government in 1958, world producers were faced with the prospect of a serious imbalance between world supply and demand for these metals. To meet this problem a series of meetings of interested governments was held, at which Australia was represented. These meetings culminated in the formation of the International Lead-Zinc Study Group which was established in January 1960. The Study Group comprises the following Governments: Algeria, Australia, Austria, Belgium, Bulgaria, Canada, Czechoslovakia, Denmark, Finland, France, the Federal Republic of Germany, Hungary, India, Italy, Japan, Mexico, Morocco, the Netherlands, Norway, Peru, Poland, the Republic of South Africa, Spain, Sweden, Tunisia, the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland, the United States of America, Yugoslavia and Zambia. The Group provides opportunities for inter-governmental consultations on international trade in lead and zinc and for studies of the world situation in lead and zinc having regard especially to the desirability of providing continuous accurate information regarding the supply and demand position and its probable development.

MINERAL INDUSTRY STATISTICS

Statistics presented in this chapter refer mainly to the mining industry, mineral production, mineral exploration, and overseas participation in the Australian mining industry. In addition to the mining industry, data relating to mineral processing and treatment and overseas trade are included to give more information about the mining industry and other associated activities in the Australian economy.

Mining industry statistics, 1968-69, 1969-70 and 1970-71

This section contains statistics of the mining industry for all States and Territories and Australia obtained from Mining Censuses conducted in respect of the years ended June 1969, 1970 and 1971.

Prior to 1968-69 the Annual Mining and Quarrying Census related to years ended 31 December. However, commencing with 1968-69, the Mining Census was changed to a year ended 30 June to conform with the period covered by other economic censuses in Australia. There are several other differences between the censuses of 1968-69, 1969-70 and 1970-71 and those for earlier years (mainly in definition, scope and coverage) and as a result the statistics obtained for 1968-69 and later, are not strictly comparable with those for earlier years. Further information regarding these differences is given in Year Book No. 57, pages 912-914. Mining industry statistics for years prior to 1968-69 are also contained in Year Book No. 57 and earlier issues.

For the year ended June 1969, the Mining Census (including quarrying) was conducted for the first time on an integrated basis with Censuses of Manufacturing, Electricity and Gas, Retail Trade and Selected Services, and Wholesale Trade.

Briefly, the integration of these economic censuses was designed to increase substantially the usefulness and comparability of economic statistics collected and published by the Bureau, and to form a basis for the sample surveys which supply current economic statistics from quarter to quarter, particularly those which provide data for the quarterly national income and expenditure estimates. A detailed description of the integrated censuses is contained in Chapter 31, Year Book No. 56.

For 1969-70 and subsequent years the annual Mining Census has been conducted on the same basis as that for 1968-69.

The table below shows key items of data for Australia for 1970-71 and summary data for 1968-69 and 1969-70. Each following table shows statistics for a particular item for all States and Territories and Australia for 1970-71 and summary data for 1968-69 and 1969-70, and is preceded by an explanation of the item.

**MINING ESTABLISHMENTS: SUMMARY OF OPERATIONS, BY INDUSTRY SUB-DIVISION
AUSTRALIA, 1968-69 TO 1970-71**

Industry sub-division	ASIC code(a)	Number of establishments operating at end of June	Persons employed at end of June(b)			Wages and Salaries	Stocks at 30 June		Purchases, transfers in and selected expenses	Fixed capital expenditure (outlay on fixed tangible assets less disposals)		
			Males	Females	Total		Turn-over	Opening		Closing	Value added	
Metallic minerals	11	No. 335	No. 29,556	No. 1,859	No. 31,415	\$'000 167,260	\$'000 989,871	\$'000 88,645	\$'000 94,178	\$'000 279,756	\$'000 715,648	\$'000 321,844
Coal	12	139	21,552	408	21,960	118,504	624,620	36,542	42,720	177,659	453,139	166,180
Crude petroleum including natural gas	13	8										
Construction materials	14	759	6,355	409	6,764	29,247	149,502	11,885	14,371	58,753	93,236	13,338
Other non-metallic minerals	15	325	2,353	150	2,503	10,167	50,925	5,226	6,096	24,326	27,472	19,213
Total mining, excluding services to mining—												
1970-71		1,566	59,816	2,826	62,642	325,178	1,814,918	142,298	157,365	540,493	1,289,495	520,575
1969-70		1,502	56,468	2,382	58,850	275,620	1,479,785	114,961	138,354	460,594	1,042,584	348,255
1968-69		1,494	53,353	2,089	55,442	241,292	1,147,881	97,771	113,367	414,277	749,201	303,537

(a) Australian Standard Industrial Classification.

(b) Includes working proprietors.

Number of establishments

The following table shows the number of establishments operating at end of June. These relate to mining establishments as such and do not include the numbers of separately located administrative offices and ancillary units.

MINING ESTABLISHMENTS: NUMBER OF ESTABLISHMENTS OPERATING AT END OF JUNE 1969 TO 1971, BY INDUSTRY SUB-DIVISION, STATES AND TERRITORIES

Industry sub-division	ASIC code(a)	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metallic minerals	11	118	11	90	8	58	33	17	..	335
Coal	12	98	6	29	1	3	2	..	..	139
Crude petroleum including natural gas	13	..	2	3	1	2	..	..	..	8
Construction materials	14	268	206	139	79	32	20	7	8	759
Other non-metallic minerals	15	184	41	31	33	27	9	..	..	325
Total mining, excluding services to mining—										
1971		668	266	292	122	122	64	24	8	1,566
1970		620	221	300	130	122	78	25	6	1,502
1969		581	248	300	135	128	75	20	7	1,494

(a) Australian Standard Industrial Classification.

Employment

The statistics of the number of persons employed shown in the following table relate to working proprietors at the end of June and employees on the payroll of the last pay period in June, including those working at separately located administrative offices and ancillary units in the State. Note that persons employed in each State (and their wages and salaries) relate to those employed at establishments, administrative offices or ancillary units located in the State, even though the administrative offices or ancillary units may have served establishments located in another State.

**MINING ESTABLISHMENTS: MALES, FEMALES AND PERSONS EMPLOYED(a)
BY INDUSTRY SUB-DIVISION, STATES AND TERRITORIES, AT END OF JUNE 1971**

Industry sub-division	ASIC code(b)	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
MALES EMPLOYED										
Metallic minerals	11	7,291	3,150	7,310 3,085	953	8,517 692	4,194 (c)	1,359	..	29,556
Coal	12	14,476								
Crude petroleum including natural gas	13	..	1,797	1,164 (c)	523	570	146	68	87	6,355
Construction materials	14	2,000								
Other non-metallic minerals	15	873	242	(c)	390	506	(c)	..	..	2,353
Total mining, excluding ser- vices to mining—										
1971		24,640	5,189	11,859	1,866	10,285	4,463	1,427	87	59,816
1970		24,135	5,261	10,701	1,924	8,857	4,139	1,361	90	56,468
1969		23,064	5,092	9,889	1,868	8,189	3,932	1,233	86	53,353

FEMALES EMPLOYED										
Metallic minerals	11	270	205	560 59	92	598 14	189 (c)	66	..	1,859
Coal	12	209								
Crude petroleum including natural gas	13	..	165	(c) 63	21	60	2	2	3	409
Construction materials	14	93								
Other non-metallic minerals	15	70	24	(c)	15	32	(c)	..	..	150
Total mining, excluding ser- vices to mining—										
1971		642	394	690	128	704	197	68	3	2,826
1970		660	326	635	122	408	173	56	2	2,382
1969		564	325	558	96	343	145	48	10	2,089

PERSONS EMPLOYED										
Metallic minerals	11	7,561	3,355	7,870 3,144	1,045	9,115 706	4,383 (c)	1,425	..	31,415
Coal	12	14,685								
Crude petroleum including natural gas	13	..	1,962	1,227 (c)	544	630	148	70	90	6,764
Construction materials	14	2,093								
Other non-metallic minerals	15	943	266	(c)	405	538	(c)	..	..	2,503
Total mining, excluding ser- vices to mining—										
1971		25,282	5,583	12,549	1,994	10,989	4,660	1,495	90	62,642
1970		24,795	5,587	11,336	2,046	9,265	4,312	1,417	92	58,850
1969		23,628	5,417	10,447	1,964	8,532	4,077	1,281	96	55,442

(a) At end of June; includes working proprietors. (b) Australian Standard Industrial Classification. (c) Not available for publication.

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. In 1970-71 (calendar year 1970 for Queensland), 60 persons were recorded as killed and 1,158 as injured in mining (including quarrying) accidents. Recorded deaths and injuries in that year in the metallic minerals industry were 29 and 678, and in the coal mining industry 19 and 311.

Wages and salaries

The following table shows the wages and salaries of all employees of the establishment, including those working at separately located administrative offices and ancillary units in the State. Drawings of working proprietors are not included.

**MINING ESTABLISHMENTS: WAGES AND SALARIES BY INDUSTRY SUB-DIVISION
STATES AND TERRITORIES, 1968-69 TO 1970-71**
(\$'000)

Industry sub-division	ASIC code(a)	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metallic minerals	11	39,153	17,596	46,075 17,385	4,723	46,734 3,246	21,661 (b)	8,317	..	167,260
Coal	12	80,502								
Crude petroleum including natural gas	13	..	8,984 938	4,323 (b)	2,152 1,584	3,023 2,937	490 (b)	385	471	29,247
Construction materials	14	9,419								
Other non-metallic minerals	15	3,161	..	..	..	..	..	..	..	10,167
Total mining, excluding ser- vices to mining—										
1970-71		132,236	27,518	69,211	8,459	55,941	22,641	8,702	471	325,178
1969-70		120,079	23,671	55,430	7,360	42,603	18,544	7,478	455	275,620
1968-69		108,287	22,840	48,181	6,929	30,851	17,217	6,626	360	241,292

(a) Australian Standard Industrial Classification. (b) Not available for publication.

Turnover

The following table shows turnover (sales of minerals and other goods whether produced by the establishment or not, plus transfers out of minerals and other goods to other establishments of the same enterprise, plus all other operating revenue from outside the enterprise, such as commission, repair and service revenue). This item excludes rents, leasing revenue, interest, royalties, and receipts from the sale of fixed tangible assets.

**MINING ESTABLISHMENTS: TURNOVER, BY INDUSTRY SUB-DIVISION
STATES AND TERRITORIES, 1968-69 TO 1970-71**
(\$'000)

Industry sub-division	ASIC code(a)	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metallic minerals	11	157,194	215,898	196,057 96,756	74,352	462,087 42,772	74,280 (b)	39,304	..	989,871
Coal	12	249,592								
Crude petroleum including natural gas	13	..	49,950 4,812	17,949 (b)	9,667 12,837	12,334 9,914	2,510 (b)	2,032	2,187	149,502
Construction materials	14	52,875								
Other non-metallic minerals	15	15,519	..	..	..	..	..	..	..	50,925
Total mining, excluding ser- vices to mining—										
1970-71		475,180	270,659	323,536	96,856	527,107	78,057	41,336	2,187	1,814,918
1969-70		443,443	118,098	299,956	90,595	403,164	84,141	38,411	1,978	1,479,785
1968-69		371,184	92,730	228,590	81,184	273,186	63,073	36,292	1,641	1,147,881

(a) Australian Standard Industrial Classification. (b) Not available for publication.

Purchases, transfers in and selected expenses

The following table shows the total of purchases of electricity, fuels, stores and other materials, transfers in of goods from other establishments of the same enterprise, charges for processing and other commission work and payments to mining contractors, repair and maintenance expenses, outward freight and cartage, motor vehicle running expenses and sales commission payments.

**MINING ESTABLISHMENTS: PURCHASES, TRANSFERS IN AND SELECTED EXPENSES
BY INDUSTRY SUB-DIVISION, STATES AND TERRITORIES, 1968-69 TO 1970-71**
(\$'000)

Industry sub-division	ASIC code(a)	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metallic minerals	11	54,188	26,171	35,886 37,211	22,678	133,918 2,587	19,853 (b)	19,126	..	279,756
Coal	12	104,879								
Crude petroleum including natural gas	13	..	23,802 2,496	6,758 (b)	3,023 6,193	5,637 4,762	1,111 (b)	864	921	58,753
Construction materials	14	16,637								
Other non-metallic minerals	15	8,100	..	..	..	..	..	..	..	24,326
Total mining, excluding ser- vices to mining—										
1970-71		183,804	52,470	83,101	31,894	146,904	21,408	19,989	921	540,493
1969-70		158,636	38,016	73,311	30,770	125,147	20,796	13,207	711	460,594
1968-69		147,166	38,469	75,913	26,242	90,867	20,128	14,827	665	414,277

(a) Australian Standard Industrial Classification. (b) Not available for publication.

Stocks

Statistics on the value of closing stocks are shown in the following table. Figures include stocks of materials, fuels, etc., and mine products and work-in-progress of the establishment whether located at the establishment or elsewhere.

**MINING ESTABLISHMENTS: CLOSING STOCKS AT END OF JUNE 1969 TO 1971
BY INDUSTRY SUB-DIVISION, STATES AND TERRITORIES**

(\$'000)

<i>Industry sub-division</i>	<i>ASIC code (a)</i>	<i>N.S.W.</i>	<i>Vic.</i>	<i>Qld</i>	<i>S.A.</i>	<i>W.A.</i>	<i>Tas.</i>	<i>N.T.</i>	<i>A.C.T.</i>	<i>Aust.</i>
CLOSING STOCKS										
Metallic minerals	11	20,229	} 9,302	{ 14,563	} 3,207	{ 38,880	{ 12,241	5,925	..	94,178
Coal	12	19,012									{ 11,016	{ (b)	..	..
Crude petroleum including natural gas	13	..	} 3,097	{ (b)	} 835	{ 2,205	{ ..	195	188	167
Construction materials	14	6,080									{ 1,768	{ 2,042	{ ..	{ ..
Other non-metallic minerals	15	763	870	(b)	1,607	2,099	(b)	..	..	6,096
Total mining, excluding services to mining—										
1970-71		46,084	13,268	28,357	5,649	45,225	12,502	6,114	167	157,365
1969-70		42,815	12,258	22,861	4,467	39,093	11,464	5,198	197	138,354
1968-69		37,347	9,713	19,733	3,607	28,343	9,450	5,097	78	113,367

(a) Australian Standard Industrial Classification. (b) Not available for publication.

Value added

The following table shows value added, calculated as the value of turnover (sales plus transfers out and other operating revenue) and closing stocks *less* purchases plus transfers in and selected expenses and opening stocks.

**MINING ESTABLISHMENTS: VALUE ADDED, BY INDUSTRY SUB-DIVISION
STATES AND TERRITORIES, 1968-69 TO 1970-71**

(\$'000)

<i>Industry sub-division</i>	<i>ASIC code (a)</i>	<i>N.S.W.</i>	<i>Vic.</i>	<i>Qld</i>	<i>S.A.</i>	<i>W.A.</i>	<i>Tas.</i>	<i>N.T.</i>	<i>A.C.T.</i>	<i>Aust.</i>
Metallic minerals	11	100,594	} 189,127	{ 161,019	} 52,360	{ 332,488	{ 55,863	20,958	..	715,648
Coal	12	146,700									{ 63,808	{ (b)	..	..
Crude petroleum including natural gas	13	..	} 26,434	{ (b)	} 6,791	{ 7,326	{ 1,379	1,203	1,236	93,236
Construction materials	14	37,253									{ 11,614	{ 6,514	{ 5,864	{ (b)	..
Other non-metallic minerals	15	7,648	2,392	(b)	6,514	5,864	(b)	..	..	27,472
Total mining, excluding services to mining—										
1970-71		292,194	217,953	245,746	65,665	386,444	58,095	22,161	1,236	1,289,495
1969-70		290,232	82,478	229,970	60,120	286,874	65,791	25,735	1,386	1,042,584
1968-69		227,752	51,628	155,788	55,473	191,098	44,286	22,200	976	749,201

(a) Australian Standard Industrial Classification. (b) Not available for publication.

Fixed capital expenditure

Figures in the following table relate to fixed capital expenditure. Such figures are calculated by deducting disposals of fixed tangible assets from the total outlay on new and second-hand tangible assets.

**MINING ESTABLISHMENTS: FIXED CAPITAL EXPENDITURE (OUTLAY ON FIXED TANGIBLE ASSETS LESS DISPOSALS) BY INDUSTRY SUB-DIVISION, STATES AND TERRITORIES
1968-69 TO 1970-71
(\$'000)**

Industry sub-division	ASIC code(a)	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metallic minerals	11	18,056	75,246	63,490	12,872	171,674	25,746	31,530	..	321,844
Coal	12	46,843		37,707		(b)				
Crude petroleum including natural gas	13	..	..	(b)	..	4,832	..	..	..	166,180
Construction materials	14	4,333	3,966	1,523	465	1,990	144	308	610	13,338
Other non-metallic minerals	15	7,775	1,177	(b)	1,328	8,147	(b)	..	..	19,213
Total mining, excluding services to mining—										
1970-71		77,008	80,389	103,454	14,665	186,644	25,967	31,837	610	520,575
1969-70		60,885	93,393	54,295	12,311	92,904	20,597	13,655	216	348,255
1968-69		44,857	103,816	38,808	7,786	84,692	12,910	10,618	51	303,537

(a) Australian Standard Industrial Classification. (b) Not available for publication.

Mineral production

This section contains details of the output (quantities and values) of minerals during the year ended June 1971 for all States and Territories and Australia, together with information for Australia for the four preceding years.

It should be noted that details for the years 1967 and 1968 relate to a year ended December. The change in 1969 to a June year was made to bring mineral production statistics and the annual mining census (which in previous years also related to a December year) to the same time basis as the other economic censuses conducted during that year.

Minerals are classified into five major groups, namely metallic minerals, coal, crude petroleum (including natural gas), construction materials and other non-metallic minerals. In the statistics published in this section the minerals are arranged in these five groups.

The statistics are derived from information supplied in returns to the various State Mines Departments and this Bureau, supplemented in some cases by information made available by the Department of Minerals and Energy and by data compiled by this Bureau from other sources.

Scope of mineral statistics and relation to mining industry statistics

The statistics of mineral production for the years ended June 1969, 1970 and 1971, apart from the change to a June year basis, are comparable with those for earlier years. Although the integration of the mining census for 1968-69 with other economic censuses conducted in that year (manufacturing, electricity and gas, retail trade, and wholesale trade) was accompanied by major changes in the scope of the mining census and thus in the scope of the mining industry statistics, these changes had little effect on the scope of the mineral production statistics now published. This is because mineral production data were collected, not only from establishments coming within the scope of the mining census as now defined, but also from those establishments classified as non-mining establishments which, as a subsidiary activity, carried out mining or quarrying activities (e.g. brick and cement manufacturing establishments extracting clays, limestone), and from itinerant and part-time miners.

However, as in past years, coverage is deficient in the case of some minerals, principally because of the difficulties in obtaining complete lists of producers and collecting satisfactory returns.

Principles for measuring output of minerals

The quantities of individual minerals produced are recorded, in general, in the form in which the minerals are dispatched from the mine or from associated treatment works in the locality of the mine. Thus, for metallic minerals, the output is recorded as ore if no treatment is undertaken at or near the mine, and as concentrate if ore dressing operations are carried out in associated works in the locality of the mine. In addition to the basic quantity data, the content of metallic minerals (based on assay) are recorded. No allowance has been made for losses in smelting and refining and the quantities shown are therefore, in general, greater than the contents actually recoverable.

The output of individual minerals is valued at the mine or at associated treatment works in the locality of the mine. This valuation is derived, in general, by valuing the quantity produced during the year at the unit selling value (including any subsidy) less any transport costs from the mine or associated treatment works to the point of sale. For some metals, however, special values of output, based on actual or estimated realisations are supplied by certain large mineral producers.

It should be noted that, commencing with the year 1968-69, the output of metals by enterprises for their own consumption in Australia has been valued on a different basis to that used in previous years. The effect of these changes is that the overall value of coal produced in 1968-69 and later years is somewhat lower and the value of certain other minerals somewhat higher than if the earlier valuation methods had been retained.

Quantity of minerals produced

The following tables show particulars of the quantities of minerals produced during 1970-71 and earlier years.

QUANTITY OF MINERALS PRODUCED: STATES AND TERRITORIES, 1970-71

Mineral	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
METALLIC MINERALS									
Antimony concentrate(a)	tonnes	345	2,673	803	..	..	..	..	3,821
Bauxite	'000 tonnes	8	8	6,611	..	4,207	..	209	11,043
Beryllium ore	tonnes	5	..	..	..	23	..	..	28
Bismuth concentrate	"	..	..	275	..	1	..	1,620	1,896
Copper concentrate(b)	"	43,804	91	501,171	4,579	2,624	83,390	26,648	662,308
Copper ore(c)	"	(d)7,429	1,085	21,226	630	93	..	673	31,137
Gold—									
Bullion	'000 grams	2	160	1,054	..	13,245	2	2,710	17,174
Ore	tonnes	..	..	579	508	..	..	..	1,087
Iron ore	'000 tonnes	..	..	..	7,401	46,417	(e)2,045	1,248	57,110
Iron oxide(f)	tonnes	26,798	290	26,814	..	10,178	..	..	64,080
Lead concentrate	"	324,524	2	294,033	..	189	12,448	526	631,722
Lead-copper concentrate	"	..	..	..	..	10,227	..	..	10,227
Lead ore(g)	"	37	..	35,968	8	..	302	..	36,315
Lead-zinc middlings	"	23,400	..	..	..	..	..	..	23,400
Manganese ore	"	..	..	..	315	144,476	..	641,364	786,155
Mineral sands(h)—									
Ilmenite concentrate	"	30,639	..	113,485	..	742,634	..	..	886,758
Leucoxene concentrate	"	..	..	..	..	12,863	..	..	12,863
Monazite concentrate	"	434	..	54	..	3,659	..	..	4,146
Rutile concentrate	"	259,258	..	105,112	..	2,495	7,903	..	374,768
Xenotime concentrate	"	..	..	..	..	42	..	..	42
Zircon concentrate	"	288,149	..	70,117	..	55,141	4,567	..	417,974
Molybdenite concentrate	"	..	..	61	..	..	..	..	61
Nickel concentrate	"	..	..	..	..	304,046	..	..	304,046
Pyrite concentrate	"	..	..	34,764	68,065	..	132,526	..	235,355
Tantalite-columbite concentrate	'000 grams	..	..	..	..	158,786	..	..	158,786
Tin concentrate	tonnes	3,186	6	1,525	..	960	10,211	62	15,951
Tin-copper concentrate	"	..	..	..	..	4,367	..	..	4,367
Tungsten concentrates—									
Scheelite concentrate	"	..	..	12	..	1,275	..	..	1,287
Wolfram concentrate	"	5	..	152	..	908	10	..	1,076
Zinc concentrate	"	525,396	..	176,561	..	..	68,548	381	770,885
Zinc ore	"	..	..	..	254	..	..	..	254

For footnotes see next page.

QUANTITY OF MINERALS PRODUCED: STATES AND TERRITORIES, 1970-71—*continued*

Mineral		N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
COAL										
Black coal—	'000 tonnes	35,704	..	11,074	1,626	1,190	125	..	..	49,720
Semi-anthracite.	"	..	..	..	..	..	1	..	..	1
Bituminous	"	35,704	..	10,631	..	..	125	..	..	46,460
Sub-bituminous	"	..	..	443	1,626	1,190	..	..	..	3,259
Brown coal (lignite)(i)	"	..	23,180	..	..	..	..	..	..	23,180
Brown coal briquettes	"	..	1,391	..	..	..	..	..	..	1,391

PETROLEUM(j)

Crude oil	'000 cu m	..	12,124	184	..	2,629	..	..	..	14,937
Natural gas	mil. cu m	..	864	221	860	15	..	..	..	1,962
Natural gas condensate(k)	cu m	..	..	1,433	..	..	..	..	..	1,433
Ethane(l)	'000 cu m	..	5,380	..	..	..	..	..	..	5,380
Liquefied petroleum gases(l)—										
Propane	cu m	..	346,700	..	..	..	..	..	..	346,700
Butane	cu m	..	393,335	..	..	..	..	..	..	393,335

CONSTRUCTION MATERIALS(m)

Sand	'000 tonnes	6,305	5,747	2,113	2,570	n.a.	280	1,193	419	(n)17,413 (n)12,993
Gravel	"	3,875	3,599	2,312	790	n.a.	1,201			
Dimension stone	"	16	12	(o)	49	106	2			186
Crushed and broken stone	"	9,874	17,505	4,665	10,787	5,219	1,545	(o)	(o)	50,419
Other (decomposed rock, etc.)	"	22,253	3,728	(o)	1,431	..	314			28,208

OTHER NON-METALLIC MINERALS

Asbestos	tonnes	699	..	..	..	52	..	..	..	751
Barite	"	229	..	..	34,067	528	..	19,184	..	54,008
Clays—										
Brick and shale	'000 tonnes	3,299	1,696	539	536	900	122	..	..	7,092
Other	"	501	384	161	110	170	71	..	..	1,397
Diatomite	tonnes	2,029	4	366	..	..	..	..	..	2,399
Dolomite	"	2,101	..	10,761	304,496	..	2,298	..	..	319,656
Felspar (including cor-nish stone)	"	2,112	..	..	806	464	..	..	..	3,382
Fluorspar	"	..	946	..	54	..	..	..	..	1,000
Garnet concentrate	"	408	..	14	..	..	..	..	..	423
Gypsum	"	40,465	46,304	..	665,381	200,751	..	..	..	952,901
Limestone (including shell and coral)	'000 tonnes	3,246	2,075	1,379	1,834	1,395	518	..	..	10,447
Lithium ores	tonnes	..	..	..	..	739	..	..	..	739
Lithia (Li ₂ O) content	"	..	..	..	..	31	..	..	..	31
Magnesite, crude	"	17,193	..	..	256	2,215	..	..	..	19,664
Mineral pigments—red ochre	"	..	..	..	..	618	84	..	..	702
Peat(p)	"	2,437	..	..	..	1,012	229	..	..	3,678
Pebbles—for grinding	"	..	..	..	66	..	1,611	..	..	1,677
Perlite	"	..	..	1,773	..	..	..	..	..	1,773
Phosphate rock	"	..	..	..	9,164	..	..	..	..	9,164
Pyrophyllite	"	6,828	..	..	..	..	..	..	..	6,828
Salt	'000 tonnes	..	(o)	(o)	647	2,729	..	..	..	3,774
Silica	tonnes	418,222	108,103	287,530	55,840	41,147	44,206	..	..	955,049
Sillimanite	"	834	..	..	305	..	..	..	..	1,139
Talc (including steatite and chlorite)	"	1,408	..	..	11,869	31,255	..	..	..	44,532
Vermiculite	"	..	..	..	..	360	..	..	..	360

(a) Includes antimony ore. (b) Includes copper precipitate. (c) Includes cupreous ore for fertiliser. (d) Includes copper slag. (e) Iron concentrate. (f) For cement manufacture, coal washing, flux and gas purification. (g) Includes silver lead-ore, silver-lead slimes and lead slag. (h) Details relating to rutile-zircon concentrates produced in one State and finally separated in another State are included, in separated form, in the data of the State of origin. (i) Includes brown coal used for briquette production. (j) Source: Department of Minerals and Energy and State Mines Departments. (k) Sales-excludes condensate blended with other petroleum products. (l) Excludes refinery production. (m) Incomplete, see individual States. (n) Incomplete, excludes Western Australia. (o) Not available for publication. (p) Comprises peat for fertiliser and peat moss.

NOTE. Particulars of the production of uranium concentrate are not available for publication.

QUANTITY OF MINERALS PRODUCED: AUSTRALIA, 1967 TO 1970-71

Mineral	1967	1968	1968-69(a)	1969-70(a)	1970-71(a)	
METALLIC MINERALS						
Antimony concentrate(b)	tonnes	156	248	265	353	3,821
Bauxite	'000 tonnes	4,243	4,955	6,317	8,294	11,043
Beryllium ore	tonnes	56	15	14	(c)	28
Bismuth concentrate	"	108	1,578	1,553	1,768	1,896
Chromite	"	140	87	..	..	..
Copper concentrate(d)	"	398,980	459,355	500,949	545,211	662,308
Copper ore(e)	"	31,958	(f)39,831	(f)46,733	(f)83,493	(f)31,137
Gold—						
Bullion	'000 grams	28,287	25,749	23,161	19,691	17,174
Ore	tonnes	6	6	6	914	1,087
Iron ore	'000 tonnes	17,309	(g)26,625	(g)32,541	(g)45,119	(g)57,110
Iron oxide(h)	tonnes	53,850	64,105	46,940	58,400	64,080
Lead concentrate	"	545,813	611,365	652,225	692,836	631,722
Lead-copper concentrate	"	12,423	12,760	13,033	13,517	10,227
Lead ore(i)	"	18,516	52,287	53,251	41,352	36,315
Lead-zinc middlings	"	14,921	5,459	3,298	37,949	23,400
Manganese ore	"	568,953	743,825	847,198	792,783	786,155
Mineral sands—						
Ilmenite concentrate	"	552,949	560,351	667,231	789,350	886,758
Leucoxene concentrate	"	707	1,633	8,870	9,553	12,863
Monazite concentrate	"	2,350	2,088	4,296	4,124	4,146
Rutile concentrate	"	269,775	292,232	316,663	372,033	374,768
Xenotime concentrate	"	18	18	39	103	42
Zircon concentrate	"	288,234	298,916	347,204	376,708	417,974
Molybdenite concentrate	"	..	10	48	117	61
Nickel concentrate	"	16,006	37,472	51,961	160,083	304,046
Osmiridium—native	grams	..	340	..	..	..
Pyrite concentrate	tonnes	256,804	167,917	134,935	154,758	235,355
Tantalite-columbite concentrate	'000 grams	36,100	108,016	92,019	45,934	158,786
Tin concentrate	tonnes	8,694	10,587	11,967	15,265	15,951
Tin-copper concentrate	"	..	891	2,145	3,708	4,367
Tungsten concentrates—						
Scheelite concentrate	"	1,221	1,489	1,588	1,406	1,287
Wolfram concentrate	"	455	568	746	1,059	1,076
Zinc concentrate	"	714,070	729,838	798,554	889,806	770,885
Zinc ore	"	(j)201	2,743	11,380	..	254
COAL						
Black coal	'000 tonnes	35,264	40,828	43,334	48,498	49,720
Semi-anthracite	"	39	31	25	7	1
Bituminous	"	31,801	37,253	39,656	44,762	46,460
Sub-bituminous	"	3,424	3,544	3,653	3,729	3,259
Brown coal (lignite)(k)	"	23,759	23,339	23,500	24,311	23,180
Brown coal briquettes	"	1,879	1,578	1,495	1,565	1,391
PETROLEUM(l)						
Crude oil	'000 cu m	1,208	2,206	2,238	4,872	14,937
Natural gas	mil. cu m	4	6	58	781	1,962
Natural gas condensate(m)	cu m	..	..	1	133	1,433
Ethane(n)	'000 cu m	..	..	..	481	5,380
Liquefied petroleum gases(n)—						
Propane	cu m	..	..	..	15,605	346,700
Butane	cu m	..	..	..	21,768	393,335

For footnotes see next page.

QUANTITY OF MINERALS PRODUCED: AUSTRALIA, 1967 TO 1970-71—continued

Mineral	1967	1968	1968-69 (a)	1969-70 (a)	1970-71 (a)	
CONSTRUCTION MATERIALS(o)						
Sand	'000 tonnes	11,328	14,637	17,575	17,139	17,413
Gravel	"	9,193	8,473	11,240	12,168	12,993
Dimension stone	"	242	280	301	276	186
Crushed and broken stone	"	46,913	45,087	45,890	48,851	50,419
Other	"	25,752	27,008	24,280	28,860	28,208
OTHER NON-METALLIC MINERALS						
Asbestos	tonnes	544	814	745	748	751
Barite	"	15,917	39,783	46,310	39,976	54,008
Clays—						
Brick and shale	'000 tonnes	5,787	6,525	7,385	7,678	7,092
Other(o)	"	1	1	1,224	1,470	1,397
Diatomite	tonnes	11,281	6,833	2,685	2,731	2,399
Dolomite	"	295,323	321,814	310,549	335,386	319,656
Felspar (including cornish stone)	"	4,521	4,916	5,834	3,648	3,382
Fluorspar . . . . .	"	..	..	..	619	1,000
Garnet concentrate	"	600	170	327	336	423
Gypsum	"	928,752	857,283	938,049	861,700	952,901
Limestone (including shell and coral) '000 tonnes		8,489	8,606	9,179	10,238	10,447
Lithium ores	tonnes	678	750	830	777	739
Lithia (Li ₂ O) content	"	30	32	35	33	31
Loam—for foundry moulding	"	(p)	(p)	(p)	(p)	(p)
Magnesite, crude	"	24,033	23,517	23,718	23,539	19,664
Mineral pigments—red ochre	"	364	534	664	42	702
Peat(q) . . . . .	"	..	..	2,168	3,278	3,678
Pebbles—for grinding	"	1,326	1,342	1,118	1,350	1,677
Perlite	"	1,411	1,066	808	1,399	1,773
Phosphate rock	"	11,959	5,836	10,726	18,463	9,164
Pyrophyllite	"	..	509	1,964	5,080	6,828
Salt	'000 tonnes	714	914	1,022	2,054	3,774
Silica	tonnes	450,673	551,388	743,798	786,528	955,049
Sillimanite	"	1,202	2,149	1,939	1,175	1,139
Talc (including steatite and chlorite)	"	18,064	38,894	42,172	60,060	44,532
Vermiculite . . . . .	"	..	..	..	..	360

(a) Year ended 30 June. (b) Includes antimony ore. (c) Not available for publication. (d) Includes copper precipitate. (e) Includes cupreous ore for fertiliser. (f) Includes copper slag. (g) Includes iron concentrate. (h) For cement manufacture, coal washing, flux and gas purification. (i) Includes silver-lead ore, silver-lead slimes and lead slag. (j) Zinc ore for fertiliser. (k) Includes brown coal used for briquette production. (l) Source: Department of Minerals and Energy and State Mines Departments. (m) Sales—excludes condensate blended with other petroleum products. (n) Excludes refinery production. (o) Incomplete, owing to difficulties of coverage. (p) Included in silica. (q) Comprises peat for fertiliser and peat moss.

NOTE. Particulars of the production of uranium concentrate are not available for publication.

Contents of metallic minerals produced

In the foregoing tables the section headed "Metallic Minerals" contains statistics of ores and concentrates produced. The following tables contain statistics of the metallic content of these ores and concentrates. The figures are the result of assays carried out on the ores and concentrates and may not represent the ultimate yield of metals produced after smelting and refining.

**CONTENTS OF METALLIC MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1970-71**

<i>Content of metallic minerals produced</i>	<i>N.S.W.</i>	<i>Vic.</i>	<i>Qld</i>	<i>S.A.</i>	<i>W.A.</i>	<i>Tas.</i>	<i>N.T.</i>	<i>Aust.</i>
Alumina (Al ₂ O ₃) . . . '000 tonnes	3	3	(a)	..	(a)	..	105	(a)
Antimony . . . tonnes	888	352	148	..	..	..	..	1,388
Beryllium oxide (BeO) . . . mtu(b)	61	..	..	..	277	..	..	338
Bismuth . . . '000 grams	..	..	23,369	..	261	..	214,386	238,016
Cadmium . . . tonnes	1,042	..	360	..	..	61	2	1,465
Cobalt . . . " "	110	..	..	..	336	..	..	446
Copper . . . " "	14,389	40	122,594	2,285	3,439	23,846	6,373	172,966
Gold . . . '000 grams	315	183	2,497	3	10,737	1,313	4,056	19,103
Iron(c) . . . '000 tonnes	..	..	..	4,584	29,338	(d)1,413	772	36,107
Lead . . . tonnes	255,044	1	148,506	5	85	12,516	274	416,432
Manganese(e) . . . " "	5,979	..	..	..	65,455	176	302,020	373,630
Manganese dioxide (MnO ₂)(f)	..	..	..	82	..	..	..	82
Mercury . . . '000 grams	..	..	..	..	..	662	..	662
Molybdenum disulphide (MoS ₂)	..	..	51,818	..	..	..	..	51,818
Monazite . . . tonnes	390	..	49	..	3,403	..	..	3,842
Nickel . . . " "	..	..	..	..	34,917	..	..	34,917
Palladium . . . grams	..	1,758	..	..	..	..	..	1,758
Platinum . . . " "	..	1,191	..	..	28,293	..	..	29,484
Silver . . . '000 grams	299,440	6	367,190	15	3,430	49,362	4,303	723,746
Sulphur(g) . . . tonnes	210,512	..	73,766	30,362	..	90,608	..	405,247
Tantalite-columbite (Ta ₂ O ₅ + Nb ₂ O ₅)	..	..	..	..	63,799	..	..	63,799
Tin . . . tonnes	1,880	3	1,013	..	667	5,322	39	8,923
Titanium dioxide (TiO ₂)	262,674	..	161,675	..	421,342	7,507	..	853,198
Tungstic oxide (WO ₃) . . . mtu(b)	261	..	10,445	..	..	154,870	486	166,062
Yttrium oxide (Y ₂ O ₃) . . . '000 grams	..	..	..	..	9,647	..	..	9,647
Zinc . . . tonnes	294,732	..	108,455	76	..	40,694	188	444,145
Zirconium dioxide (ZrO ₂) . . . " "	191,784	..	46,943	..	36,124	3,026	..	277,877

(a) Not available for publication. (b) Metric ton unit (mtu) equals 10 kilograms. (c) Excludes iron content of iron oxide not intended for metal extraction. (d) Contained in iron concentrate. (e) Content of metallurgical grade manganese ore and zinc concentrate. (f) Content of manganese ore of other than metallurgical grade. (g) Sulphur content of pyrite and other minerals from which sulphur is recovered.

NOTE. Particulars of production of uranium oxide (U₃O₈) are not available for publication.

CONTENTS OF METALLIC MINERALS PRODUCED: AUSTRALIA, 1967 TO 1970-71

<i>Content of metallic minerals produced</i>	<i>1967</i>	<i>1968</i>	<i>1968-69</i>	<i>1969-70</i>	<i>1970-71</i>
			(a)	(a)	(a)
Alumina (Al ₂ O ₃) . . . '000 tonnes	(b)	(b)	(b)	(b)	(b)
Antimony . . . tonnes	945	856	868	969	1,388
Beryllium oxide (BeO) . . . mtu(c)	686	181	175	(b)	338
Bismuth . . . '000 grams	11,583	182,888	191,271	201,267	238,016
Cadmium . . . tonnes	1,345	1,381	1,229	1,339	1,465
Chromic oxide (Cr ₂ O ₃) . . . " "	45	27	..	..	..
Cobalt . . . " "	148	239	215	311	446
Copper . . . " "	91,811	109,638	125,308	142,322	172,966
Gold . . . '000 grams	25,049	24,316	22,713	20,496	19,103
Iron(d) . . . '000 tonnes	11,104	(e)17,192	(e)20,831	(e)28,676	(e)36,107
Lead . . . tonnes	381,809	388,812	417,661	459,357	416,432
Manganese(f) . . . " "	268,907	350,637	378,503	396,536	373,630
Manganese dioxide (MnO ₂)(g)	232	136	150	111	82
Mercury . . . '000 grams	1,907	974	1,566	1,466	662
Molybdenum disulphide (MoS ₂)	..	8,693	40,653	99,319	51,818
Monazite . . . tonnes	2,198	1,879	3,936	3,831	3,842
Nickel . . . " "	2,094	4,677	6,184	18,047	34,917
Osmiridium . . . grams	..	340	..	..	..
Palladium . . . " "	..	..	9,979	482	1,758
Platinum . . . " "	..	..	14,713	17,208	29,484
Silver . . . '000 grams	617,159	665,424	707,856	855,926	723,746
Sulphur(h) . . . tonnes	398,667	355,606	367,852	361,377	405,247
Tantalite-columbite (Ta ₂ O ₅ + Nb ₂ O ₅)	14,926	25,482	10,622	28,992	63,799
Tin . . . tonnes	5,676	6,642	7,536	8,705	8,923
Titanium dioxide (TiO ₂) . . . " "	561,766	588,007	676,775	803,127	853,198
Tungstic oxide (WO ₃) . . . mtu(c)	121,123	146,872	165,728	176,009	166,062
Yttrium oxide (Y ₂ O ₃) . . . '000 grams	4,298	4,309	7,399	21,404	9,647
Zinc . . . tonnes	406,954	422,393	444,407	502,036	444,145
Zirconium dioxide (ZrO ₂) . . . " "	191,486	198,724	227,688	250,070	277,877

(a) Year ended 30 June. (b) Not available for publication. (c) Metric ton unit (mtu) equals 10 kilograms. (d) Excludes iron content of iron oxide not intended for metal extraction. (e) Includes iron contained in iron concentrate. (f) Content of metallurgical grade manganese ore and zinc concentrate. (g) Content of manganese ore of other than metallurgical grade. (h) Sulphur content of pyrite and other minerals from which sulphur is recovered.

NOTE. Particulars of production of uranium oxide (U₃O₈) are not available for publication.

MINE PRODUCTION OF PRINCIPAL METALS: AUSTRALIA
 (METALLIC CONTENT OF MINERALS)
 1936 TO 1970-71

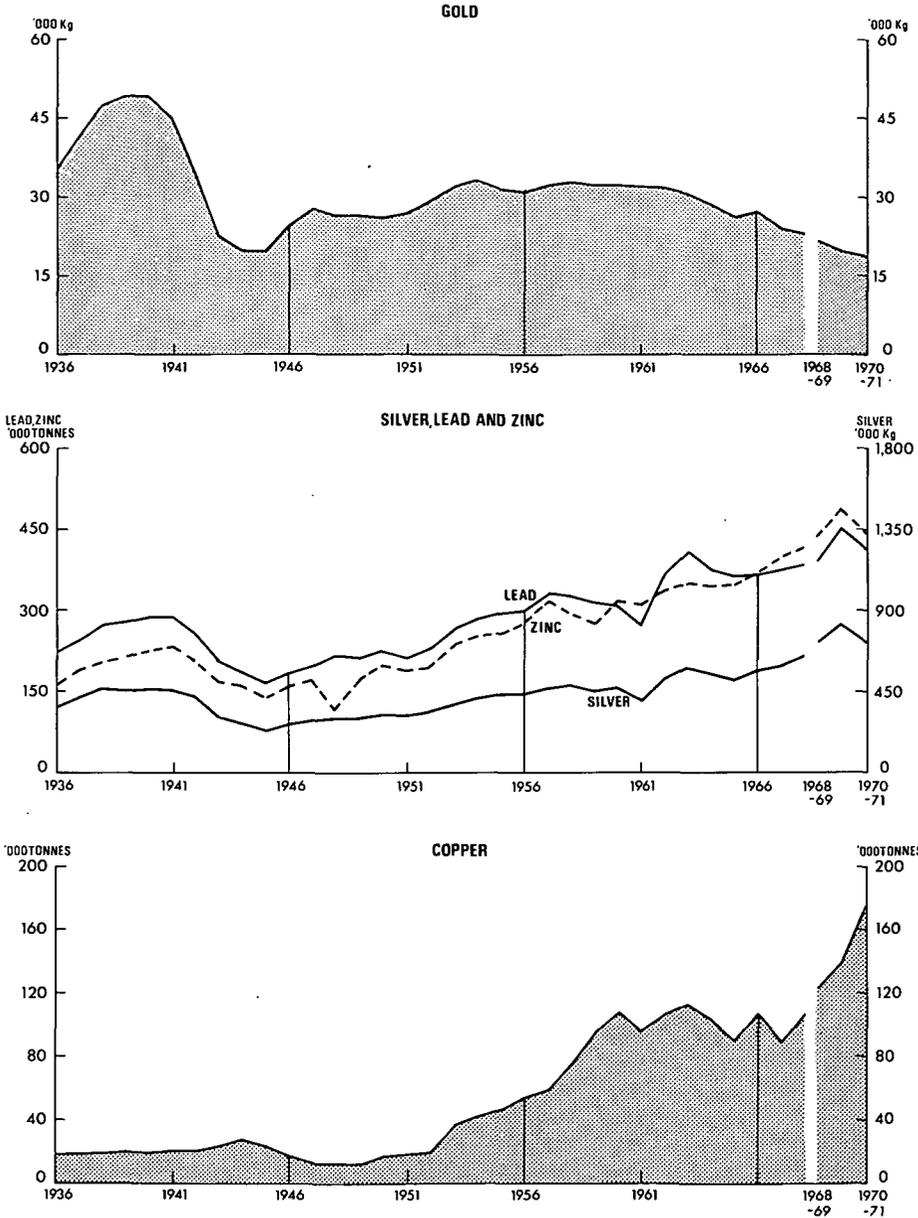
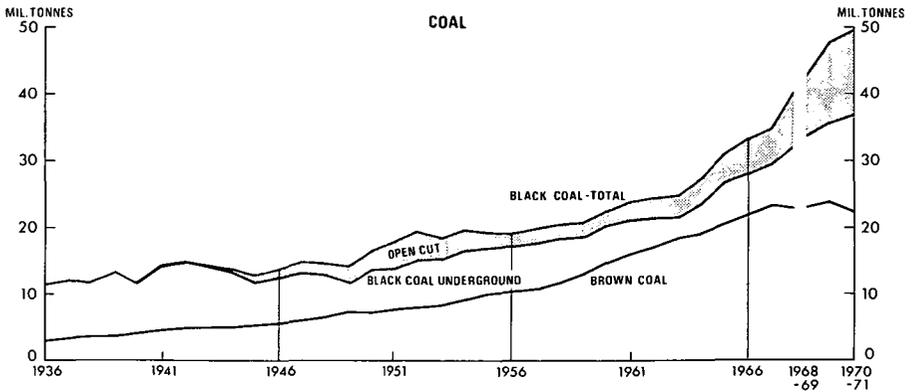
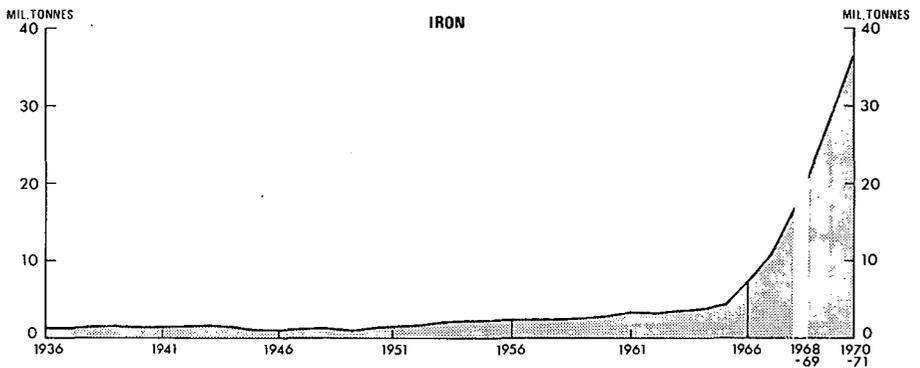
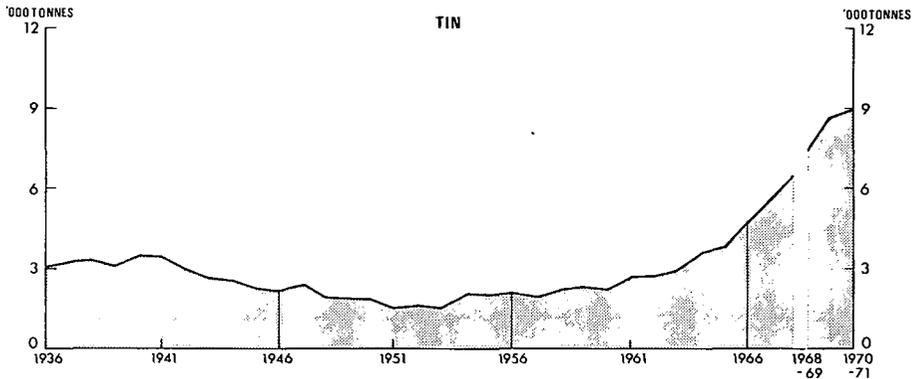


PLATE 51

MINE PRODUCTION OF PRINCIPAL METALS
AND PRODUCTION OF COAL

(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1936 TO 1970-71



Note. Prior to 1968-69 mineral figures were collected on a calendar year basis.

Value of minerals produced

The following table shows the value of minerals produced in 1970-71 and earlier years.

VALUE OF MINERALS PRODUCED: AUSTRALIA, 1967 TO 1970-71
(\$'000)

<i>Mineral</i>	1967	1968	1968-69(a)	1969-70(a)	1970-71(a)
METALLIC MINERALS					
Antimony—					
Concentrate }	54	83	83	84	422
Ore }				7	83
Bauxite	(b)	(b)	(b)	(b)	(b)
Beryllium ore	21	7	7	(b)	9
Bismuth concentrate	139	1,979	2,087	2,441	2,672
Chromite	7	4	..	..	..
Copper—					
Concentrate }			103,872	145,246	129,752
Ore }	72,515	(c)92,396	(c)2,073	(c)2,874	(b)(c)
Ore for fertiliser }			136	97	18
Precipitate }			352	232	148
Gold—					
Bullion(d)	24,456	23,525	22,965	19,945	17,779
Ore . . . . .	..	..	..	26	3
Iron ore	82,994	131,482	193,246	258,950	343,682
Iron oxide	501	578	542	645	754
Lead concentrate }			80,598	99,507	75,825
Lead-copper concentrate }	73,654	89,705	4,043	4,760	3,031
Lead ore(e) }			797	463	395
Lead-zinc middlings }			303	3,032	2,269
Manganese ore	8,007	8,358	10,734	9,680	10,852
Mineral sands—					
Ilmenite concentrate	4,390	4,572	5,380	6,638	7,434
Leucoxene concentrate	33	70	358	420	975
Monazite concentrate	289	237	501	493	530
Rutile concentrate	19,615	21,528	23,388	31,246	37,214
Xenotime concentrate	45	45	76	119	54
Zircon concentrate	10,937	10,967	11,481	11,827	13,207
Molybdenite concentrate . . . . .	..	(b)	76	175	85
Nickel concentrate	(b)	(b)	(b)	(b)	(b)
Osmiridium-native . . . . .	..	2	..	..	..
Pyrite concentrate	(b)	1,842	1,713	1,473	2,190
Tantalite-columbite concentrate	(b)	(b)	(b)	(b)	936
Tin concentrate	15,011	16,691	19,199	26,744	25,533
Tin-copper concentrate . . . . .	..	(b)	469	915	905
Tungsten concentrates	4,509	5,514	6,725	8,753	9,044
Zinc concentrate }			35,285	45,973	43,548
Zinc ore }	29,354	30,398	112	..	2
Zinc ore for fertiliser . . . . . }			..	..	..
<i>Total metallic minerals</i>	370,892	468,172	562,849	761,600	845,423
COAL					
Black coal	160,099	188,785	198,713	246,659	278,280
Brown coal (lignite)	20,686	21,555	20,879	22,131	22,975
<i>Total coal</i>	180,785	210,340	219,592	268,790	301,256
PETROLEUM					
<i>Petroleum</i>	21,286	39,307	40,098	88,532	216,722

For footnotes see next page.

VALUE OF MINERALS PRODUCED: AUSTRALIA, 1967 TO 1970-71—*continued*
(\$'000)

<i>Mineral</i>	1967	1968	1968-69(a)	1969-70(a)	1970-71(a)
CONSTRUCTION MATERIALS					
<i>Construction materials(f)</i>	91,789	96,812	117,113	134,638	144,708
OTHER NON-METALLIC MINERALS					
Asbestos	108	181	180	174	170
Barite	214	410	409	437	476
Clay—					
Brick clay and shale	6,472	7,042	7,042	7,682	7,126
Other clays	1,729	2,122	1,828	2,338	2,342
Diatomite	71	52	21	21	20
Dolomite	674	720	699	825	747
Felspar (including cornish stone)	43	42	57	49	45
Fluorspar	..	..	..	14	32
Garnet concentrate	4	2	5	4	6
Gems(g)	4,605	6,575	9,261	14,541	17,830
Gypsum	2,119	2,171	2,351	2,238	2,577
Limestone (including shell and coral)	11,700	11,963	13,380	14,431	15,110
Lithium ores	9	9	13	12	12
Loam—for foundry moulding	(h)	(h)	(h)	(h)	(h)
Magnesite, crude	256	228	238	272	233
Mineral pigments—red ochre	5	7	10	1	7
Peat(i)	n.a.	n.a.	26	59	62
Pebbles—for grinding	22	23	17	24	30
Perlite	3	7	5	14	18
Phosphate rock	47	23	42	73	27
Pyrophyllite	..	7	22	45	68
Salt	2,769	3,600	4,246	7,947	11,563
Silica	772	1,038	1,775	2,542	3,276
Sillimanite	29	47	44	30	27
Talc (including steatite and chlorite)	295	657	617	946	732
Vermiculite	..	..	..	..	2
<i>Total other non-metallic minerals</i>	31,946	36,928	42,287	54,717	62,540
TOTAL					
Total, all minerals and construction materials	696,701	851,562	981,939	1,308,277	1,570,650
<i>Of which—</i>					
New South Wales	274,123	298,392	314,802	388,561	387,301
Victoria	57,339	59,026	60,633	104,967	242,446
Queensland	135,379	185,753	209,273	278,142	293,751
South Australia	40,449	42,064	72,135	84,955	92,482
Western Australia	134,319	195,316	235,017	339,959	446,507
Tasmania	34,688	44,968	59,163	77,631	74,169
Northern Territory	19,316	24,846	29,365	32,528	32,274
Australian Capital Territory	1,087	1,195	1,550	1,535	1,719

(a) Year ended 30 June. (b) Not available for publication. (c) Includes value of copper slag. (d) Includes alluvial gold. (e) Includes value of silver-lead ore, silver-lead slimes and lead slag. (f) Incomplete owing to difficulties of coverage in some States. (g) Mainly opals and sapphires. (h) Included in silica. (i) Comprises peat for fertiliser and peat moss.

Overseas participation in Australian mining industry

For the latest information available concerning overseas ownership and control in Australian mining industry see Year Book No. 57, pages 932-5.

Mineral exploration (other than for petroleum)

Definition

Mineral exploration (other than for petroleum) consists of the search for, and/or appraisal of, new ore occurrences and known deposits of minerals (including extensions to deposits being worked) by geological, geophysical, geochemical, and other methods (including drilling). Exploration for water is excluded. The construction of shafts and adits is included if primarily for exploration purposes. Excluded are mine development activities (which include the construction of drives, shafts, winzes, etc.) in underground mines and the preparation of quarrying sites for open-cut extraction (including overburden removal) carried out primarily for the purpose of commencing or extending mining and quarrying operations. Mine development activities (including mines under development) are included in the scope of the annual mining census.

Sources of statistics

The statistics of exploration for minerals *other than petroleum* are derived from the annual mineral exploration census (excluding petroleum exploration), which is carried out by this Bureau in association with State Mines Departments.

Period covered

For 1968 and earlier years the annual mineral exploration census (excluding petroleum exploration) related to years ended 31 December. As from 1968-69, the reporting period for this census has related to years ended 30 June, to conform with a similar change in the annual mining census. It should be noted that data for the six months ended 31 December 1968 are included in both the 1968 and 1968-69 figures in these tables.

Scope of mineral exploration census

The scope of the census comprises the following activities.

(a) *Private exploration on production leases*—relates to exploration carried out *on the production lease* by privately operated mines currently producing or under development for production of minerals other than petroleum. This also includes particulars of exploration within their production leases by business undertakings operated by State and local government authorities. Mines included in this section of the mineral exploration census are also included in the annual mining census with the exception of a limited number of itinerant prospectors and small mines for which information was not collected.

(b) *Private exploration on other licensed areas*—relates to exploration carried out by private enterprises and business undertakings operated by State and local government authorities on areas covered by exploration licences, authorities to enter, authorities to prospect, and similar licences and authorities issued by State Governments for exploration for minerals other than petroleum.

(c) *Other private exploration*—relates to exploration by private enterprises and business undertakings operated by State and local government authorities for minerals other than petroleum, which is not directly connected with areas under lease, licence, etc., including general surveys, aerial surveys, report writing, map preparation and other off-site activities not directly attributable to particular leases or licence areas.

(d) *Exploration by government*—relates to exploration for minerals other than petroleum carried out by—

- (i) Commonwealth Government (Bureau of Mineral Resources, Geology and Geophysics, and Joint Coal Board), and
- (ii) State Mines Departments.

Employment in mineral exploration

In censuses prior to 1970-71 employment data were classified to one of the two categories: 'professional persons', and 'non-professional persons'. Employment data for working proprietors and working partners were, however, included in either one or the other of these categories. From 1970-71 separate details of man-weeks worked by 'working proprietors and working partners' were collected and are shown separately in the table on page 945.

Expenditure, employment, footage drilled, etc., States and Northern Territory

The following table shows expenditure, employment and footage drilled, etc., on mineral exploration other than for petroleum in each State and the Northern Territory during the years 1968 to 1971-72.

**MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)
STATES AND NORTHERN TERRITORY, 1968 TO 1971-72**

	EXPENDITURE(a) (\$'000)				
	1968(b)	1968-69	1969-70	1970-71	1971-72
PRIVATE EXPLORATION					
New South Wales	5,620	7,272	16,562	21,238	15,093
Victoria	1,476	1,600	2,353	1,853	1,258
Queensland	13,343	18,018	25,078	32,662	22,119
South Australia	2,661	2,961	5,760	6,220	4,057
Western Australia	23,148	35,412	59,821	86,082	62,823
Tasmania	2,059	2,408	3,299	4,397	3,478
Northern Territory	4,156	4,891	5,241	8,610	8,233
<i>Total</i>	52,463	72,562	118,115	161,063	117,061
GOVERNMENT EXPLORATION					
Commonwealth(c)	3,529	3,591	3,995	3,928	4,603
State Mines Departments	2,329	2,939	2,708	3,386	3,732
<i>Total</i>	5,858	6,530	6,704	7,314	8,334
TOTAL EXPENDITURE					
On drilling	20,448	26,196	33,522	45,106	32,905
Other	37,873	52,896	91,296	123,272	92,490
Australia	58,321	79,092	124,818	168,377	125,396
Payments to contractors(d)	19,409	28,715	41,557	55,693	35,437

For footnotes see next page.

MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM): STATES AND
NORTHERN TERRITORY, 1968 TO 1971-72—*continued*

EMPLOYMENT(e) (^{'000} man-weeks worked)					
	1968(b)	1968-69	1969-70	1970-71	1971-72
PRIVATE EXPLORATION					
New South Wales	20.9	26.2	30.7	40.7	31.8
Victoria	7.0	6.3	5.7	5.1	3.4
Queensland	33.3	36.5	48.4	60.7	44.6
South Australia	12.2	9.2	10.9	11.2	9.0
Western Australia	52.8	67.5	103.3	135.5	114.5
Tasmania	7.5	7.4	8.8	11.4	7.5
Northern Territory	11.0	10.8	12.7	17.4	18.3
<i>Total</i>	<i>144.6</i>	<i>163.9</i>	<i>220.5</i>	<i>282.1</i>	<i>229.0</i>
GOVERNMENT EXPLORATION					
Commonwealth(c)	11.9	11.7	16.5	18.1	14.5
State Mines Departments	13.7	17.0	20.9	21.1	22.8
<i>Total</i>	<i>25.5</i>	<i>28.7</i>	<i>37.4</i>	<i>39.2</i>	<i>37.3</i>
TOTAL					
By working proprietors and working partners	(f)	(f)	(f)	7.2	4.6
By professional persons(g)	49.9	57.6	73.1	94.5	94.4
By non-professional persons(h)	120.2	135.0	184.8	219.5	167.3
<i>Australia</i>	<i>170.1</i>	<i>192.6</i>	<i>257.9</i>	<i>321.2</i>	<i>266.3</i>
FOOTAGE DRILLED, SUNK OR DRIVEN (^{'000} ft)					
PRIVATE EXPLORATION					
New South Wales	1,031	1,146	1,527	1,657	1,235
Victoria	127	142	137	100	61
Queensland	1,669	1,873	1,959	2,797	1,901
South Australia	227	250	613	654	404
Western Australia	1,768	2,493	6,344	6,661	6,659
Tasmania	149	177	192	307	219
Northern Territory	302	352	293	451	375
<i>Total</i>	<i>5,273</i>	<i>6,432</i>	<i>11,066</i>	<i>12,627</i>	<i>10,854</i>
GOVERNMENT EXPLORATION					
Commonwealth(c)	15	21	28	10	7
State Mines Departments	282	314	283	274	233
<i>Total</i>	<i>297</i>	<i>335</i>	<i>311</i>	<i>285</i>	<i>240</i>
TOTAL FOOTAGE DRILLED, SUNK OR DRIVEN(i)					
Drilled—core	2,003	2,641	3,045	3,114	2,606
non-core	3,445	3,916	8,101	9,224	8,247
Sunk or driven	122	210	231	574	239
<i>Australia</i>	<i>5,570</i>	<i>6,767</i>	<i>11,377</i>	<i>12,911</i>	<i>11,093</i>

(a) Expenditure whether charged as working expenses or capitalised. (b) Year ended 31 December. (c) Bureau of Mineral Resources and Joint Coal Board. (d) Included in expenditure shown above. Comprises amounts paid to drilling contractors, geological consultants, technical advisers, etc., for exploration services. (e) Operator and staff only (includes time spent on report writing and similar off-site activities associated with exploration); excludes contractors and their employees. (f) Not collected separately prior to 1970-71. Included in professional and non-professional employment, see text page 944. (g) Geologists, geophysicists, engineers, etc., engaged on exploration work. (h) Drill operators, field hands, etc. (i) 'Sunk or driven' relates to shafts, winzes, etc., sunk, and drives, adits, etc., driven.

Petroleum exploration

Source of statistics

These statistics were collected and compiled by the Bureau of Mineral Resources, Geology and Geophysics, Canberra. Statistical and other information relating to petroleum exploration is published by the Bureau of Mineral Resources in *The Petroleum Newsletter* (issued quarterly) and *The Australian Mineral Industry—Annual Review*.

Scope

Petroleum exploration consists of the search for, and/or appraisal of, deposits of crude oil and/or natural gas and natural gas liquids by geological, geophysical, geochemical, and other exploration methods, including drilling. Included in the expenditure are the costs of drilling exploratory oil and/or gas wells and the testing of such wells. Also included are the cost of access roads, site construction, permits, licences and similar fees, relevant office buildings and furniture, transportation equipment, storage facilities, plant and equipment, and review work, where these are undertaken primarily for purposes of exploration for deposits of petroleum. Details of developmental oil and/or gas wells are excluded.

Operations

The following tables show particulars of expenditure, and wells and footage drilled in petroleum exploration in recent years.

EXPENDITURE ON PETROLEUM EXPLORATION BY PRIVATE ENTERPRISE
AND BY GOVERNMENTS: AUSTRALIA, 1967 TO 1971
(\$'000)

	1967	1968	1969	1970	1971
PRIVATE SOURCES(a)					
Utilised in—					
New South Wales	1,284	1,126	2,473	2,597	287
Victoria	15,892	19,538	18,415	11,538	1,453
Queensland	5,875	5,178	7,058	5,474	3,011
South Australia	6,257	2,979	3,669	6,431	7,084
Western Australia	11,788	21,532	26,194	29,557	41,872
Tasmania	2,424	999	1,837	4,708	1,939
Northern Territory	6,978	6,222	7,064	13,753	17,250
<i>Australia</i>	<i>50,497</i>	<i>57,573</i>	<i>66,711</i>	<i>74,059</i>	<i>72,896</i>
GOVERNMENT SOURCES					
Payments under <i>Petroleum Search Subsidy Act</i> 1959-1969—					
Utilised in—					
New South Wales	516	474	548	406	225
Victoria	727	1,940	441	732	231
Queensland	1,767	1,419	1,524	1,623	500
South Australia	1,058	1,407	609	923	537
Western Australia	3,441	4,027	6,286	4,604	3,590
Tasmania	469	497	903	395	208
Northern Territory	1,657	1,448	2,561	1,061	695
<i>Total subsidy payments, Australia</i>	<i>9,635</i>	<i>11,213</i>	<i>12,871</i>	<i>9,744</i>	<i>5,986</i>
Utilised for—					
Geophysical	4,512	3,590	3,557	2,924	2,470
Drilling	5,123	7,622	9,315	6,820	3,517
Other Government sources—					
Commonwealth(a)	4,508	4,756	4,238	3,841	4,696
State Mines Departments	466	783	832	456	458
<i>Total other Government sources, Australia</i>	<i>4,974</i>	<i>5,540</i>	<i>5,070</i>	<i>4,296</i>	<i>5,155</i>
<i>Total Government sources, Australia</i>	<i>14,609</i>	<i>16,752</i>	<i>17,941</i>	<i>14,040</i>	<i>11,140</i>
TOTAL FUNDS, PRIVATE AND GOVERNMENT					
<i>Australia</i>	<i>65,106</i>	<i>74,325</i>	<i>84,652</i>	<i>88,099</i>	<i>84,037</i>

(a) Excludes payments under the *Petroleum Search Subsidy Act* 1959-1969.

**SUMMARY OF EXPLORATION WELLS AND FOOTAGE DRILLED IN PETROLEUM
EXPLORATION: STATES AND TERRITORIES, 1971**

		<i>N.S.W.</i>	<i>Vic.</i>	<i>Qld</i>	<i>S.A.</i>	<i>W.A.</i>	<i>Tas.</i>	<i>N.T.</i>	<i>Total</i>
Wells—									
Drilled (i.e. those which reached final depth)—									
As oil producers	No.	..	..	1	1	1	..	..	1
As gas producers	No.	..	..	1	10	1	..	..	12
Plugged and abandoned	No.	1(a)	2	17	9	29	1	3	62
Total	No.	1(a)	2	18	20	30	1	3	75
Average final depth of wells drilled	ft	321	4,966	5,115	8,785	8,363	4,665	8,638	7,460
Drilling still in progress at 31 December (uncompleted holes)	No.	..	2	1	2	1	..	2	8
Wells drilled or drilling over 10,000 feet	No.	..	..	..	7	14	..	2	23
Footage drilled—									
Completed wells	ft	321	9,932	87,352	156,555	222,150	4,665	22,123	503,098
Uncompleted holes	ft	..	302	6,870	15,605	10,857	..	16,230	49,864
Total	ft	321	10,234	94,222	172,160	233,007	4,665	38,353	552,962

(a) Represents 4 shallow structure holes counted as one operation.

**SUMMARY OF EXPLORATION WELLS AND FOOTAGE DRILLED IN PETROLEUM
EXPLORATION: AUSTRALIA, 1967 TO 1971**

		1967	1968	1969	1970	1971
Wells—						
Drilled (i.e. those which reached final depth)—						
As oil producers	No.	4	1	..	2	1
As gas producers	No.	7	4	6	15	12
Plugged and abandoned	No.	72	78	101	108	62
Total	No.	83	83	107	125	75
Average final depth of wells drilled	ft	5,575	6,135	6,170	5,361	7,460
Drilling still in progress at 31 December (uncompleted holes)	No.	8	8	11	8	8
Wells drilled or drilling over 10,000 ft	No.	11	13	24	19	23
Footage drilled—						
Completed wells	ft	373,336	453,318	604,683	631,732	503,098
Uncompleted holes	ft	48,332	57,729	70,922	52,710	49,864
Total	ft	421,668	511,047	675,605	684,442	552,962

Mineral processing and treatment

The extraction of minerals from ore deposits, as in mining and quarrying, is only part of the wider field of mineral technology. It is only in rare instances that minerals can be used directly in the form in which they are produced by mines, and, much more commonly, minerals must undergo considerable processing and treatment before their full utility and value can be realised. Examples of this processing and treatment are the smelting and refining of metals, the production of coke from coal, the refining of oil, and the treatment of non-metallic minerals as in the production of superphosphate and other chemicals and building materials like bricks and cement. The sectors of the economy which carry out this work are classified for statistical purposes to the manufacturing industry, and particulars relating to those activities which principally involve mineral processing and treatment—i.e. the treatment of non-metalliferous mine and quarry products, the manufacture of mineral oils and chemical fertilisers, the smelting, converting, refining and rolling of iron and steel, the extracting and refining of other metals, and the manufacture of alloys are given in Chapter 21, Manufacturing Industry.

Principal products

The following table shows particulars of the production of certain important manufactured products of mineral origin during the years 1966–67 to 1971–72.

**PRODUCTION OF PRINCIPAL MANUFACTURED PRODUCTS
OF MINERAL ORIGIN: AUSTRALIA, 1966-67 TO 1970-71**
(recorded in imperial units)

Commodity	1966-67	1967-68	1968-69	1969-70	1970-71
METALS(a)					
Non-ferrous—					
Alumina tons	474,716	1,136,208	1,591,802	1,995,474	2,366,673
Refined aluminium "	92,826	87,733	109,998	165,709	214,797
Blister copper(b) "	77,788	75,344	109,582	108,852	128,143
Refined copper "	74,313	72,166	94,732	103,680	113,500
Lead bullion (for export)(b) "	84,690	101,477	132,218	169,007	176,590
Refined lead "	192,384	186,908	175,664	185,366	152,490
Refined zinc "	197,030	187,325	228,198	257,674	249,753
Refined tin "	3,224	3,955	3,960	4,637	5,848
Ferrous—					
Pig iron(c) '000 tons	4,893	5,209	5,703	5,862	6,142
Steel ingots(c) "	6,114	6,287	6,705	6,874	6,693
Precious—					
Refined gold(d) '000 f oz	726	655	622	527	464
Refined silver "	9,825	9,693	9,428	10,581	8,162
FUELS					
Coal products—					
Metallurgical coke '000 tons	3,365	3,678	3,647	3,969	4,470
Brown coal briquettes "	1,820	1,745	1,471	1,539	1,376
Petroleum products—					
Motor spirit mil. gal	1,763	1,897	2,032	2,110	2,230
Furnace fuel '000 tons	5,759	6,206	6,113	5,987	5,700
Automotive distillate "	2,167	2,344	2,579	2,954	3,127
Industrial diesel fuel "	901	984	1,038	1,080	1,102
BUILDING MATERIALS					
Clay bricks millions	1,361	1,440	1,627	1,694	1,669
Portland cement '000 tons	3,661	3,805	4,075	4,428	4,611
Plaster of paris "	261	278	282	298	304
Plaster sheets '000 sq yd	30,601	32,809	31,434	35,748	41,100
CHEMICALS					
Sulphuric acid '000 tons	1,991	1,892	1,851	1,734	1,586
Caustic soda tons	91,009	98,190	105,478	110,659	117,788
Superphosphate(e) '000 tons	4,430	3,935	3,879	3,522	3,066

(a) Excludes secondary metal with the exception of pig iron and steel ingots. (b) metallic content. (c) Year ended 31 May. (d) Newly-won gold of Australian origin. (e) Includes double and triple superphosphate and ammonium phosphate expressed in terms of single superphosphate i.e. 22% P₂O₅ equivalent.

Overseas trade

Exports and imports

Data of imports and exports of minerals and mineral products have been extracted from the official trade statistics compiled in the Commonwealth Bureau of Census and Statistics. Particulars of the quantities and values (\$f.o.b. port of shipment) of the principal minerals and mineral products exported from and imported into Australia during the years 1969-70 to 1971-72 are shown in the following table

**EXPORTS AND IMPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS
AUSTRALIA, 1969-70 TO 1971-72**

Commodity(a)	Quantity			Value ('000 f.o.b.)			
	1969-70	1970-71	1971-72	1969-70	1970-71	1971-72	
EXPORTS(b)							
Non-ferrous—							
Copper—							
Concentrate	tonnes	65,110	140,218	141,395	14,620	32,031	27,298
Blister	"	8,030	6,972	5,868	13,256	8,992	6,643
Refined	"	38,624	36,014	56,519	54,733	35,521	51,395
Matte, slags, etc.	"	12,600	8,371	5,210	6,889	3,332	1,571
Lead—							
Concentrate	"	121,385	83,096	93,537	23,320	16,290	15,961
Bullion	"	169,755	179,811	137,865	60,461	56,455	38,279
Refined	"	161,617	123,155	130,345	42,944	29,023	28,230
Slags and residues	"	3,240	3,035	2,342	934	586	423
Zinc—							
Concentrate	"	437,120	387,334	364,147	30,503	25,739	26,184
Refined	"	154,717	136,664	190,428	38,736	35,671	56,825
Slags and residues	"	5,540	5,853	5,809	373	513	504
Tin—							
Concentrate	"	7,144	6,343	9,249	10	7,636	11,963
Refined	"	566	1,450	2,156	1,791	4,535	6,573
Aluminium—							
Alumina	'000 tonnes	n.a.	1,807	2,626	n.a.	95,125	132,042
Refined	tonnes	50,522	79,661	96,313	22,972	35,962	38,886
Ferrous and alloy—							
Iron ore—							
Pellets	'000 tonnes	5,129	5,628	5,420	58,830	62,802	58,274
Fines	"	7,730	13,478	18,081	48,731	81,101	105,885
Lump	"	20,918	29,215	26,738	170,249	231,485	211,330
Tungsten—							
Scheelite concentrate	tonnes	1,432	1,224	1,789	4,225	3,607	4,332
Wolfram concentrate	"	964	1,002	736	3,494	4,100	2,066
Pig iron	"	311,069	389,722	527,856	15	21,587	23,581
Steel ingots, blooms	"	451,203	117,210	296,275	31	9,596	18,967
Mineral sands—							
Ilmenite concentrate	"	596,214	641,060	530,933	5,888	6,471	5,628
Rutile concentrate	"	346,435	380,922	314,770	30,209	36,399	36,116
Zircon concentrate	"	351,039	363,160	364,343	13,489	13,200	13,038
Precious—							
Gold, refined	'000 grams	14,619	2,250	3,717	16,265	2,305	4,573
Silver, refined	"	247,025	247,586	211,574	13,350	12,237	9,033
Coal, black	'000 tonnes	17,623	18,997	21,826	164,497	193,725	237,592
Crude oil(c)	'000 cu m	..	1,091	241	..	2,760	14,207

IMPORTS

Tin, refined	tonnes	105	119	104	347	376	325
Nickel (pigs, anodes, etc.)	"	1,490	2,138	1,241	5,372	8,781	3,178
Ferro-alloys	"	31,080	37,841	27,941	12,748	11,660	8,234
Gold—							
Unrefined bullion(d)	'000 grams	4,021	3,212	3,202	4,146	3,416	3,794
Refined	"	1,936	254	17	2,389	232	27
Crude oil(e)	'000 cu m	23,168	13,689	10,960	200,356	121,325	115,101
Asbestos	tonnes	59,373	71,681	61,665	8,572	10,705	9,852
Diamonds—							
Industrial	metric carats	963,226	744,802	567,075	3,626	3,106	2,360
Gemstone	"	33,826	49,847	44,016	5,447	6,573	6,331
Phosphate rock	'000 tonnes	2,790	2,108	1,643	27,875	22,174	18,157
Potassium fertilisers	tonnes	129,391	153,268	145,912	3,432	4,793	4,118
Sulphur	"	434,157	273,341	276,745	10,786	4,906	4,637

(a) In addition to the commodities listed, significant quantities of bauxite and nickel ores and concentrates are exported but details are not available for publication. (b) Quantities shown for metallic minerals are gross quantities, not metallic contents. (c) Includes also partly refined oil, topped crudes and enriched crudes. (d) Gold content. (e) Includes also partly refined oil, topped crudes, enriched crudes and refinery feed stock.

Considerable quantities of metallic ores, concentrates, slags, and residues are exported from Australia for refining overseas. The following table shows selected items exported during 1970-71 and 1971-72 and their principal metallic content as estimated by assay.

**PRINCIPAL METALLIC CONTENTS OF SELECTED ORES AND CONCENTRATES
ETC., EXPORTED FROM AUSTRALIA, 1970-71 AND 1971-72**

<i>Ores and concentrates, etc.</i>	<i>Metallic contents—estimated from assay</i>							
	<i>Copper</i>	<i>Lead</i>	<i>Zinc</i>	<i>Tin</i>	<i>Iron</i>	<i>Tungstic oxides</i>	<i>Gold</i>	<i>Silver</i>
1970-71								
	tonnes	tonnes	tonnes	tonnes	'000 tonnes	tonnes	'000 grams	'000 grams
Copper concentrate	33,447	..	..	109	..	..	841	6,937
Blister copper	6,941	..	..	..	..	..	1,694	1,234
Copper matte, slags, etc.(a)	2,967	4,281	27	..	..	..	1	6,608
Lead concentrate	1,303	55,188	5,529	..	..	..	4,271	59,724
Lead bullion	187	178,617	..	..	..	..	..	299,635
Lead slags and residues	191	2,047	38	17	..	..	..	330
Zinc concentrate . . . . .	..	2,271	201,141	..	..	..	..	2,420
Zinc slags and residues . . . . .	..	..	4,133	..	..	..	..	..
Tin concentrate	4	5	..	2,733	..	..	..	..
Iron ore—								
Pellets . . . . .	..	..	..	..	3,692	..	..	..
Fines . . . . .	..	..	..	..	8,640	..	..	..
Lump . . . . .	..	..	..	..	18,865	..	..	..
Scheelite concentrate . . . . .	..	..	..	..	..	859	..	..
Wolfram concentrate . . . . .	..	..	..	2	..	679	..	..
Total metallic content	45,040	242,409	210,868	2,861	31,197	1,538	6,806	376,888
1971-72								
Copper concentrate	34,163	..	..	112	..	..	664	7,867
Blister copper	5,745	..	..	..	..	..	1,219	600
Copper matte, slags, etc.(a)	1,472	2,280	..	1	..	..	..	3,824
Lead concentrate	2,552	55,236	10,012	..	..	..	1,248	92,971
Lead bullion	2	136,929	..	..	..	..	..	296,206
Lead slags and residues	372	1,354	65	36	..	..	..	742
Zinc concentrate . . . . .	..	2,487	189,398	..	..	..	..	2,597
Zinc slags and residues . . . . .	..	20	4,074	..	..	..	..	..
Tin concentrate	4	..	..	4,440	..	..	..	..
Iron ore—								
Pellets . . . . .	..	..	..	..	3,499	..	..	..
Fines . . . . .	..	..	..	..	11,240	..	..	..
Lump . . . . .	..	..	..	..	17,435	..	..	..
Scheelite concentrate . . . . .	..	..	..	..	..	1,033	..	..
Wolfram concentrate . . . . .	..	..	..	..	..	532	..	..
Total metallic content	44,310	198,306	203,549	4,589	32,174	1,565	3,132	404,808

(a) Includes copper matte, copper slags and residues and copper-lead dross and speiss.

Prices

The following table shows average prices of some principal refined metals and ores and concentrates on Australian and certain major overseas markets. Prices of minerals such as iron ore, coal and bauxite are not shown, as these minerals are commonly sold on a contract basis rather than on an open market basis.

AVERAGE DAILY PRICES OF SELECTED METALS AND METALLIC ORES AND CONCENTRATES: AUSTRALIAN AND OVERSEAS MARKETS, 1967-68 TO 1971-72

(Source: Bureau of Mineral Resources, Geology and Geophysics)

Detail	Units	1967-68	1968-69	1969-70	1970-71	1971-72
METALS(a)						
Aluminium—						
Australia	\$A-ton	520.90	538.00	564.90	578.00	578.00
United States	USc-lb	25.1	26.4	27.9	29.0	26.6
Copper—						
Australia	\$A-ton	1,132.10	1,126.50	1,500.10	1,087.40	976.60
London Metal Exchange	£Stg-tonne	(b)511.5	(b)516.7	671.8	477.7	427.9
Lead—						
Australia	\$A-ton	210.00	234.30	283.50	262.40	237.90
London Metal Exchange	£Stg-tonne	(b)92.0	(b)109.3	132.2	114.7	106.7
United States	USc-lb	13.84	13.46	16.10	14.60	14.72
Zinc—						
Australia	\$A-ton	258.00	266.10	291.20	295.70	343.00
London Metal Exchange	£Stg-tonne	(b)105.3	(b)114.0	123.9	121.3	141.4
'Producers'	£Stg-ton	108.0	115.8	127.3	128.8	150.0
United States	USc-lb	13.50	13.84	15.30	15.25	17.21
Tin—						
Australia	\$A-ton	3,007.80	3,063.20	3,463.80	3,344.90	3,306.30
London Metal Exchange	£Stg-tonne	(b)1,274.9	(b)1,363.6	1,524.6	1,476.7	1,435.8
Straits	\$Mal-picul	577.8	585.6	669.7	643.1	629.7
Nickel—						
United Kingdom	£Stg-tonne	837.0	(b)944.0	1,123.7	1,231.1	1,246.5
Gold—						
Premium markets—						
Australia	\$A-f oz	(c)36.42	36.83 } 36.17 } 41.28 }	33.50	33.76	39.74
Overseas	\$A-f oz	32.54				
United Kingdom	\$US-f oz	(d)		37.40	37.87	46.89
Silver—						
United Kingdom	Stg new pence-f oz	(e)195.2	(e)198.6	(e)179.1	70.3	58.6

ORES AND CONCENTRATES

Tin—						
Australia	\$A-ltu	25.81	25.98	30.90	28.66	28.21
Wolfram—						
United Kingdom	£Stg-mtu (f)	14.75-21.13	(f)18.00-22.50	(f)21.00-48.00	(f)22.80-36.75	14.00-22.00
Rutile—						
Australia	\$A-ton	88-96	88-124	124-150	145-150	115-150
United Kingdom	£Stg-tonne	(b)43.00-50.00	(b)48.50-66.00	(b)66.00-79.00	74.78-79.72	64.00-79.72
Ilmenite—						
Australia	\$A-ton	9.00-10.00	9.00-10.00	9.00-11.00	11.00	11.00-12.00
United Kingdom	£Stg-tonne	(b)7.00-9.50	(b)7.50-9.50	(b)7.50-9.50	(b)7.38-11.32	9.35-11.32
Zircon—						
Australia	\$A-ton	46-50	42-50	35-47	35-39	35-39
United Kingdom	£Stg-tonne	(b)25.00-30.00	(b)26.25-30.00	(b)25.25-27.75	24.85-28.05	26.82-28.05

(a) Where a daily price does not actually exist for a commodity, daily prices have been imputed from price data which are available. (b) £Stg per ton. (c) May and June 1968 only; prior to May 1968 there was no Australian premium market. (d) Not available owing to break in continuity of series; from April 1968 London Gold Market transactions have been in non-monetary gold only. (e) d Stg per f oz. (f) £Stg-ltu.

Details of monthly prices, and price specifications, relating to each commodity in this table, are contained in each issue of the monthly mimeographed bulletin *Minerals and Mineral Products* (10.19).

REVIEW OF RECENT DEVELOPMENTS IN THE AUSTRALIAN MINERAL INDUSTRY

Prior to Year Book No. 52 it was customary to include a series of detailed reviews of the principal commodities produced by the Australian mineral industry and recent developments concerning these commodities. However, with the increasing diversification and development of the industry, it has become impractical to continue these reviews in the Year Book and the reader who wishes to obtain information of this kind is referred to *The Australian Mineral Industry—Annual Review* published by the Bureau of Mineral Resources, Geology and Geophysics. That publication contains comprehensive reviews of mineral commodities of importance to the Australian economy, as well as a general review of the industry's performance during each year. Major developments in the industry, particularly during the last year, are reviewed briefly in subsequent parts of this section.

Most sectors of the Australian mining industry reflected the improving world situation in 1972 and continued expansion of output of bauxite, black coal, copper, iron ore, nickel, and petroleum resulted in a record level of mine production. Although a new record was established in 1972 in the ex-mine value of minerals produced at about \$1,780 million, a rise of 7.8 per cent, there has been an easing in the rate of expansion of the industry in recent years. However, the operating rates of mining and processing facilities moved closer to full capacity during 1972.

Bauxite

The history of the aluminium industry and recent significant developments in the industry were reviewed in previous issues of the Year Book (No. 51, page 1168 and No. 52, page 1048). The year 1972 was a period of continued growth in the industry both in mining and processing as detailed below.

In 1972 bauxite production capacity from deposits at Weipa, Queensland, increased to a rate of 10.5 million tons per annum following completion of a further stage in the development of the mine and associated township, and of ore treatment and loading facilities. Approximately 3 million tons from Weipa were used by the Gladstone, Queensland, alumina refinery in 1972, and the requirements of the small refinery at Bell Bay, Tasmania, are estimated as 120,000 tons yearly; the remaining production is available for export.

Bauxite deposits at Gove, Northern Territory, covering reserves of the order of 250 million tons of ore, are being developed by a consortium of seven Australian and one overseas companies. The consortium has commissioned an alumina plant at Gove with an initial capacity of 500,000 metric tons per annum to increase to 1,000,000 metric tons annually by mid-1973.

The Mitchell Plateau (Admiralty Bay, Kimberley area), Western Australian bauxite/alumina project has been postponed, chiefly because of the world recession in the industry in 1971 and 1972. The second bauxite/alumina project based on the Darling Range bauxites, involves an alumina refinery at Worsley, 140 miles south of Perth, and port facilities at Bunbury. The \$300 million project will see the expenditure of more than \$9 million on building a new railway and \$1.9 million on harbour development at Bunbury. The first stage of the alumina refinery at Worsley will be completed in 1977 and have an initial capacity of 350,000 tons per year. This will be expanded to 1.2 million and possibly eventually to 2 million tons per year. Bauxite reserves in the Mount Saddleback area have been reported as 240 million tons with an average grade of 32 per cent Al_2O_3 . Mining will start at Bodlungton, about 80 miles south of Perth.

In the third bauxite/alumina project in Western Australia, bauxite will be mined from the Chittering area in the Darling Range, Western Australia, for an alumina refinery to be built near Muchea. Completion date for the refinery is January 1977 and initial annual production capacity will be 400,000 tons with eventual capacity at 1.2 million tons annually.

Alumina

Expansion of the alumina refinery at Gladstone, Queensland, was completed by the end of 1968, increasing the capacity of the refinery to 900,000 tons per annum; the plant has since been expanded to 1,275,000 tons yearly and will be increased further to 2,000,000 tons per annum by late 1973. The alumina refinery at Kwinana, Western Australia, was expanded from 817,000 tons to 1,040,000 tons annually by July 1970 and to 1,250,000 tons by the end of 1970. Bauxite supplies for the Kwinana refinery are obtained from deposits 30 miles away at Jarrahdale, Western Australia, the reserves of which are assessed as at least 500 million tons. A new alumina plant was also commissioned at Pinjarra, Western Australia, in May 1972, with an initial production capacity of 210,000 tons yearly. An alumina plant, with a capacity of 1,600,000 tons annually, is planned at Weipa in 1976.

Copper

Copper production at Mount Isa will be increased to a rate of 153,000 tons yearly in 1973. The expansion program provides for a new hoisting shaft, extensions to the existing copper smelter and a new concentrator, as well as enlargement of ancillary facilities.

A new copper-gold ore body at Warrego has been developed near Tennant Creek, Northern Territory. The first stage of development cost \$21 million; it has an installed mining capacity of 500,000 tons of ore per annum and production commenced in 1973.

Since the beginning of 1967 the Australian producers' price has been adjusted regularly to reflect movements in the London Metal Exchange daily settlement price. From January to June 1972 the Australian price ranged from 41-45 cents per pound (\$918.40-\$1,008.00 per ton). On 1 July 1972 a new method of quotation was adopted and the price remained at \$925.94 per tonne (42 cents per pound) until 11 February 1973 when it rose, reaching \$1,100 per tonne on 22 March 1973.

Iron

The major development of recent years has been the establishment in Australia of a large scale iron ore export industry based principally on steelmaking requirements in Japan. Exports of iron ore and iron ore pellets in 1971-72 to Japan and elsewhere were 49 million tons valued at \$375 million.

Commercial output from Paraburdoo, originally scheduled for 1972, was postponed until 1973 because of a reduced demand for ore.

A \$10 million expansion of the Robe River mining operation will be implemented in 1973, one year ahead of schedule. Export of Robe River iron ore fines and pellets from Cape Lambert commenced in 1972 and shipments are expected to increase to an annual rate of 6.1 million tons of fines and 4.2 million tons of pellets by 1975. At Mount Whaleback expansion of iron ore production and shipment capacity will proceed to reach 30 million tons per year by the end of 1973. Shipments of ore from the Mount Goldsworthy group of mines were expected to increase to an annual rate of 8 million tons after April 1973 following the opening of the Shay Gap and Sunrise Hill mines. A 43-mile railway extension has been constructed from Mount Goldsworthy to Shay Gap rail-head.

Lead and zinc

Production of lead metal rose in 1972. Metal production should rise in 1973 and there may be a surplus. Supply and demand for zinc metal in 1973 should be balanced.

The South Mine at Broken Hill was not operating profitably and ore production was terminated in July 1972; retreatment of residue dumps continued. The mine was purchased by another company in October 1972.

Lead production at the reduced rate adopted in 1971 continued at Mount Isa but zinc concentrate production increased because of the higher zinc content of ore treated.

A record tonnage of zinc metal was produced in 1971-72 at the Risdon (Tasmania) refinery on completion of the expansion program. Output is expected to reach 185,000 tons in 1972-73.

Black coal

There has been a significant revival in the Australian black coal industry in recent years as a result of increased exports and increased consumption of black coal in iron and steel production and electricity generation. These increases have more than balanced reduced consumption in some applications due to competition from fuel oil.

The expansion of the export trade has been of major significance. In 1955 exports were about 200,000 tons valued at about \$1.7 million; in 1972 exports were 23.1 million tons valued at \$269 million. These increased exports have been largely to Japan for use in the iron and steel industry. As a result of this increased demand, new mines have been opened and others are under development in Queensland and New South Wales, and many established mines are being expanded. Exploration for coal has been stimulated and further rich deposits of coking coal have been located, particularly in Queensland.

Petroleum

At the end of 1972, there were seven Australian oil fields in production, namely, Moonie, Alton and Bennett, Queensland; Barrow Island, Western Australia; and Barracouta, Kingfish, and Halibut in the Gippsland Shelf area offshore from Victoria. In addition, a small amount of oil is being produced from several other wells in the Surat Basin in Queensland. In 1969 commercial and domestic

use of natural gas began in Brisbane, Melbourne and Adelaide and in late 1971, in Perth. The production of crude oil in 1972 from the Australian oil fields was 119 million barrels representing some 64 per cent of the country's requirement of refinery feedstock. The cumulative production of crude oil to 31 December 1972 amounted to 340 million barrels.

In 1972 gas discoveries were made at various locations in the Cooper Basin in South Australia and Queensland, and at Big Lake and Fly Lake in South Australia. Additional discoveries were also made at Goodwyn, North Rankin, and Angel on the northwest continental shelf of Western Australia. Additional oil discoveries were made at Tirrawarra in the Cooper Basin, Goodwyn and Eagle Hawk on the North-west Shelf and Mackerel in the Gippsland Basin offshore from Victoria. The provisional figure for footage drilled in petroleum exploration and development in Australia in 1972 was 971,387 feet which is some 210,573 feet (about 28 per cent) more than the footage drilled in the previous year. About 735,491 feet of the 1972 total was attributable to exploration drilling of which 388,151 feet were drilled offshore. A total of 135 wells were completed in 1972, of which 99 were exploration wells, 38 of them offshore. In comparison with the previous year there was a rise of 14 in the number of exploration wells and a decline of 15 development wells in 1972. There was a rise of 24 in the number of offshore exploratory wells which also made a significant contribution to the rise in drilling activity. Of the exploration wells drilled, 1 was completed as a potential oil producer and 9 as gas producers; of the development wells, 3 were oil producers and 23 gas producers.

Nickel

Output from Australia's major nickel mining operation at Kambalda in Western Australia has grown to more than 35,000 tons of contained nickel per annum since mining commenced in 1967. Mines at Nepean and Scotia also commenced production in early 1969 and that at Windarra will commence production in 1974; mines have been developed at Carr Boyd Rocks and in the Widgeemooltha area and it is possible that one will be developed at Redross in 1974. At the end of 1972 the refinery at Kwinana, Western Australia, was producing more than 15,000 tons of nickel metal per annum from concentrates; the remaining concentrates will continue to be exported until further smelting and refining facilities are constructed. The flash smelter commissioned at Kalgoorlie in December 1972 will be capable of processing 209,000 tons of concentrate a year. Capacity will be increased by 75 per cent when certain modifications are made. The matter produced is feed for the Kwinana refinery and overseas refineries.

Plans have been drawn for the development of the lateritic nickel deposit at Greenvale in northern Queensland. Following the successful completion of pilot plant tests, construction of a railway and an ammonia leach treatment plant at Townsville, northern Queensland, were commenced in early 1972. Production of 23,000 tons of nickel oxide sinter per annum could commence during 1974.

Mineral sands

The history of the mineral sands industry and an assessment of resources is presented in the *Australian Mineral Industry—Quarterly Review* Vol. 25 No. 1.

The first mineral sand separation plant at Eneabba, Western Australia, commenced production in early 1973. The initial capacity is 7,000 tons of rutile, 15,000 tons of zircon and 28,000 tons of ilmenite per year. If this initial plant demonstrates the viability of a large-scale operation, a plant may be built with production capacity at an annual rate of 50,000 tons of rutile, 100,000 tons of zircon and 200,000 tons of ilmenite. A second plant with a capacity of 240,000 tons per year, at a cost of \$10 million, is planned and two other companies are carrying out testing programs and feasibility studies in the Eneabba area.

The ilmenite beneficiation plant at Capel, Western Australia, which has operated on a semi-commercial scale since 1968 is being extended to produce 40,000 tons of upgraded ilmenite per year. A plant for the upgrading of ilmenite is being built at Bunbury, Western Australia.

Phosphate

Major deposits of phosphate rock were discovered during 1966 near Duchess and Lady Annie in north-west Queensland. The deposits are large by world standards, and feasibility studies are still in progress. Survey work has been finished on a possible railway route between Lady Annie and the Gulf of Carpentaria, 800 miles away. Transport and port facilities will be key factors in determining whether the project is to be undertaken.