CHAPTER 25

MINERAL INDUSTRY

Further detailed statistics and information on the subjects dealt with in this chapter are contained in the annual printed bulletins *Non-Rural Primary Industries* issued by this Bureau and in *The Australian Mineral Industry—Annual Review* and other publications issued by the Bureau of Mineral Resources, Geology and Geophysics, which also issues, in conjunction with this Bureau, a quarterly publication, *The Australian Mineral Industry*, comprising two parts—Part 1—Quarterly Review and Part 2—Quarterly Statistics. The annual mimeographed statistical bulletins *Mining and Quarrying, Minerals and Mineral Products, Mineral Exploration,* and *Overseas Participation in Australian Mining Industry* 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* is issued also, and other current statistics on mining or mine products are contained in the *Quarterly Summary of Australian Statistics*, the *Monthly Review of Business Statistics*, the *Digest o Current Economic Statistics*, and the *Monthly Bulletin of Production Statistics.*

GENERAL

Geology

General geology

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

Economic geology

Minerals of economic significance occur widely throughout the Precambrian and Palaezoic rocks of the continent. Palaezoic mineralisation is perhaps more varied, but the Palaezoic 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 Palaezoic rocks in the east. This situation is especially true in the case of the larger base metal deposits and also for smaller deposits of metallic minerals.

The major deposits of metallic minerals, including iron ore, lead, zinc, silver, copper, uranium, nickel, and gold, are contained in the Precambrian rocks of the Australian shield. Smaller deposits of tin, tungsten, tantalum, mica, beryllium, manganese, and cobalt 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 occurrences. Smaller amounts of tin, tungsten, molybdenum, bismuth, and 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 which occurs as a surface capping over various rocks, mostly of Mesozoic age. 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.

Mineral sands, another important exception, contain rutile, zircon, ilmenite, monazite, 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 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.

Deposits of black coal in Australia are mainly of Permian age and are located in sedimentary basins in the coastal areas of the eastern States. The majority of the New South Wales and Queensland black coal deposits are bituminous in type. The extensive brown coal deposits of Victoria were formed during the Tertiary Period.

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 and Alton fields, and commercial deposits of natural gas exist in numerous prospects in the Roma and Rolleston areas. In the Adavale basin, Gilmore is a proven gas field. 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 Victoria in the Bass Strait, oil in considerable quantities was discovered in the Kingfish and Halibut fields, and oil and natural gas in the Marlin and Barracouta fields. In the same basin, deposits of hydrocarbons, the magnitude of which has yet to be evaluated, were encountered in the Flounder, Tuna, Snapper and Bream prospects. In the Gippsland Basin, the Cretaceous and Tertiary strata are the reservoir rocks. In the Cooper Basin, South Australia, commercial deposits of natural gas were discovered at Gidgealpa and Moomba, and also at Daralingie and Toolachee. The reservoir rocks are of Permian age. In the Carnarvon Basin, Western Australia, commercial crude oil mainly in the Cretaceous formations, and also to a lesser degree in the Jurassic, was discovered at Barrow Island. Further south, in the Perth Basin, natural gas in commercially significant quantities was discovered in the Yardarino, Gingin, Dongara, Mondarra and Whicher Range prospects, the reservoir rock being of Lower Permian age. In the Amadeus Basin, Northern Territory, natural gas was discovered in commercial quantities in formations of Ordovician age at Mereenie and Palm Valley.

Of the non-metallic minerals, many, such as clay, sand and silica, etc., are not restricted to the rocks of any particular era and are often polycyclic in nature. However, Precambrian rocks do contain deposits of blue asbestos in Western Australia, limestone and dolomite in South Australia, and mica in the Northern Territory.

Opals are found in the flat-lying sedimentary beds of the Great Artesian Basin in Queensland, New South Wales and South Australia. These opal deposits 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

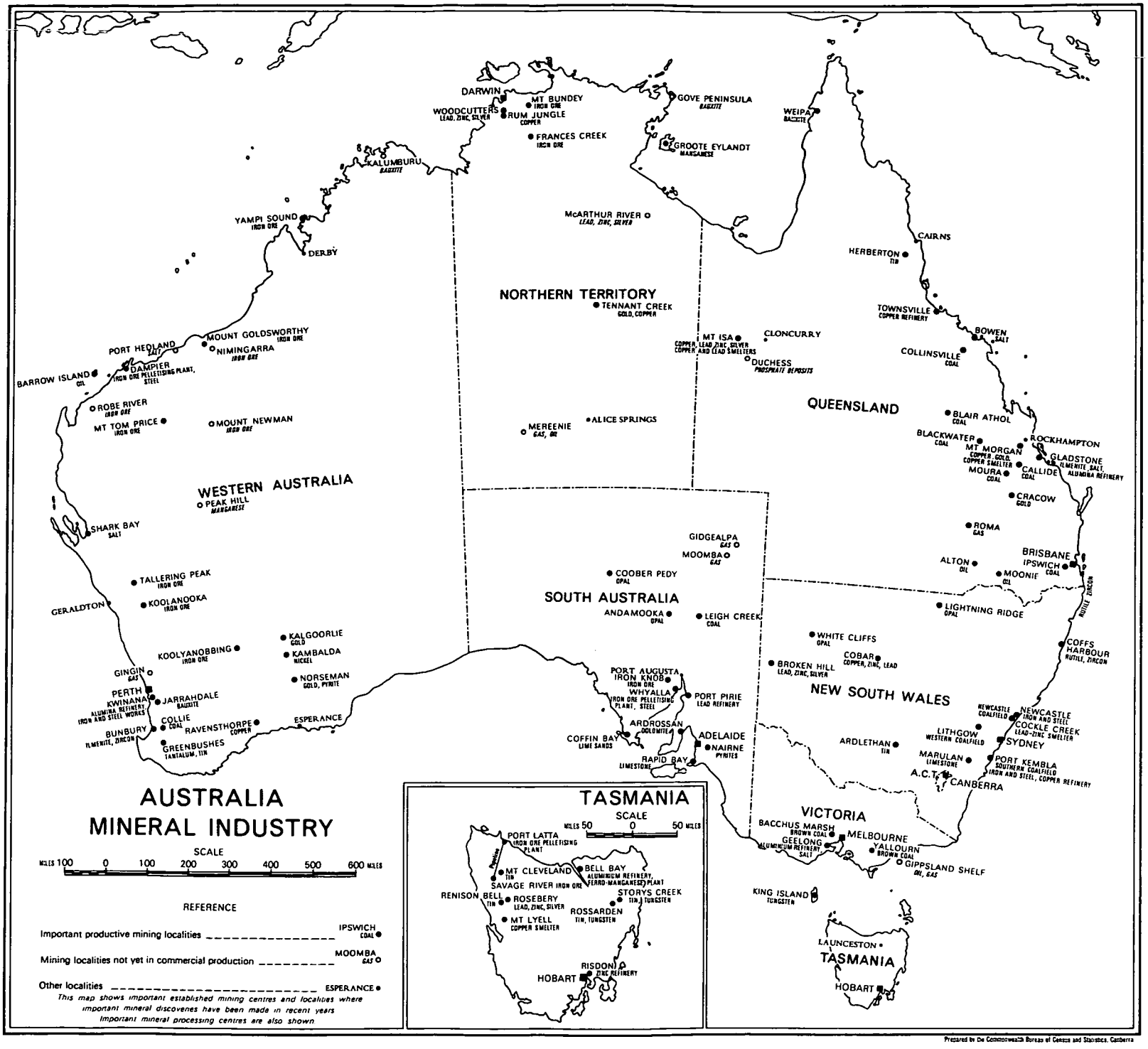
Australia is self-sufficient in most minerals of economic importance and much more than self-sufficient in some. The following table summarises, in a general way, known reserves and production of the principal metals and minerals in relation to Australian consumption of these commodities and present 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)

Production	*Reserves adequate*	*Reserves uncertain*	*Reserves negligible*
Production sufficient for domestic demand and exports	Barite Bauxite Cadmium Coal (black) Copper Gold Gypsum Iron ore Lead	Beryl Talc Tantalite	

For footnotes *see* next page.



Prepared by the Commonwealth Bureau of Census and Statistics, Canberra

PLATE 49

RESERVES OF MINERALS: AUSTRALIA—*continued*

Production	*Reserves adequate*	*Reserves uncertain*	*Reserves negligible*
Production sufficient for domestic demand and exports	Manganese ore (metallurgical) Mineral sands(*a*) Nickel Opal Salt Silver Tin Tungsten Zinc		
Production sufficient for domestic demand	Clays (except light grade china clay) Coal (brown) Dolomite Felspar Limestone	Glass sands Sillimanite	
Production not sufficient for domestic demand	Bismuth Lithium minerals Phosphate rock Sulphides (as source of sulphur)	Abrasives Antimony Bentonite China clay Chromite Cobalt Diatomite Fluorite Magnesite Manganese ore (chemical) Mercury Mineral pigments Petroleum Platinum	Asbestos (chrysotile) Molybdenum
Production nil	Magnesium Potassium salts	Arsenic Asbestos (crocidolite) Diamonds Graphite Vanadium Vermiculite	Borates Nitrates Sulphur

(*a*) Ilmenite, monazite, rutile, zircon.

Aluminium

As a result of the recent discoveries at Weipa, Gove and the Darling Range, Australia's reserves of bauxite are known to be very large, perhaps the largest in the world. Total reserves in the Weipa region are in excess of 2,000 million tons, while the deposits at Gove are reported to contain up to 250 million tons of bauxite. The Darling Range deposit has nearly 80 million tons of proved reserves, and preliminary estimates by the company indicate that the base areas contain at least 500 million tons of economic bauxite. In addition, another significant deposit of about 200 million tons has so far been proved in the Kimberley district of Western Australia.

Coal

Australia has coal resources adequate to provide for future domestic requirements and a substantial export surplus. These resources include coal of all types, except pure anthracite. 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. A table showing Australian coal reserves is published in Year Book No. 53, page 1065.

Copper

The principal deposit of this metal is at Mt Isa, where ore reserves were estimated at 46.5 million tons in 1968. Recent discoveries have indicated very large additional reserves at Mt Isa, and further

exploration and testing is proceeding. Other important deposits are situated at Cobar, New South Wales, Mt Morgan, Queensland, and Mt Lyell, Tasmania. Small deposits at Ravensthorpe, Western Australia, and Tennant Creek, Northern Territory, have also been developed.

Crude oil

From recent exploratory activity it is now apparent that Australia possesses substantial resources of crude oil. The Moonie and Alton fields in Queensland, and the Barrow Island field in Western Australia have been producing since 1964, 1966 and 1967 respectively. The Kingfish, Halibut, Marlin and Barracouta fields in the off-shore Gippsland Basin should begin commercial production in late 1969. Current recoverable reserves in Australia are conservatively estimated to be 1,800 million barrels and with exploration activity continuing at a high level there is a possibility of further upward revision of these estimates in the near future.

Gold

Australia's gold resources are heavily concentrated in Western Australia, mainly in the Kalgoorlie–Coolgardie area. However, 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. Gold ore reserves at Kalgoorlie were estimated at more than 13.5 million tons in 1967, with a gold content of 5.64 dwt per ton.

Iron ore

In recent years very extensive deposits of iron ore have been discovered in Australia. These discoveries have established Australia as one of the most important iron ore provinces in the world. The largest deposits are located in the Hamersley and Ophthalmia Ranges 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, at Yampi Sound, Koolyanobbing, and Tallering Peak in Western Australia, and at Mt Bundey and 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 are estimated to be more than 16,000 million tons.

Lead-zinc

Since the discovery in 1883 and subsequent development of the ore body at Broken Hill, Australia has been a major producer of lead and zinc. Ore reserves in the Broken Hill area are stated to exceed 17 million tons, and further exploration is being undertaken to extend reserves. Mt Isa, with ore reserves of 32 million tons, is the major lead-zinc deposit in Queensland, and further substantial reserves exist in adjacent leases. In Tasmania substantial lead-zinc deposits are situated at Read-Rosebery near the west coast. In the Northern Territory lead-zinc ore bodies have been located at Macarthur River and at Woodcutters near Rum Jungle. A small zinc silicate ore body is to be developed at Beltana, South Australia.

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 increased sharply in recent years. The principal deposits currently being worked are in the Pilbara and Peak Hill areas of Western Australia and on Groote Eylandt in the Gulf of Carpentaria. Reserves on Groote Eylandt are substantial.

Mineral sands

Ores of titanium (rutile and ilmenite), zirconium (zircon) and thorium (monazite) occur in beach 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 corner of Western Australia. Resources are large and easily workable. Australia's reserves of rutile represent a large proportion of the world's reserves of this mineral.

Natural gas

Several significant discoveries of natural gas have been made throughout Australia, the most notable being the Barracouta and Marlin fields in Bass Strait, off-shore Victoria, where reserves are estimated to be approximately 5 U.S. trillion cubic feet. Commercial production from these fields commenced in March 1969.

In Queensland numerous gas fields have been discovered in the Roma area and to the north near Rolleston. The combined reserves estimate is approximately 215 U.S. billion cubic feet. Other fields at Gidgealpa and Moomba in South Australia, which are to supply Adelaide in the near

future, have combined estimated reserves of 1.5 U.S. trillion cubic feet. To this must be added the as yet unknown reserves of the nearby Daralingie and Toolache prospects. In Western Australia significant discoveries have been made at Yardarino, Gingin, and Dongara where reserves are thought to be of the order of 500 billion cubic feet; also in this region, significant reserves of natural gas are indicated in the Mondarra prospect. In the Northern Territory the Mereenie and Palm Valley fields show evidence of 1.5 U.S. trillion cubic feet gas reserves, in association with some crude oil.

Nickel

Deposits of nickel have been discovered in Western Australia, central Australia, and Queensland. At Kambalda, near Kalgoorlie in Western Australia, there are reserves of more than 9 million tons of high grade nickel ore.

Phosphate rock

Accelerated search for phosphate rock commencing in late 1964 resulted in the discovery of major deposits in north-west Queensland in 1966. Detailed assessment and feasibility studies have yet to be completed.

Tin

The main deposits of tin now being exploited are in the Herberton field inland from Cairns, Queensland, in north, west, and central Tasmania, in the Pilbara region and in the south-west of Western Australia, and in the New England area, at Mt Tallebang, and Ardlethan in New South Wales. As the result of exploration and expansion of known deposits in recent years, Australia is now self-sufficient in tin.

Tungsten

The main deposits of tungsten ores are in northern Tasmania (wolfram) and on King Island (scheelite). Australia's own requirements are small, and production is principally for export.

Uranium

Australia's known reserves of uranium ore were exploited during the years 1953 to 1963. During this period substantial quantities of uranium concentrate were exported to the United Kingdom and the United States. In May 1967 it was stated that reserves of 11,620 short tons of uranium oxide were reasonably assured and a further 3,230 short tons were possible but not proven; of these reserves, 10,660 short tons were said to be economically recoverable within the price range $5 to $10 per pound and 4,190 short tons economically recoverable within the price range $10 to $30 per pound.

Administration

For all practical purposes all mineral rights in Australia are vested in the Crown. In the States, sovereign rights are held by the State Governments with respect to mineral resources within their boundaries. 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. These Acts, etc. are similar in principle, but differ in detail. They all make provision for the following tenures.

(i) The holding of a miner's right gives the holder the right to prospect on Crown Land, and to use the timber and water necessary for his operations. The miner's right does not give the power to remove or sell any mineral.

(ii) Small mining leases, having a maximum area of about 100 acres, necessitate the payment of rent and, in most cases, a royalty. There is usually no limit on the number of such leases which may be held by any one person, partnership, private or public company. In practice a restriction is imposed by the requirement that a lease must be continuously worked, or that work to a given value must be done annually, but exemption from the labour requirements

may be obtained under certain circumstances. The exemption is given for limited periods only, and where the labour requirements are not met and exemption has not been granted any person may apply for forfeiture of the lease in his favour. If the rental is not paid the lease is forfeited.

Provision is also made in the various Acts and Ordinances for prospecting areas, claims, etc. Such areas, claims, etc. are all quite limited in size and from the practical viewpoint are cheap forms of mining lease which carry limited powers relating to the removal of minerals. A very 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, particularly where very large-scale capital intensive projects are involved (e.g. iron ore in Western Australia, coal and bauxite in Queensland, bauxite in the Northern Territory).

The following table sets out particulars of the areas occupied under mining Acts and Ordinances in the several States and Territories for the period 1964 to 1968. Further details of the various types of mining lease and licence are given in Year Book No. 48, pages 94–5.

AREAS OCCUPIED UNDER MINING ACTS AND ORDINANCES
STATES AND NORTHERN TERRITORY, 1964 TO 1968

('000 acres)

Year	*N.S.W.(a)*	*Vic.*	*Qld(b)*	*S.A.(a)(b)*	*W.A.(c)*	*Tas.*	*N.T.*	*Total*
1964	956	50	2,097	7,894	221	40	61	11,319
1965	1,015	60	2,494	6,621	263	43	61	10,557
1966	1,083	84	2,591	29,638	343	53	36	33,828
1967	1,177	74	2,304	15,508	372	58	37	19,530
1968	1,146	81	2,618	14,521	705	65	43	19,179

(*a*) Year ended 30 June. (*b*) Excludes lands held under miners' rights and dredging claims. (*c*) Excludes holdings under miners' rights.

Control of exploration

Following the introduction of large-scale modern prospecting methods (particularly air-borne prospecting), small prospecting areas were found to be unsuitable, 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 in either of the following ways:

(i) by the Minister of Mines withdrawing an area from the provisions of the Mining Act and giving an informal agreement that the prospector would have preference in applying for titles to leases within the area; or

(ii) 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. Neither form of prospecting concession gives 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.

The above discussion refers in general to the exploration for all types of mineral deposits in Australia. Additional information relating to the search for petroleum is given below.

Control of petroleum exploration

On-shore. In Australia, all petroleum on or below the land is, and shall be deemed always to have been, 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, syndicate, or individual proposing to join in the search for petroleum must first satisfy the Government concerned that the necessary financial resources are available to carry out exploration activity.

The names given to different types of exploration permits differ with variations in petroleum legislation from State to State, but there are in general, three basic types of permits: (*a*) permit for geological and geophysical survey; (*b*) licence for more detailed surveys and exploration drilling; (*c*) leases for commercial production.

In most States, the minimum permit area is 1,000 square miles, however in the Northern Territory, it is 500 square miles and in Queensland and Tasmania it is left to the discretion of the Minister of Mines. The maximum permit area in the Northern Territory is 10,000 square miles and in New South Wales and Victoria 5,000 square miles. In Queensland and Tasmania the size of the area is left to the discretion of the Minister of Mines and in South Australia and Western Australia there is no limit.

The term of the initial permit varies from State to State. The period being five years in South Australia and the Northern Territory, two years in New South Wales, Victoria and Western Australia and at the discretion of the Minister of Mines in Queensland and Tasmania. The term of the permit may be extended at the Minister's discretion in the light of valid reasons submitted by the holder or for periods designated in the legislation. All permits carry obligations to initiate geological and/or geophysical surveys, usually within three or six months of the granting of the permit. Quarterly reports, maps and other relevant data are required.

Licence areas vary between States as do terms, bonds, etc. The maximum licence area is 200 square miles in all States except Tasmania where it is five square miles. The licence stage in the Northern Territory was omitted by a 1966 Amendment. The minimum area varies between 8 square miles in New South Wales, South Australia and Western Australia and no minimum in Victoria, Queensland and Tasmania. There is no limit on the number of licences that may be held by one holder in all States except Tasmania, where it is limited to one. The term of initial licence is five years in South Australia, four years in New South Wales and Victoria and two years in each of Queensland, Western Australia and Tasmania. There is provision in all States for renewal for periods ranging from one to five years. Licences carry obligations that a more detailed survey be carried out, usually within three to six months of the granting of the licence. In some cases, drilling is also required. Quarterly reports, maps, samples, etc. are a requisite.

Leases. If exploration during the permit and licence shows promise then a lease is usually granted, which gives the right to produce petroleum. The maximum lease area in the Northern Territory is 1,000 square miles. In all other States it is 100 square miles except in Tasmania where it is at the discretion of the Minister for Mines. The minimum area of a lease is four square miles in New South Wales, South Australia and Western Australia and no minimum has been set for the remaining States and the Northern Territory.

In most States there is no limit to the number of leases that may be held by one holder, however in Queensland the maximum number of leases permitted to any one holder is five. The initial term of the lease in most cases is twenty-one years and it may be renewed for a similar period; however in New South Wales the period is twenty years and in Victoria it is fifteen years. In all States and the Northern Territory except Queensland drilling for production must begin within six months of the granting of the lease. In Queensland the period is within three months. Sound oilfield practice and approved safety measures must be observed at all times.

Off-shore. The Petroleum (Submerged Lands) Act 1967 was assented to on 22 November 1967. This Act is the instrument whereby the control and safeguarding of the exploration for, and the exploitation of, petroleum resources on the territorial sea-bed, and on the outer continental shelf are assured. Complementary legislation was passed by each State Government and by the Federal Government, the laws becoming fully effective on 1 April 1968.

The State Governments administer the legislation and collect all rents and fees, but the granting of tenements is subject to Federal Government approval, because of its commitments on defence, customs, navigation, external affairs, etc.

Basically, the legislation consists of a two-stage system of tenements—exploration and production.

Exploration Permit. All off-shore areas are divided into graticular blocks, each being 5 minutes of arc of longitude by 5 minutes of arc of latitude. This approximates to 30 square miles in Northern Australia and 25 square miles in Southern Australia, the reduction being due to the decrease in latitude length from the Equator to the South Pole. An Exploration Permit may be granted for a maximum of 400 such blocks (10–12,000 square miles), and covers all forms of exploration, including drilling, but all work programmes are subject to Government approval. There is no limit to the number of permits which may be granted to any one holder. The initial term is six years, with successive renewal periods of five years each. At each renewal, the holder is required to surrender one half of the permit area, with Governmental discretion to allow a minimum area of sixteen blocks (400–480 square miles).

An annual fee equivalent to $5 per block, ($100 minimum) is payable to the adjacent State in respect of each permit.

Production Licence. On discovery of petroleum, the permittee must nominate one block as the centre of a 'location' comprising all available contiguous blocks, thus giving a 'location' of nine blocks (three by three). Within two to four years thereafter, the permittee may apply for a primary Production Licence covering not more than five blocks in the 'location', the remaining four blocks reverting to the Crown. The licensee may apply for a secondary licence for any or all of these four blocks. The State may offer for sale any location blocks which the holder of a primary licence may not wish to retain.

The standard royalty payable is 10 per cent of the well-head value of the petroleum produced if only the first five blocks are retained. Should a secondary licence be granted for any or all of the remaining four blocks, an over-riding royalty of up to 2½ per cent is applicable and is negotiated between the adjacent State and the licensee, which would raise the total royalty payable up to a maximum of 12½ per cent of the well-head value.

Royalty is shared between the State and the Federal Governments on a 60:40 basis in the 'primary' case, and the State retains all overriding royalties in the 'secondary' case. The State also receives an annual licence fee of $3,000 per block in each licence, and the proceeds from sales of relinquished blocks.

Production licences are issued for a term of twenty-one years, with the right of renewal for further periods of twenty-one years.

The only licences issued so far under this legislation have been for the Gippsland Shelf prospects, where primary and secondary licences were granted over the maximum 'location' of nine blocks for each of the four fields to be developed initially. The following table shows rates of royalty and expiry dates:

LICENCES ISSUED FOR GIPPSLAND SHELF

Field	*Royalty Rate*	*Licences Expire*
	%	
Barracouta	11	31.3.88
Marlin	11	31.3.88
Halibut	12½	13.5.89
Kingfish	12½	17.7.89

The off-shore legislation gives the holder of a production licence a preferential right to a pipe-line licence. This licence allows the construction and operation of a marine pipeline for transmission of petroleum from field to shore. Licence renewal is available on expiry.

AREAS OCCUPIED UNDER PETROLEUM EXPLORATION AND DEVELOPMENT TITLES : STATES AND NORTHERN TERRITORY, 1964 TO 1968

('000 acres)

Year	*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T.*	*Total*
1964	176,768	64,895	595,865	351,526	831,948	35,325	216,188	2,272,518
1965	156,439	58,921	609,058	376,326	762,921	54,375	268,673	2,236,713
1966	151,122	43,561	621,506	371,236	672,609	54,775	289,144	2,208,953
1967	117,020	49,786	389,780	353,634	643,158	59,342	222,353	1,840,073
1968(*a*)	77,593	51,436	327,714	323,844	549,854	54,237	156,318	1,546,101

(*a*) To 30 June 1968.

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 State Governments in recent years are shown in the table below.

MINERAL ROYALTY RECEIPTS: STATES AND NORTHERN TERRITORY
1963–64 TO 1967–68
($)

State or Territory	*1963–64*	*1964–65*	*1965–66*	*1966–67*	*1967–68*
New South Wales	5,090,622	19,946,772	24,317,168	16,326,973	11,029,697
Victoria(*a*)	94,072	494,128	546,117	597,639	661,214
Queensland	642,560	1,201,264	1,183,046	2,241,575	1,711,503
South Australia	860,371	926,984	985,560	1,091,582	1,036,552
Western Australia	243,182	291,354	478,295	2,639,895	6,237,593
Tasmania	712	1,376	2,570	6,306	11,105
Northern Territory	68,682	80,894	88,727	110,574	290,701

(*a*) Includes, in addition to mineral royalties receipts, mine-tailing licences and rents.

Control of exports

The Commonwealth Government maintains export controls over certain minerals and metals. These controls are enforced by means of Customs (Prohibited Exports) Regulations as amended from time to time by Statutory Rules. The Commonwealth authorities having jurisdiction over mineral and metal exports, together with the relevant products, are listed below. A clearance to export is needed in each case.

Department of National Development—iron ores, beneficiated iron ores and iron concentrates; mineral sands (whether treated or untreated), and concentrates of mineral sands, containing zircon, rutile or ilmenite; manganese ores; beryllium ores and concentrates; tin ores and concentrates, refined tin in the form of ingots or in any other refinery form, and any of the following materials from which tin may be obtained, being materials resulting from the refining of tin, that is to say residues, slag, dross, dust and other wastes; copper matte, blister copper, copper anodes, copper cathodes, copper ingots, copper rods, copper scrap, 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; copper alloy scrap; any of the following materials from which copper may be obtained, that is to say, residues, speiss, slag, dross, scale, sweepings, ash, sludge, slime, dust and wastes.

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

Australian Atomic Energy Commission—minerals, raw and treated (including residues and tailings) containing more than 0.05 per cent of uranium or thorium, singly or together; uranium and thorium minerals including pitchblende and monazite; uranium, thorium, beryllium and lithium metals, compounds and alloys; hafnium-free zirconium metal, alloys and compounds; nickel metal in certain forms.

In addition to these controls which are, in general, of fairly long standing, the Commonwealth Government has imposed export controls on copper and copper-bearing materials in recent years. These controls have been administered by the Department of National Development. The Commonwealth Government announced on 5 March 1969 that the ban on the export of copper scrap and ingots, and copper alloy scrap and ingots would be continued. Export permits are freely issued for primary copper materials, copper anodes (for electro-plating purposes) and copper rods. Exports of copper scrap and ingots and copper alloy scrap and ingots are in general prohibited, but consideration will be given to the issue of export permits for ingots of certain copper master alloys, and nickel silver (copper-based) scrap contaminated with solder or certain other metals. Export permits are generally issued also for copper residues, dross, ashes, slag and similar materials.

Export controls on tin and other tin-bearing materials were introduced by the Commonwealth Government on 23 December 1968 for reasons arising from Australia's membership of the International Tin Agreement. Under the provisions of the Agreement Australia was requested by the International Tin Council to co-operate with other producers of tin by way of exercising some restraint on its exports of tin.

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 functions under the direction of the Minister for National Development.

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 1004.

Income taxation concessions. One-fifth of the net income derived from mining for prescribed minerals in Australia or the Territory of Papua and 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 the Territory of Papua and 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 the Territory of Papua and 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 investigators 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 the Territory of Papua and 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 Territory 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. The *Petroleum Search Subsidy Act* 1959 widened the scope of operations for which subsidy was offered to include all types of geophysical surveys and off-structure drilling operations. Another amendment in 1961 further widened the scope of the 1959 Act to provide subsidy for test drilling and detailed structure drilling operations. It also provided for the calculation of drilling subsidies on a footage basis as an alternative to the total cost basis. A sum of $10 million was allocated to the petroleum search subsidy scheme for 1962–63 compared with an allocation of $5.4 million in the previous year. Applications for subsidy increased to such an extent, however, that in spite of the increased allocation, the maximum rate of subsidy was reduced from 50 per cent of the allowable cost of approved operations to 30 per cent.

The *Petroleum Search Subsidy Act* 1959–1964 was amended in June 1967 to extend Commonwealth subsidy for a further one year. The *Petroleum Search Subsidy Act* 1959–1967 provides subsidy for approved geophysical surveys and test and stratigraphic drilling operations; bore-hole surveys and detailed structure drilling are no longer eligible. As in the previous Act, an applicant may elect to receive subsidy for both types of drilling operations on either a footage basis or a total cost basis. In addition, the production testing of any well approved for subsidy is also eligible for additional subsidy. Under the Act the Minister may vary the rates of subsidy for prescribed operations, but they may not exceed one-half the total cost. The present rates of subsidy for approved operations on a cost basis are 30 per cent for test-drilling and 40 per cent for stratigraphic drilling. The rate for all types of geophysical operations is 30 per cent. The 1959–1967 Act also specifies that exploration for petroleum on the Australian continental shelf is eligible for subsidy retrospective to 1959. The Federal budget for 1968–69 contained an appropriation of $19.3 million for subsidies under the Act. Payments under this Act in each of the years 1964 to 1968 are shown in the table on page 1004.

On 28 October 1964 the Minister announced that action was necessary to limit the burden of the Commonwealth subsidy scheme on the Australian taxpayer in view of the many recent encouraging discoveries of oil and gas which were now providing the incentive to further exploration. To this end the Minister announced that operations within certain defined areas around discovery wells and fields would not be approved for subsidy. For the present, projects in the following areas would not be eligible for subsidy: twenty miles from a gas well; thirty miles from an oil well; forty miles from a gas field; fifty miles from an oil field. Specified areas excluded from subsidy payments are periodically announced by the Minister.

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 Australian crude oil should be valued at $US 2.48 ($A 2.21) a barrel at the nearest refinery centre, plus a differential for the quality of the oil produced. 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.

Any oil found in the Territory of Papua and New Guinea will be covered by these policies in the same way as oil found in Australia.

Under these arrangements the price of Moonie crude is $A3.14 a barrel delivered Brisbane, broken down as follows: crude oil value $2.21; incentive margin $0.67; quality differential $0.26.

Subsequently, the Barrow Island field began production and is $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, due to begin production in 1969, 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 forego the $0.67 a barrel incentive, plus a further $0.05 per barrel. This will result in the pricing of Gippsland Shelf crude oil at $2.47 per barrel in the early stages of production and $2.44 per barrel in the third quarter of 1970 to 17 September 1970, i.e. the original price of $3.19 minus 72 cents (incentive plus 5 cent discount). The further reduction to $2.44 is a quality differential reduction of 3 cents as heavier crude oils commingle with the stream.

An agreement was reached between the Commonwealth Government and representatives of private enterprise on the price structure for indigenous crude oil for the five-year period commencing 18 September 1970.

Gippsland Shelf crude oil will be priced at $2.06 per barrel f.o.b., Long Island Point, Westernport. This price is calculated as follows:

	per barrel $
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
	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
	1.89
less a deduction for coastal freight	0.09
	1.80

To this, the quality differential of 26 cents per barrel is added giving a total of $2.06 per barrel.

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 32 cents, giving a total of $2.21 per barrel f.o.b. Kwinana.

The price structure of any indigenous crude will be subject to any changes in composition and quality that might occur during the course of production.

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 the Territories of Papua and 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 enacted on 22 October 1957, 22 May 1959 and 2 June 1965.

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 $8 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 the official price 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 July 1968, reduced by seventy-five per cent of the amount of the excess. Prior to 1 July 1968 subsidy was reduced by the full amount of the excess.

Payments under the Act apply to production until 30 June 1970. Payments under the Act commenced in March 1955, and the amounts paid to gold producers in the various States and Territories of Australia in each of the years 1964 to 1968 are shown in the table on page 1004.

The purpose of the *Gold Mines Development Assistance Act* 1962 was to provide assistance to gold producers in Australia and the Territories of Papua and New Guinea not receiving subsidy under the *Gold-Mining Industry Assistance Act* 1954–1962, in order to increase the rate of their development work and so to add to their proved reserves of gold-bearing minerals. With the liberalisation of the Gold-Mining Industry Assistance Act from 1 July 1965, the Commonwealth Government decided not to extend the development assistance legislation, which, accordingly, lapsed on 30 June 1965.

Assistance to the copper mining industry. After a Tariff Board investigation, assistance was accorded to the industry in 1958, partly by import duty and partly by bounty. The assistance was continued until 31 December 1965. However, because of the unsettled conditions in the industry at this time, it was decided to defer a Tariff Board Inquiry and to continue the existing bounty assistance until 31 December 1966 unless an earlier date of cessation was proclaimed. Under the *Copper Bounty Act* 1958–1966 bounty was payable, subject to specified conditions, on refined copper sold for use in Australia. The rate of bounty was $70 per ton when the overseas price, as determined by the Minister for Customs and Excise, was $580 (£Stg232) or less. When the overseas price rose above $580, the bounty fell by the same extent, so that no bounty was payable when the overseas price was $650 (£Stg260) or more. The Act lapsed on 31 December 1966. Payments under the Act in each of the years 1964 to 1966 are shown on page 1004. The import duty continues in operation, and is imposed on imports of copper when the overseas price falls below $580 a ton, to the extent of $1 for each $1 that the price falls below $580. Including freight and other charges, the landed cost of imported copper is thus expected not to fall below $610 a ton.

Assistance to producers of sulphuric acid and iron pyrites. Following recommendations of the Tariff Board, the *Sulphuric Acid Bounty Act* 1954 was extended for a period of five years from 1 July 1960. Arising from these same recommendations, the *Pyrites Bounty Act* 1960 was enacted on 15 December 1960 to be operative for a period of four and a half years from 1 January 1961. The Acts provide for bounties to be paid, subject to specified conditions, on sulphuric acid produced from prescribed materials of Australian origin and to producers of iron pyrites. In June 1965 it was announced that assistance under these Acts would continue until 31 December 1965. Both of these Acts have now been extended by legislation to 30 June 1969. Payments under the above Acts in each of the years 1964 to 1968 are shown in the table on page 1004.

Payments to producers of phosphate fertilisers. The *Phosphate Fertilizers Bounty Act* 1963–1968 provides for a bounty to be paid on superphosphate and ammoniated phosphate fertilisers manufactured and sold for use in Australia on and after 14 August 1963. A recent amendment to this Act provides that approved trace elements, compounds or substances, when added to superphosphate, shall be deemed to be superphosphate for purpose of bounty eligibility. The bounty is based on the fertiliser value of superphosphate as measured by its soluble content of phosphorus pentoxide. A standard grade of superphosphate containing 20 per cent, plus or minus 0.5 per cent, soluble

content of phosphorus pentoxide qualifies for the full bounty of $8 per ton. When the phosphorus pentoxide content of the superphosphate is less than 19.5 per cent or above 20.5 per cent, bounty is payable at the rate of $40 for each ton of contained phosphorus pentoxide. Bounty in respect of ammonium phosphate is payable at the rate of $40 for each ton of the phosphorus pentoxide content of the ammonium phosphate. In addition to standard grade superphosphate, 'double' and 'triple' superphosphates are produced in Australia and bounty on these products is payable in accordance with the phosphorus pentoxide content. The intention of this Act is to assist consumers of superphosphate (primary producers), to this end the benefits of bounty are required to be passed on to the end user of the bountiable product. The Act is due to expire on 31 October 1971. Payments under the above Act in each of the years 1964 to 1968 are shown in the following table.

COMMONWEALTH GOVERNMENT PAYMENTS TO THE MINERAL INDUSTRY AUSTRALIA, 1964 TO 1968

($)

Year	*Petroleum exploration* (*a*)	*Gold mining* (*b*)	*Copper mining* (*c*)	*Pyrites mining* (*d*)	*Sulphuric acid production* (*e*)	*Phosphate fertiliser production* (*f*)
1964	9,121,910	1,382,124	1,065,782	1,320,668	2,046,542	22,772,978
1965	10,412,842	1,984,966	5,262	1,113,964	2,138,914	22,604,562
1966	10,154,169	3,784,241	1,314	288,319	1,397,679	25,817,516
1967	10,326,587	3,858,763	..	45,714	1,382,485	25,543,785
1968	13,805,484	2,817,453	..	..	1,279,260	24,906,817

(*a*) *Petroleum Search Subsidy Act* 1959–1967. (*b*) *Gold-Mining Industry Assistance Act* 1954–1966 and *Gold Mines Development Assistance Act* 1962 (expired 30 June 1965). (*c*) *Copper Bounty Act* 1958–1966. (*d*) *Pyrites Bounty Act* 1960–1965. (*e*) *Sulphuric Acid Bounty Act* 1954–1966. (*f*) *Phosphate Fertilizers Bounty Act* 1963–1966.

Bureau of Mineral Resources, Geology and Geophysics. The functions of the Bureau of Mineral Resources, Geology and Geophysics are to explore, investigate and encourage the development of mineral deposits; to survey and assess the mineral resources of the Commonwealth and its Territories and to initiate and investigate proposals for their development; to interpret the results of completed surveys and recommend ways of remedying or meeting mineral deficiencies and to advise on all aspects of the mineral economy of Australia, including the best utilisation of mineral resources in the national interest; to carry out geological and geophysical surveys and investigations and advise on all aspects of applied geology and geophysics.

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 programme, 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* 1959–1967 and is also engaged in the assessment of sedimentary basins in Australia and its Territories. The establishment of the Bureau is 622 officers, of whom 308 are professional. The budget for the financial year 1967–68 was $18.0 million, of which $11.8 million was provided for payment under the *Petroleum Search Subsidy Act* 1959–1967.

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 a vulcanological observatory at Rabaul and geophysical observatories at Melbourne, Toolangi, Mundaring, Darwin, Port Moresby, Mawson and Wilkes (Antarctica), and Macquarie Island. The geophysical observatories are engaged in magnetic, ionospheric, and seismic investigations and are base stations for field operations.

Commonwealth Scientific and Industrial Research Organization. The activities of this body with respect to the mineral industry are discussed on page 1007 under Research.

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. State aid to assist metalliferous mining may consist of grants to assist the prospecting and or mining for gold and minerals, and for the purchase, removal and installation of mining plant or equipment. A quantity of mechanical equipment is also available in several localities for hire at reasonable rentals to prospectors and small mine operators, and district inspectors have geiger counters and scheelite detectors which are loaned to approved persons. In the year 1967–68 $530,000 was made available for exploration work carried out by the Department and to give financial assistance to exploration groups and prospectors.

Victoria. Loans may be granted to assist prospecting and development or the purchase of machinery for gold mining. The Mines Department has stamp batteries in different parts of the State to crush ore for prospectors at nominal rates. Small mining companies may avail themselves of these facilities. Drilling with diamond, rotary and percussion drills is carried out by the Mines Department for mining companies and for general mineral exploration. The production of 1 : 63,630 and 1 : 250,000 series geological maps of the State is continuing and three quarters of the State is now covered by provisional 1 : 250,000 maps. Memoirs and Bulletins are being published regularly on specific regional geology and economic studies. Mineral Resources surveys for extractive industry materials, radioactive minerals and base metal ores are currently in progress. In addition a continual assessment is being made on the work carried out by Mineral Exploration Companies to ensure that a high standard of mineral search is maintained.

Detailed sedimentary basin studies are continuing in the Otway, Gippsland and Murray Basins to elucidate the stratigraphy and structure and evaluate the economic potential. The survey of the State's groundwater resources is now well advanced and a large amount of data is now compiled. In conjunction with this survey the development of provisional town supplies from groundwater sources is being investigated.

Queensland. Various forms of assistance to mining are made available by the Queensland Department of Mines. Grants are made from the Consolidated Revenue Fund for use on construction and maintenance of roads in mining areas. Advances are made from the Gold Mining Encouragement Fund for mining development work. This assistance is restricted to gold mines, and advances are repayable from proceeds of the mine, if any. From the Assistance to Metalliferous Mining Fund, plant such as jackhammers, compressors and pumps is purchased and maintained. Such plant is made available on hire, the rental payments being credited back to the fund. Prospecting assistance is made available in approved cases, the rates being $5 a week for a single man and $7 a week for a married man with dependants. This is not repayable. From the Advances to Mining Fund, assistance by way of subsidy is advanced for mine development. This is repayable from proceeds of the mine. The department also maintains a treatment works for tin ores, etc. at Irvinebank, an assay office at Cloncurry and diamond-drilling plants in several parts of the State. The Venus State battery at Charters Towers is available for the treatment of gold-bearing ores.

South Australia. The Department of Mines provides the following services and facilities to the mineral industry: (i) hire of drilling plant and mining equipment, drilling and testing of mineral deposits, financial assistance in approved cases for prospecting and mining development, development of sub-surface water supplies for farming, pastoral, irrigation, and mining purposes; (ii) geological examination of mineral deposits, water supply, dam foundation and drainage problems, guidance on mining legislation, and publication and issue of geological bulletins and maps. It also provides, through the Australian Mineral Development Laboratories, chemical and metallurgical and analytical and assay investigation, 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 twenty State batteries operating intermittently throughout the goldfields for the treatment of ore from prospectors and small mine-owners at a nominal charge. A cartage subsidy is also granted to such operators sending ore to State batteries for treatment. Provision is made for loans to mine-owners who require assistance to develop mines. The Government also has a drilling scheme, financing mine-owners on a $1 for $1 basis.

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 Northern Territory Administration operates two batteries for the treatment of miners' ores. The batteries are at Tennant Creek and at Mount Wells near Burrundie. The Tennant Creek battery is currently cyaniding the gold in accumulated tailings while the Mount Wells battery is crushing parcels of tin ores and small quantities of gold, lead and copper ores. The crushing charges are subsidised by government grants. In addition, the Administration provides cartage subsidies and financial advances to encourage miners to carry out mining operations. Assistance is also given to the industry by drilling encouraging prospects. Roads and water supply services are provided and maintained for mines under active development throughout the Territory.

Research

Research investigations into problems of mining, ore-search, ore-dressing and metallurgy are conducted by Governmental 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 the chapter Education, Cultural Activities and Research.

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 sponsored by the South Australian Government, the Commonwealth Government and the Australian Mineral Industries Research Association (*see* Research by private enterprise, page 1007). The laboratories have sections dealing with mineralogy, petrology, analytical chemistry, chemical and metallurgical engineering, ceramics, materials technology and operations research.

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 1007). 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.

Initial emphasis is being 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 will include 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; mobility of sulphides under the influence of temperature and pressure and the interaction of mineral types; and biological leaching of low-grade sulphide minerals.

The laboratory is named after the late Dr L. G. M. Baas Becking, who was one of the first to recognise the possibility that biological, in particular microbial, activity may play an important part in the genesis of sulphide ores. Dr Baas Becking carried out research in this field while on loan to the Bureau of Mineral Resources from the C.S.I.R.O.

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 1004.

Commonwealth Scientific and Industrial Research Organization

Research for the mineral industry by the Commonwealth Scientific and Industrial Research Organization is undertaken mainly in the Divisions of Applied Mineralogy and Mineral Chemistry and in the Ore Dressing Investigations Laboratory. Work of a more specifically chemical engineering nature is undertaken in the Division of Chemical Engineering. All of these groups have laboratories in Melbourne. In addition, the Division of Applied Mineralogy has laboratories in Perth and Sydney, and the Division of Mineral Chemistry has a laboratory in Sydney.

The research programme of the Division of Applied Mineralogy is concerned mainly with the production and utilisation of natural and synthetic mineral products. Research is undertaken on cement and concrete, industrial refractories, engineering ceramics, clays, mineral-organic complexes, fillers, foundry materials, and the geochemistry of some economic minerals. The Division of Mineral Chemistry is undertaking research aimed at a more thorough evaluation of Australian minerals and their better utilisation through chemical, electrochemical and metallurgical processes. It includes studies on mineral exploration techniques, chemical upgrading of minerals, and the production of metals, and investigations on processes with possibilities for application in the exploitation of minerals. Work is continuing on the evaluation of coals from all the significant deposits in Australia, and on the technical problems of coal combustion in large power stations. In the Division of Chemical Engineering, projects of particular interest to the mineral industry include studies on the dynamics and automatic control of mineral processing operations such as grinding, classifying and flotation, fluidised-bed techniques, high-temperature extraction metallurgy and metal refining. The Ore Dressing Investigations laboratory undertakes research on problems arising in the processing of particular Australian ores. In addition, it is collaborating with interested firms in long-term studies on the chemistry of flotation pulps and the assessment of the resistance of ores to grinding.

All C.S.I.R.O. groups taking part in mineral research are in close contact with industry. Several projects are being developed by collaboration between C.S.I.R.O. and Australian firms and a significant proportion of the Organization's mineral research is now carried on with funds provided by industry. A committee set up by the Advisory Council of C.S.I.R.O. is continuing to examine and advise on research needs in the mining and processing industries in the changing environment.

National Coal Research Advisory Committee

The functions of the National Coal Research Advisory Committee, which began operating in January 1965, are to report on all programmes of research into coal winning, beneficiation and utilisation in Australia, as well as developments in these fields overseas; and to advise the contributing Governments and industry as to the disposition of funds made available for such research. The Commonwealth matches additional funds made available by State Governments and by the coal producing and consuming industries. In the first four years of operation of the scheme additional funds of $520,000 have been made available in each year for increased coal utilisation research, bringing total expenditure on coal research in Australia to approximately $3.0 million annually. In association with the setting up of the National Coal Research Advisory Committee, a new company, the Australian Coal Industry Research Laboratories Limited, was formed in late 1965 to take over the research and industrial service activities of the Australian Coal Association (Research) Limited, which was financed largely by the coal producing industry. Additional funds have been made available to this company from the coal producing and consuming industries and from State and Commonwealth Governments to permit the expansion of the work of the former Australian Coal Association (Research) Limited initially in the particular direction of coal utilisation research, latterly in the direction of coal winning and beneficiation research. The constitution of the Advisory Committee and the establishment of the laboratories have brought into effect the major recommendations of the Coal Utilisation Research Advisory Committee which tabled its Report to Parliament in 1962.

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 immediate problems. Private industry has formed the Australian Mineral Industries Research Association, which is composed of fifty members representing a large proportion of the mining, metallurgical and related companies operating in Australia at present. It was set up in 1959, chiefly to represent private industry in the management of the Australian Mineral Development Laboratories, but the Association now finances other research work into geology, mining and ore-dressing at Universities, C.S.I.R.O. and elsewhere. Expenditure for the year 1967–68 was $106,024.

In addition, the Association provided $50,000 to the Australian Mineral Development Laboratories toward the cost of a new building (the first of four such payments) and an advance of $20,000 to underwrite the formation of International Technical Services Limited. The latter is a new non-profit consulting company jointly owned by the Association and Battelle Memorial Institute, Columbus, U.S.A. and associated with the Australian Mineral Development Laboratories.

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 International Tin Agreement, which came into force provisionally on 1 July 1961 and definitively on 21 February 1962.

This Agreement was for a period of five years and had the following objectives:

(*a*) to prevent or alleviate widespread unemployment or under-employment and other serious difficulties likely to arise from maladjustments between the supply and the demand for tin;

(*b*) to prevent excessive fluctuations in the price of tin and to achieve a reasonable degree of stability of price;

(*c*) to ensure adequate supplies of tin at prices which are fair to consumers and provide a reasonable return to producers; and

(*d*) to provide a framework for the consideration of measures to promote the progressively more economic production of tin, while protecting deposits of tin from unnecessary waste or premature abandonment, thus facilitating expansion in world consumption of tin; and to keep under review the long-term need for the development of new deposits of tin.

The Third International Tin Agreement, which came into force provisionally on 1 July 1966 and definitively on 21 March 1967, contains several additional objectives:

(*a*) to ensure conditions which will help achieve a dynamic and rising rate of production of tin on the basis of a remunerative return to producers, which will help secure an adequate supply at prices fair to consumers and which will help provide a long-term equilibrium between production and consumption;

(*b*) in the event of a serious shortage of supplies of tin occurring or being expected to occur, to take steps to secure an increase in the production of tin and a fair distribution of tin metal at equitable prices.

Although the framework of the Third Agreement is basically that of the Second, objectives have been broadened in line with the principles of the United Nations Conference on Trade and Development (UNCTAD) and, as such, emphasise the need for expansion of export earnings in the developing countries. Thus the emphasis has been shifted from surplus production and export controls inherent in the Second Agreement to one of increased production in the new Agreement.

The Agreement is operated by the International Tin Council, which is made up of the following Governments: Australia, Austria, Belgium, Bolivia, Canada, Czechoslovakia, Democratic Republic of the Congo, Denmark, France, India, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Federation of Nigeria, Spain, Thailand, Turkey, United Kingdom. Member Governments participate as producing or consuming countries. 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. 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. The buffer stock was established with contributions from producing countries, equivalent to 10,000 tons of metal, wholly made in cash at £stg1,000 a ton; a further £10 million remains on call from the producer members and a standby-credit facility of £10 million from a consortium of banks. The original buffer stock price range under the Third Agreement was: ceiling £1,400—must sell; £1,300 to £1,400—may sell; £1,200 to £1,300—no action; £1,100 to £1,200—may buy; floor £1,100—must buy. However, following devaluation of sterling, the buffer stock price range was adjusted to the following limits: £1,630—must sell; £1,515 to £1,630—may sell; £1,400 to £1,515—no action; £1,280 to £1,400—may buy; £1,280—must buy.

On 18 September 1968 the International Tin Council declared the period 19 September 1968 to 31 December 1968 to be a period of export control. The total permissible export amount during that period for the six producing members in the agreement, Bolivia, Congo D.R., Indonesia, Malaysia, Nigeria, and Thailand, was 42,950 long tons. The quotas established for the producer members represented a moderate cut, in effect some 4 per cent on reports in the second quarter of 1968. The Council also addressed an invitation to the Australian Government, asking that Australia limit its exports of tin to the same degree and for the same period as the producer members of the Agreement. The Australian Government introduced export controls on tin and tin concentrates as from 6 December 1968.

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 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 expecially 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 mining and quarrying, mineral exploration, and overseas participation in Australian mining industry. Data relating to mineral processing and treatment activities are included where appropriate to present a more complete picture of the place of minerals in the Australian economy.

Mining and quarrying

Definition

The mining and quarrying industry is defined for statistical purposes as including all mining and quarrying and the recovery of minerals from ore dumps, tailings, etc., and ore-dressing and elementary smelting of gold and miscellaneous treatment of non-metallic minerals where these operations are carried out in an associated plant at or near the mine. However, establishments primarily engaged in smelting and or refining (including the smelting and refining sections of the large plants operated at Mount Morgan and Mount Isa in Queensland and at Mount Lyell in Tasmania) are excluded from the statistical definition of the mining industry and are classified to the manufacturing industry.

Coverage

The statistical coverage of establishments engaged in mining is considered to be satisfactory. However, coverage of establishments engaged in the quarrying of construction materials is incomplete in most States. This deficiency is due primarily to the inherent difficulty of obtaining complete lists of quarries (including those operated by government authorities), many of which operate intermittently and in different locations. There is difficulty also in obtaining satisfactory returns from quarries operated in conjunction with some other activity, e.g. roadmaking, brick-works, etc., and quarries operated in conjunction with large construction projects, such as the Snowy Mountains Scheme, are excluded from these statistics. In some States there have been deficiencies also in the collection of data for certain non-metal (excluding fuel) mining industries, mainly because these are outside the fields normally under the administrative control of Mines Departments. Products chiefly affected are clays, loam and silica.

Sources of statistics

Mining industry data (such as employment, costs, value of output, etc.) have been obtained annually since 1952 from the Mining and Quarrying Census. This Census is carried out in collaboration with the several Mines Departments and involves the uniform collection of particulars from all establishments employing on the average four or more persons during the period worked by the mine. A representative specimen collection form is included in the bulletin *Non-Rural Primary*

Industries, No. 3, 1964–65. For smaller mines either simplified census returns covering number of persons employed and value of output are collected, or these particulars are compiled from data made available by the Mines Departments. Oil search operations are excluded from the annual census, but the Bureau of Mineral Resources conducts an annual survey of these activities.

Mineral production statistics contained in this chapter consist, in the main, of data from the annual census and official statistics of the Mines Departments of the several States and of the Northern Territory Mines Branch. The particulars shown have been compiled as far as practicable on the standardised basis which has been used in Australia since 1950, and this presentation has involved some re-arrangement of official statistics published by the Mines Departments in some States. These statistics have been supplemented, as necessary, by data obtained from the Statisticians of the several States, the Bureau of Mineral Resources, Geology and Geophysics, the Joint Coal Board, and from several other sources.

Classification of mining and quarrying industry

The mining and quarrying industry is classified into four major groups, namely metal mining, fuel mining, non-metal mining (excluding fuel), and construction material quarrying. Mining and quarrying establishments are classified to these groups and to sub-divisions of these groups on the basis of the product or products of the establishments. This method of classification is straightforward for those establishments which produce only one product, but for mines and quarries which produce more than one product classification is not as simple a matter. Such establishments are classified according to the most important mineral produced in terms of value. Thus a mine producing, say, both tin and tungsten minerals would be classified as a tin mine if tin were the more important product by value, and as a tungsten mine if tungsten were the dominant product. There is, however, one important exception to this rule in that the mining establishment at Mount Isa is classified to the silver-lead-zinc sector rather than to the copper-gold sector.

For mines and quarries which produce more than one product it is not possible to apportion particulars of operations (such as employment, salaries and wages paid, costs) to the minerals produced. In practice, then, these data are recorded only as a total for each mine, and the mine is classified to an industry sector as outlined above.

Statistics relating to the structure of the industry, employment, production costs, value of additions and replacements to fixed assets, and value of output and production are given below and in the following pages.

Number of mines and quarries

The following tables show the number of mines and quarries which operated in each State and Territory in 1967 and in Australia for the years 1963 to 1967.

NUMBER OF MINES AND QUARRIES: STATES AND TERRITORIES, 1967

Industry	*N.S.W.*	*Vic.*	*Qld*	*S.A*	*W.A.*	*Tas.*	*N.T.*	*A.C.T.*	*Aust.*
Metal mining—									
Gold	17	10	27	..	105	1	11	..	171
Silver-lead-zinc	17	..	8	1	4	1	1	..	32
Copper-gold	13	..	136	5	10	1	9	..	174
Tin	52	7	269	..	19	32	14	..	393
Mineral sands	14	..	7	..	4	..	..	..	25
Iron	..	..	..	1	8	1	1	..	11
Other metal	27	3	21	1	8	3	6	..	69
Total, metal mining	*140*	*20*	*468*	*8*	*158*	*39*	*42*	..	*875*
Fuel mining—									
Black coal—									
Underground	84	1	46	..	2	3	..	..	136
Opencut	8	..	4	1	1	..	..	..	14
Total, black coal	92	1	50	1	3	3	..	..	150
Brown coal	..	5	..	..	..	..	..	..	5
Other fuel	..	1	3	..	1	..	..	..	5
Total, fuel mining	*92*	*7*	*53*	*1*	*4*	*3*	..	..	*160*
Non-metal (excluding fuel) mining(a)	436	128	142	107	60	26	..	..	1,098
Total, all mining	*867*	*155*	*663*	*116*	*222*	*68*	*42*	..	*2,133*
Construction material quarrying(a)	342	403	64	259	58	109	32	13	1,280
Total, all mining and quarrying	**1,209**	**558**	**727**	**375**	**280**	**177**	**74**	**13**	**3,413**

(a) Incomplete, owing to difficulties of coverage. *See* Coverage, page 1009.

NUMBER OF MINES AND QUARRIES: AUSTRALIA, 1963 TO 1967

Industry	*1963*	*1964*	*1965*	*1966*	*1967*
Metal mining—					
Gold	257	246	193	179	171
Silver-lead-zinc	13	20	32	30	32
Copper-gold	98	86	75	124	174
Tin	300	371	391	363	393
Mineral sands	18	20	21	23	25
Iron	(*a*)	(*a*)	(*a*)	11	11
Other metal	62	56	53	52	69
Total, metal mining	*748*	*799*	*765*	*782*	*875*
Fuel mining—					
Black coal	185	179	168	158	150
Brown coal	6	7	6	5	5
Other fuel	2	3	3	4	5
Total, fuel mining	*193*	*189*	*177*	*167*	*160*
Non-metal (excluding fuel) mining(*b*)	792	756	802	973	1,098
Total, all mining	*1,733*	*1,744*	*1,744*	*1,922*	*2,313*
Construction material quarrying(*b*)	1,044	1,148	1,234	1,276	1,280
Total, all mining and quarrying	**2,777**	**2,892**	**2,978**	**3,198**	**3,413**

(*a*) Included in Other metal. (*b*) Incomplete. *See* Coverage, page 1009.

Employment in mining and quarrying

Persons engaged. Statistics of persons employed in the mining and quarrying industry are derived mainly from the annual census of that industry. Data on the work force employed in the industry are also obtained from the population censuses of Australia. The population census figure for mining and quarrying includes a number of persons excluded from the mining and quarrying census employment figure, e.g. persons engaged in exploration activities, prospectors, head office employees, etc. The number of persons whose industry statements were classified to 'mining and quarrying' at the population census of 30 June 1966 was 56,343 out of a total of 512,994 for all primary industries and 4,856,455 in the total work force. For further information *see* the chapter Employment and Unemployment and 1966 Census Bulletin No. 9.6, *Population, By Industry and Occupational Status, Australia.*

The following two tables are derived from mining census data and show the average numbers engaged in the various mining industries in each State or Territory in 1967 and in Australia for the years 1963 to 1967. The figures show the average number of persons employed during the whole year, including working proprietors.

MINING AND QUARRYING: EMPLOYMENT(*a*)
STATES AND TERRITORIES, 1967

Industry	*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T.*	*A.C.T.*	*Aust.*
Metal mining—									
Gold	8	111	(*b*)	..	3,683	(*b*)	(*b*)	..	4,074
Silver-lead-zinc	4,705	..	5,205	2	(*b*)	(*b*)	90	..	9,703
Copper-gold	315	..		4	(*b*)	(*b*)	408	..	2,712
Tin	289	30	530	..	226	647	26	..	1,748
Mineral sands	1,597	..	593	..	353	..	..	..	2,543
Iron	..	..	..	313	999	(*b*)	242	..	1,609
Other metal	42	8	(*b*)	90	389	(*b*)		..	1,299
Total, metal mining	*6,956*	*149*	*6,769*	*409*	*5,782*	*2,691*	*932*	..	*23,688*
Fuel mining—									
Black coal—									
Underground	11,608	(*c*)122	(*b*)	..	(*b*)	61	..	..	(*c*)14,385
Opencut	221	..	(*b*)	263	(*b*)	..	..	..	1,063
Total, black coal	11,829	122	(*c*)2,265	263	(*c*)908	61	..	..	(*c*)15,448
Brown coal	..	1,677	..	..	..	..	..	..	1,677
Total, fuel mining	*11,829*	*1,799*	*2,265*	*263*	*908*	*61*	..	..	*17,125*
Non-metal (excluding fuel) mining(*d*)	1,372	331	408	442	169	81	..	..	2,803
Total, all mining	*20,157*	*2,279*	*9,442*	*1,114*	*6,859*	*2,833*	*932*	..	*43,616*
Construction material quarrying(*d*)	1,872	1,947	479	848	313	235	74	80	5,848
Total, all mining and quarrying	22,029	4,226	9,921	1,962	7,172	3,068	1,006	80	49.464

(*a*) Average employment during whole year, including working proprietors. (*b*) Not available for publication. (*c*) Includes other fuel mining. (*d*) Incomplete, owing to difficulties of coverage. *See* Coverage, page 1009.

MINING AND QUARRYING: EMPLOYMENT(*a*), AUSTRALIA, 1963 TO 1967

Industry	*1963*	*1964*	*1965*	*1966*	*1967*
Metal mining—					
Gold	5,287	4,753	4,525	4,447	4,074
Silver-lead-zinc	7,946	7,811	7,269	8,681	9,703
Copper-gold	2,288	2,341	2,312	2,554	2,712
Tin	1,116	1,191	1,402	1,550	1,748
Mineral sands	1,565	1,734	2,000	2,434	2,543
Iron	(*b*)	(*b*)	(*b*)	1,323	1,609
Other metal	1,168	1,348	2,251	972	1,299
Total, metal mining	*19,370*	*19,178*	*19,759*	*21,961*	*23,688*
Fuel mining—					
Black coal(*c*)	15,636	15,364	15,391	15,169	15,448
Brown coal	1,613	1,673	1,710	1,760	1,677
Total, fuel mining	*17,249*	*17,037*	*17,101*	*16,929*	*17,125*
Non-metal (excluding fuel) mining(*d*)	2,823	2,783	2,795	2,930	2,803
Total, all mining	*39,442*	*38,998*	*39,655*	*41,820*	*43,616*
Construction material quarrying(*d*)	5,406	5,814	6,217	5,957	5,848
Total, all mining and quarrying	**44,848**	**44,812**	**45,872**	**47,777**	**49,464**

(*a*) Average employment during whole year including working proprietors. (*b*) Included in Other metal. (*c*) Includes other fuel mining. (*d*) Incomplete, *see* Coverage, page 1009.

Size classification of mines and quarries. The following table shows the distribution of the total number of mines into various size groups according to the average number of persons employed *during the period worked* by each mine in 1967.

NUMBER OF MINES AND QUARRIES AND PERSONS EMPLOYED, BY AVERAGE NUMBER EMPLOYED: STATES AND TERRITORIES, 1967

Mines and quarries employing on the average(a)—	*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T. and A.C.T.*	*Aust.*
Less than 4 persons—								
Establishments	912	381	581	284	179	134	69	2,540
Persons	1,691	614	905	498	448	225	99	4,480
From 4 to 20 persons—								
Establishments	184	146	81	77	62	30	11	591
Persons	1,460	1,160	804	708	450	217	120	4,919
From 21 to 200 persons—								
Establishments	86	30	60	12	30	8	6	232
Persons	7,183	1,251	3,092	590	2,400	536	504	15,556
More than 200 persons—								
Establishments	27	1	4	2	9	5	1	49
Persons	12,838	1,570	5,613	576	4,234	2,300	382	27,513
Total—								
Establishments	**1,209**	**558**	**727**	**375**	**280**	**177**	**87**	**3,413**
Persons	**23,172**	**4,595**	**10,414**	**2,372**	**7,532**	**3,278**	**1,105**	**52,468**

(*a*) Average during period worked. Includes working proprietors.

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 1967, 35 persons were recorded as killed and 1,145 as injured in mining (excluding quarrying) accidents. Recorded deaths and injuries in that year in black coal mines were 12 and 339, silver-lead-zinc mines 5 and 252, gold mines 5 and 242. In mineral sands mining there were no recorded deaths and 42 injuries reported. Persons killed and injured in the construction material quarrying industry numbered 4 and 138 respectively in 1967.

Salaries and wages paid

Salaries and wages paid in the mining and quarrying industries in Australia during each year 1963 to 1967 are shown in the following table. Information regarding rates of wages paid in the mining industry is shown in the chapter Labour, Wages and Prices (page 265) and also in the *Labour Report*.

MINING AND QUARRYING: SALARIES AND WAGES PAID(*a*), AUSTRALIA
1963 TO 1967
($'000)

Industry	*1963*	*1964*	*1965*	*1966*	*1967*
Metal mining—					
Gold	13,072	11,812	11,974	12,409	12,591
Silver-lead-zinc	25,678	29,948	34,397	44,651	46,711
Copper-gold	6,200	6,834	7,415	8,205	9,235
Tin	2,502	2,648	3,313	4,156	5,035
Mineral sands	4,156	4,706	5,837	7,673	8,603
Iron	(*b*)	(*b*)	(*b*)	4,917	7,529
Other metal	3,184	4,038	7,241	3,683	5,790
Total, metal mining	*54,792*	*59,986*	*70,177*	*85,696*	*95,495*
Fuel mining—					
Black coal(*c*)	49,230	52,204	55,942	60,191	65,549
Brown coal	4,634	5,144	5,503	5,672	5,662
Total, fuel mining	*53,864*	*57,348*	*61,445*	*65,863*	*71,210*
Non-metal(excluding fuel) mining(*d*)	5,764	6,248	6,388	6,821	5,570
Total, all mining	*114,420*	*123,582*	*138,010*	*158,380*	*172,275*
Construction material quarrying(*d*)	8,684	9,364	10,751	11,256	11,136
Total, all mining and quarrying	**123,104**	**132,946**	**148,761**	**169,636**	**183,411**

(*a*) Excludes mines and quarries employing less than four persons, and drawings by working proprietors; the amounts are net after deducting value of explosives sold to employees. (*b*) Included in Other metal. (*c*) Includes other fuel mining. (*d*) Incomplete. *See* Coverage, page 1009.

Power, fuel, light, and materials, etc. used

MINING AND QUARRYING: VALUE OF POWER, FUEL, LIGHT, AND OTHER MATERIALS AND STORES USED, AUSTRALIA, 1963 TO 1967
($'000)

Industry	*1963*	*1964*	*1965*	*1966*	*1967*
Metal mining—					
Gold	9,758	8,334	8,433	8,207	8,147
Silver-lead-zinc	21,590	22,688	21,009	22,265	24,923
Copper-gold	7,232	7,698	8,365	10,537	12,544
Tin	1,508	1,854	2,115	3,095	3,676
Mineral sands	5,052	5,496	6,138	7,569	7,820
Iron	(a)	(a)	(a)	3,923	11,564
Other metal	2,850	3,162	4,366	2,285	3,656
Total, metal mining	*47,990*	*49,234*	*50,427*	*57,883*	*72,329*
Fuel mining—					
Black coal(b)	27,002	29,114	31,718	35,746	41,069
Brown coal	1,478	1,532	2,108	2,082	1,968
Total, fuel mining	*28,480*	*30,648*	*33,827*	*37,828*	*43,036*
Non-metal (excluding fuel) mining(c)	5,534	5,342	5,720	5,641	5,209
Total, all mining	*82,004*	*85,226*	*89,974*	*101,351*	*120,574*
Construction material quarrying(c)	9,060	9,728	11,067	12,072	13,115
Total, all mining and quarrying	**91,064**	**94,952**	**101,041**	**113,423**	**133,689**

(a) Included in Other metal. (b) Includes other fuel mining. (c) Incomplete. *See* Coverage, page 1009.

Value of additions and replacements to fixed assets in mining and quarrying

MINING AND QUARRYING: VALUE OF ADDITIONS AND REPLACEMENTS TO FIXED ASSETS(a), AUSTRALIA, 1963 TO 1967
($'000)

Industry	*1963*	*1964*	*1965*	*1966*	*1967*
Metal mining—					
Gold	2,024	1,365	1,094	1,195	1,558
Silver-lead-zinc	14,154	20,071	10,939	12,535	14,595
Copper-gold	5,066	7,419	5,333	6,085	5,813
Tin	1,548	4,459	6,583	9,798	10,361
Mineral sands	2,436	3,592	6,729	11,103	9,674
Iron	(b)	(b)	(b)	36,436	20,112
Other metal	4,476	5,556	32,228	13,051	12,827
Total, metal mining	*29,702*	*42,462*	*62,906*	*90,203*	*74,939*
Fuel mining—					
Black coal(c)	20,668	19,952	28,695	45,442	71,506
Brown coal	6,610	5,416	6,115	5,107	5,277
Total, fuel mining	*27,278*	*25,368*	*34,810*	*50,548*	*76,783*
Non-metal (excluding fuel) mining(d)	1,742	3,497	2,109	3,638	8,302
Total, all mining	*58,722*	*71,327*	*99,825*	*144,387*	*160,024*
Construction material quarrying(d)	3,898	5,867	7,303	5,273	7,640
Total, all mining and quarrying	**62,620**	**77,194**	**107,128**	**149,661**	**167,664**

(a) Excludes mines and quarries employing less than four persons. (b) Included in Other metal. (c) Includes other fuel mining. (d) Incomplete. *See* Coverage, page 1009.

Value of output and production

The following tables show particulars of value of output on an ex-mine basis (local value of production) and value of production (net value of production) for recent years. *These statistics are on an industry basis and not by product.* A more detailed reference to the value of production of mining and quarrying and other industries together with a brief explanation of terms used will be found in the chapter Miscellaneous.

Local value of mining and quarrying production. The following tables show particulars of the local value of production of mining and quarrying for 1967 and earlier years.

MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION(a) STATES AND TERRITORIES, 1967

($'000)

Industry	*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T.*	*A.C.T.*	*Aust*
Metal mining—									
Gold	4	468	(b)	..	21,849	(b)	(b)	..	24,688
Silver-lead-zinc	73,820	..	64,064	5	(b)	(b)	670	..	138,951
Copper-gold	7,126	..		16	(b)	(b)	7,093	..	36,883
Tin	4,269	90	4,123	..	2,314	(b)	(b)	..	15,388
Mineral sands	22,736	..	8,792	..	5,723	..	..	..	37,251
Iron	..	..	..	11,150	70,253	..	1,615	..	83,018
Other metal	255	28	(b)	1,437	7,561	(b)	6,742	..	36,625
Total, metal mining	*108,210*	*586*	*93,794*	*12,608*	*108,408*	*31,102*	*18,095*	..	*372,803*
Fuel mining—									
Black coal	126,446	251	(b)	3,272	(b)	322	..	..	160,099
Brown coal	..	20,686	..	..	..	..	..	..	20,686
Other fuel	..	..	(b)	..	(b)	..	..	..	21,286
Total, fuel mining	*126,446*	*20,937*	*32,567*	*3,272*	*18,528*	*322*	..	..	*202,071*
Non-metal (excluding fuel) mining—									
Clays(c)	3,260	3,183	259	622	427	118	..	..	7,869
Gypsum	204	362	..	1,498	62	..	..	..	2,126
Limestone	3,322	2,671	(b)	2,599	(b)	473	..	..	12,047
Salt	..	543	(b)	2,065	(b)	..	..	..	2,769
Other non-metal mining(c)	2,552		(b)	3,719	(b)	21	..	..	7,129
Total, non-metal mining	*9,338*	*6,760*	*3,446*	*10,503*	*1,282*	*611*	..	..	*31,940*
Total, all mining	*243,994*	*28,282*	*129,807*	*26,382*	*128,218*	*32,035*	*18,095*	..	*606,814*
Construction material quarrying(c)	31,935	29,056	5,703	14,066	6,101	2,652	1,221	1,087	91,822
Total, all mining and quarrying	**275,929**	**57,339**	**135,510**	**40,449**	**134,319**	**34,688**	**19,316**	**1,087**	**698,636**

(a) Value of output or selling value of products at the mine or quarry. (b) Not available for publication, included in total for Australia. (c) Incomplete. *See* Coverage, page 1009.

MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION(a) STATES AND TERRITORIES, 1963 TO 1967

($'000)

Year	*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T. and A.C.T.*	*Aust.*
1963	185,352	40,840	84,084	34,208	44,768	20,304	7,126	416,682
1964	233,298	44,892	97,286	38,938	45,366	25,048	7,972	492,800
1965	267,673	48,926	98,964	39,466	49,072	28,998	9,272	542,370
1966	263,751	53,156	138,483	41,954	78,918	34,561	14,328	625,152
1967	275,929	57,339	135,510	40,449	134,319	34,688	20,403	698,636

(a) Value of output or selling value of products at the mine or quarry.

Net value of mining and quarrying production

The following tables show particulars of the net value of production of mining and quarrying for 1967 and earlier years.

MINING AND QUARRYING: NET VALUE OF PRODUCTION(a) STATES AND TERRITORIES, 1967

($'000)

Industry	*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T.*	*A.C.T.*	*Aust.*
Metal mining—									
Gold	1	307	(b)	..	14,287	(b)	(b)	..	16,541
Silver-lead-zinc	60,831	..	50,469	3	(b)	(b)	517	..	114,028
Copper-gold	4,690	..		14	(b)	(b)	5,558	..	24,340
Tin	3,472	70	3,274	..	1,736	(b)	(b)	..	11,711
Mineral sands	18,773	..	6,088	..	..	(b)	..	..	29,431
Iron	..	..	..	10,364	66,954	..	7,649	..	71,454
Other metal	225	24	(b)			(b)		..	32,969
Total, metal mining	*87,993*	*401*	*75,906*	*10,382*	*87,991*	*22,416*	*15,385*	..	*300,474*
Fuel mining—									
Black coal	95,080	158	(c)24,824	2,706	(c)17,291	258	..	..	(c)140,317
Brown coal	..	18,718	..	..	..	..	..	..	18,718
Total, fuel mining	*95,080*	*18,876*	*24,824*	*2,706*	*17,291*	*258*	..	..	*159,035*
Non-metal (excluding fuel) mining—									
Clays(d)	2,943	2,924	219	566	284	110	..	..	7,046
Gypsum	161	328	..	1,337	52	..	..	..	1,878
Limestone	2,320	1,936	(b)	2,273	(b)	316	..	..	8,879
Salt	..	(b)		1,795	(b)	..	..	..	2,235
Other non-metal mining(d)	2,384	497	..	3,525	(b)	16	..	..	6,693
Total, non-metal mining	*7,808*	*5,685*	*2,373*	*9,496*	*926*	*442*	..	..	*26,730*
Total, all mining	*190,881*	*24,963*	*103,103*	*22,583*	*106,209*	*23,116*	*15,385*	..	*486,240*
Construction material quarrying(d)	31,935	22,419	4,336	12,011	4,058	2,082	1,031	834	78,708
Total all mining and quarrying	**222,817**	**47,382**	**107,440**	**34,595**	**110,267**	**25,197**	**16,416**	**834**	**564,947**

(a) Local value (i.e. value of output at mine or quarry) *less* cost of power, fuel, light and other materials and stores used; depreciation and maintenance costs have not been deducted. (b) Not available for publication, included in total for Australia. (c) Includes other fuel mining. (d) Incomplete. *See* Coverage, page 1009.

MINING AND QUARRYING: NET VALUE OF PRODUCTION(a) STATES AND TERRITORIES, 1963 TO 1967

Year	*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T. and A.C.T.*	*Aust.*
NET VALUE OF PRODUCTION ($'000)								
1963	149,710	33,652	61,948	29,614	30,698	14,466	5,530	325,618
1964	195,980	37,056	74,406	34,068	32,162	18,174	5,998	397,846
1965	225,771	39,958	79,742	33,979	35,192	20,309	6,378	441,330
1966	215,902	43,438	115,370	36,250	63,097	25,828	11,842	511,728
1967	222,817	47,382	107,440	34,595	110,267	25,197	17,250	564,947
NET VALUE OF PRODUCTION PER HEAD OF POPULATION ($)								
1963	36.70	10.95	38.84	28.94	38.43	39.88	43.55	29.44
1964	47.31	11.82	45.73	32.38	39.36	49.61	43.72	35.27
1965	53.63	12.51	48.04	31.41	42.03	54.95	43.08	38.37
1966	50.76	13.37	68.34	32.84	73.19	69.07	74.95	43.70
1967	51.26	14.35	62.54	30.94	123.54	66.43	102.08	47.37

(a) Local value (i.e. value of output at mine or quarry), *less* cost of power, fuel, light, and other materials and stores used; depreciation and maintenance costs have not been deducted.

Quantities of principal minerals produced

In the preparation of Australian mineral commodity production statistics the quantities and values of individual minerals produced are recorded in terms of the form in which they are dispatched from the locality of each mine. For example, in the case of metalliferous mines, the output is recorded as ore if no treatment is undertaken at the mine, or as a 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 contents of metallic minerals and contents or average grade of selected non-metallic minerals are recorded. Whenever practicable, contents (based on assay) of metallic minerals are shown for each metal which is a 'pay metal' or a 'refiners' prize' when present in the particular mineral. In general, other metallic contents which are not recovered are excluded. Individual mineral products are arranged in four groups corresponding to the major groups of the industry, namely metal mining, fuel mining, non-metal mining (excluding fuels), and construction material quarrying, referred to on page 1010. Particulars relating to uranium bearing minerals are excluded.

The following tables show particulars of the quantity of the principal minerals produced during 1967 and earlier years.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1967

Mineral		*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T.*	*Aust.*
METALLIC MINERALS									
Antimony concentrate	tons	152	..	..	..	..	..	..	152
Bauxite	'000 tons	11	2	2,810	..	1,354	..	..	4,176
Beryllium ore	tons	44	..	..	..	11	..	..	55
Chromite	,,	..	138	..	..	..	..	..	138
Copper ore(*a*)	,,	525	72	19,141	1,447	776	8,422	1,070	31,453
Copper concentrate	,,	35,731	2	262,673	..	3,093	55,600	34,855	391,954
Copper precipitate	,,	173	..	20	..	..	90	442	725
Gold(*b*)	oz	186	11,749	48,477	1	877,221	160	59,999	997,793
Ilmenite concentrate	tons	11,356	..	2,946	..	529,914	..	..	544,216
Iron ore(*c*)	'000 tons	..	..	..	4,561	12,012	..	314	16,887
Lead ore(*d*)	tons	8,979	..	9,245	..	..	..	..	18,224
Lead concentrate	,,	364,124	..	156,078	..	910	13,766	2,315	537,193
Lead-copper concentrate	,,	..	..	..	..	..	12,227	..	12,227
Lead-zinc concentrate	,,	14,685	..	..	..	..	..	..	14,685
Leucoxene concentrate	,,	..	..	..	..	696	..	..	696
Manganese ore	,,	29	..	..	..	195,065	..	364,873	559,967
Monazite concentrate	,,	494	..	247	..	1,570	..	..	2,313
Pyrite concentrate	,,	..	..	11,740	102,609	78,685	59,714	..	252,748
Rutile concentrate	,,	184,390	..	80,724	..	400	..	..	265,514
Tantalite-columbite concentrate	lb	..	..	..	..	79,587	..	..	79,587
Tin concentrate	tons	2,669	47	2,323	..	1,074	2,349	95	8,557
Tungsten concentrates—									
Scheelite concentrate	,,	1	..	..	..	1	1,200	..	1,202
Wolfram concentrate	,,	5	..	3	..	1	435	4	448
Xenotime	,,	..	..	..	..	18	..	..	18
Zinc concentrate	,,	538,756	..	78,329	..	..	81,751	3,956	702,792
Zircon concentrate	,,	176,304	..	75,212	..	32,166	..	..	283,682
FUEL MINERALS									
Coal, black—									
Semi-anthracite	'000 tons	..	..	37	..	..	2	..	38
Bituminous	,,	26,813	32	4,379	..	..	75	..	31,299
Sub-bituminous	,,	..	..	264	2,045	1,062	..	..	3,370
Total coal, black	,,	*26,813*	*32*	*4,679*	*2,045*	*1,062*	*77*	..	*34,707*
Coal, brown (lignite)	,,	..	23,384	..	..	..	..	..	23,384
Natural gas	'000 cu ft	..	..	126,785	..	25,575	..	..	152,360
Crude oil	'000 barrels	..	..	2,781	..	4,819	..	..	7,600

For footnotes *see* next page.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED STATES AND NORTHERN TERRITORY, 1967—*continued*

Mineral		*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T.*	*Aust.*
NON-METALLIC (EXCLUDING FUEL) MINERALS									
Asbestos	short tons	515	..	..	..	85	..	..	600
Barite	tons	1,600	..	..	13,104	962	..	..	15,666
Clays—									
Brick clay and shale	'000 tons	2,546	1,616	451	419	510	155	..	5,696
Other(*e*)	,,	419,798	226,971	76,148	93,655	104,205	40,318	..	961,095
Diatomite	tons	2,183	5,190	(*f*)	..	(*f*)	..	..	11,103
Dolomite(*g*)	,,	8,237	..	(*f*)	270,935	..	(*f*)	..	290,659
Felspar	,,	2,510	..	..	1,598	342	..	..	4,450
Gypsum	,,	42,504	224,065	..	607,437	40,078	..	..	914,084
Limestone(*g*)	'000 tons	2,706	1,992	1,022	1,591	699	345	..	8,355
Magnesite	tons	22,207	..	..	188	1,258	..	..	23,653
Phosphate rock	,,	..	..	..	11,770	..	..	..	11,770
Salt, crude	,,	..	(*f*)	(*f*)	516,166	(*f*)	..	..	703,157
Silica (glass, chemical, etc.)(*e*)	,,	289,175	..	64,992	34,594	41,778	13,016	..	443,555
Talc	,,	2,690	..	..	7,188	7,901	..	..	17,779
CONSTRUCTION MATERIALS(*e*)									
Sand	'000 tons	4,525	4,210	n.a.	1,756	n.a.	231	(*i*)1,193	(*h*)11,149
River gravel	,,	2,293	3,624	n.a.	921	n.a.	1,445		(*h*)9,048
Dimension stone	,,	44	10	2	47	127	3		286
Crushed and broken stone	,,	8,454	18,012	4,686	10,540	3,058	1,158	(*i*)566	46,268
Other (decomposed rock, etc)	,,	21,732	2,519	542	n.a.	n.a.	256		(*h*)25,202

(*a*) Includes cupreous ore for fertiliser. (*b*) Bullion, alluvial, retorted gold, etc. (*c*) Iron oxide for metal extraction. (*d*) Includes lead-silver-zinc ore. (*e*) Incomplete, *see* Coverage, page 1009. (*f*) Not available for publication. (*g*) Excludes quantities used directly as building or road material. (*h*) Incomplete, *see* individual States. (*i*) Includes Australian Capital Territory which is not available for publication by individual items.

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

QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA 1963 TO 1967

Mineral		*1963*	*1964*	*1965*	*1966*	*1967*
METALLIC MINERALS						
Antimony ore and concentrate	tons	115	414	55	150	152
Bauxite	'000 tons	354	784	1,168	1,798	4,176
Beryllium ore	tons	110	111	38	52	55
Chromite	,,	160	72	23	..	138
Copper ore(*a*)	,,	82,035	59,686	41,325	53,463	31,453
Copper concentrate	,,	434,368	427,258	389,398	477,987	391,954
Copper precipitate	,,	504	264	299	723	725
Gold(*b*)	'000 oz	1,231	1,150	1,119	1,079	998
Ilmenite concentrate	tons	200,983	303,628	441,034	513,011	544,216
Iron ore(*c*)	'000 tons	5,515	5,669	6,695	10,893	16,887
Lead ore(*d*)	tons	16,249	25,174	24,906	19,221	18,224
Lead concentrate	,,	584,462	536,213	503,356	515,573	537,193
Lead-copper concentrate	,,	9,309	10,214	10,424	12,083	12,227
Lead-zinc concentrate	,,	..	..	..	14,254	14,685
Leucoxene concentrate	,,	547	656	380	756	696
Manganese ore	,,	36,061	61,109	100,369	312,540	559,967
Monazite concentrate	,,	1,992	1,981	2,305	1,984	2,313
Pyrite concentrate	,,	194,059	220,078	204,011	245,998	252,748
Rutile concentrate	,,	183,260	182,371	217,330	243,858	265,514
Tantalite-columbite concentrate	lb	30,889	33,600	25,581	10,550	79,587
Tin concentrate	tons	4,132	5,314	6,237	7,604	8,557
Tungsten concentrates—						
Scheelite concentrate	,,	958	1,020	1,150	1,308	1,202
Wolfram concentrate	,,	394	380	487	498	448
Xenotime	..	..	..	..	..	18
Zinc concentrate	,,	594,861	588,840	604,211	638,788	702,792
Zircon concentrate	,,	184,830	184,082	226,863	235,649	283,682

For footnotes *see* next page.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA
1963 TO 1967—*continued*

Minerals		*1963*	*1964*	*1965*	*1966*	*1967*
FUEL MINERALS						
Coal, black—						
Semi-anthracite	'000 tons	61	79	70	45	38
Bituminous	,,	22,268	24,477	28,228	30,045	31,299
Sub-bituminous	,,	2,528	2,845	3,140	3,243	3,370
Total coal, black	,,	*24,856*	*27,401*	*31,439*	*33,334*	*34,707*
Coal, brown (lignite)	,,	18,456	19,035	20,659	21,783	23,384
Natural gas	'000 cu ft	95,725	106,490	143,402	143,478	152,360
Natural gas condensate	barrels	123	245	122	121	..
Crude oil	'000 barrels	..	1,244	2,622	3,390	7,600
NON-METALLIC (EXCLUDING FUEL) MINERALS						
Asbestos	short tons	13,374	13,654	11,566	13,468	600
Barite	tons	8,220	12,302	11,976	13,724	15,666
Clays—						
Brick clay and shale	'000 tons	4,549	5,163	5,056	5,187	5,696
Other (*e*)	,,	984	1,039	1,007	1,052	961
Diatomite	tons	5,133	8,732	7,063	7,592	11,103
Dolomite(*f*)	,,	214,339	236,068	258,661	256,008	290,659
Felspar	,,	8,842	9,021	8,726	7,259	4,450
Gypsum	,,	725,444	795,003	833,521	801,552	914,084
Limestone(*f*)	'000 tons	6,721	7,223	7,516	7,730	8,355
Magnesite	tons	56,946	31,250	26,362	19,556	23,653
Phosphate rock	,,	4,925	5,689	4,519	5,715	11,770
Salt, crude	,,	581,537	545,491	654,533	644,817	703,157
Silica (glass, chemical, etc.)(*e*)	,,	247,928	322,269	320,937	347,123	443,555
Talc	,,	13,106	15,695	19,719	17,327	17,779
CONSTRUCTION MATERIALS(*e*)						
Sand	'000 tons	9,050	10,757	11,444	10,666	11,149
River gravel	,,	7,625	8,117	7,760	8,549	9,048
Dimension stone	,,	629	590	467	241	286
Crushed and broken stone	,,	29,768	34,175	39,733	46,796	46,268
Other (decomposed rock, etc.)	,,	20,830	23,460	21,363	22,216	25,202

(*a*) Includes cupreous ore for fertiliser. (*b*) Bullion, alluvial, retorted gold, etc. (*c*) Iron oxide for metal extraction (*d*) Includes lead-silver-zinc ore. (*e*) Incomplete, owing to difficulties of coverage. *See* Coverage, page 1009. (*f*) Excludes quantities used directly as building or road material.

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

Contents of metallic minerals produced

The following tables show the contents of metallic minerals produced in 1967 and earlier years.

CONTENTS OF METALLIC MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1967

Content of metallic minerals produced		*N.S.W.*	*Vic.*	*Qld*	*S.A.*	*W.A.*	*Tas.*	*N.T.*	*Aust.*
Alumina (Al_2O_3)	'000 tons	4	1	1,644	..	609	..	..	2,258
Antimony	„	930	..	..	..	..	..	..	930
Beryllium oxide (BeO)	units(*a*)	550	..	..	..	125	..	..	675
Bismuth	lb	..	..	..	..	..	..	25,536	25,536
Cadmium	tons	1,079	..	160	..	..	73	12	1,324
Chromic oxide (Cr_2O_3)	„	..	44	..	..	..	..	..	44
Cobalt	„	100	..	..	..	45	..	1	146
Copper	„	11,393	5	51,457	85	1,027	17,468	8,926	90,361
Gold	fine oz	10,716	10,996	95,601	1	573,755	37,528	76,739	805,336
Iron(*b*)	'000 tons	..	..	..	2,906	7,725	..	201	10,831
Lead	tons	282,173	..	76,439	..	688	15,134	1,345	375,779
Manganese(*c*)	„	6,092	..	..	..	89,024	243	169,301	264,660
Manganese dioxide (MnO_2)(*d*)	„	21	..	..	..	..	..	207	228
Monazite	„	434	..	237	..	1,492	..	..	2,163
Silver	'000 fine oz	10,714	..	6,832	..	224	1,798	274	19,842
Sulphur(*e*)	tons	223,338	..	30,851	42,275	34,359	61,548	..	392,371
Tantalite-columbite ($Ta_2O_5 + Nb_2O_5$)	lb	..	..	..	..	32,906	..	..	32,906
Tin	tons	1,569	33	1,649	..	747	1,528	60	5,586
Titanium dioxide (TiO_2)	„	182,122	..	78,880	..	291,892	..	..	552,894
Tungstic oxide (WO_3)	units(*a*)	349	..	195	..	143	118,253	270	119,210
Xenotime	lb	..	..	..	..	9,475	..	..	9,475
Zinc	tons	298,672	..	51,034	34	..	48,850	1,937	400,527
Zircon	„	174,502	..	74,460	..	31,362	..	..	280,324

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

NOTE. Particulars of production of uranium oxide (U_3O_8) are not available for publication.

CONTENTS OF METALLIC MINERALS PRODUCED: AUSTRALIA, 1963 TO 1967

Content of metallic minerals produced		*1963*	*1964*	*1965*	*1966*	*1967*
Alumina (Al_2O_3)	'000 tons	154	396	613	939	2,258
Antimony	„	1,007	1,116	944	971	930
Beryllium oxide (BeO)	units(*a*)	1,278	1,279	457	637	675
Bismuth	lb	..	..	..	717	25,536
Cadmium	tons	1,210	1,154	1,155	1,212	1,324
Chromic oxide (Cr_2O_3)	„	72	32	10	..	44
Cobalt	„	86	73	90	84	146
Copper	„	112,967	104,050	90,388	109,537	90,361
Gold	fine oz	1,023,970	963,834	877,643	916,985	805,336
Iron(*b*)	'000 tons	3,558	3,655	4,297	6,956	10,831
Lead	tons	410,291	374,856	362,137	364,898	375,779
Manganese(*c*)	„	23,951	36,564	55,280	151,401	264,660
Manganese dioxide (MnO_2)(*d*)	„	1,228	1,033	1,652	4,091	228
Molybdenum disulphide (MoS_2)	lb	21,645	..	41,911	5,549	..
Monazite	tons	1,875	1,848	2,165	1,836	2,163
Platinum	oz	4	..	..	13	..
Silver	'000 fine oz	19,642	18,427	17,281	18,888	19,842
Sulphur(*e*)	tons	345,636	346,502	345,554	371,567	392,371
Tantalite-columbite ($Ta_2O_5 + Nb_2O_5$)	lb	12,935	12,499	10,281	5,698	32,906
Tin	tons	2,860	3,642	3,849	4,807	5,586
Titanium dioxide (TiO_2)	„	288,050	342,646	448,318	516,745	552,894
Tungstic oxide (WO_3)	units(*a*)	96,000	99,541	117,672	130,776	119,210
Xenotime	lb	..	..	..	..	9,475
Zinc	tons	351,470	344,600	349,231	369,341	400,527
Zircon	„	182,112	182,174	224,654	232,903	280,324

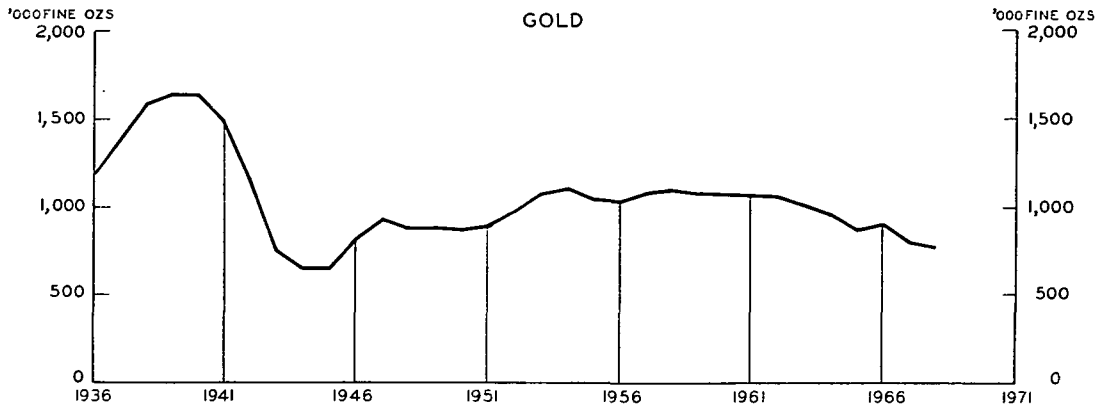
(*a*) 1 unit = 22.4 lb. (*b*) Iron oxide for metal extraction. (*c*) Content of metallurgical grade manganese ore and zinc concentrate. (*d*) Content of manganese ore of other than metallurgical grade. (*e*) Sulphur content of pyrite and other minerals from which sulphur is extracted.

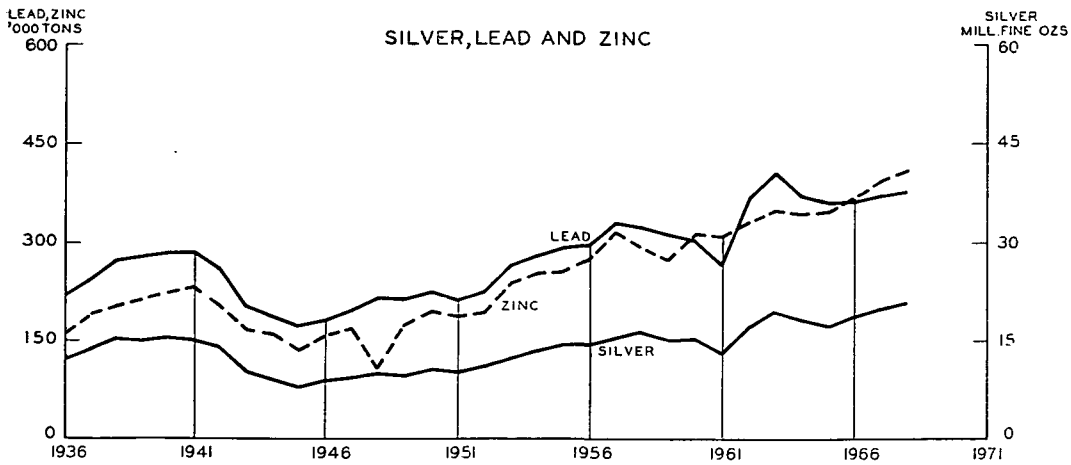
NOTE. Particulars of production of uranium oxide (U_3O_8) are not available for publication.

MINE PRODUCTION OF PRINCIPAL METALS: AUSTRALIA

(METALLIC CONTENT OF MINERALS)

1936 TO 1968





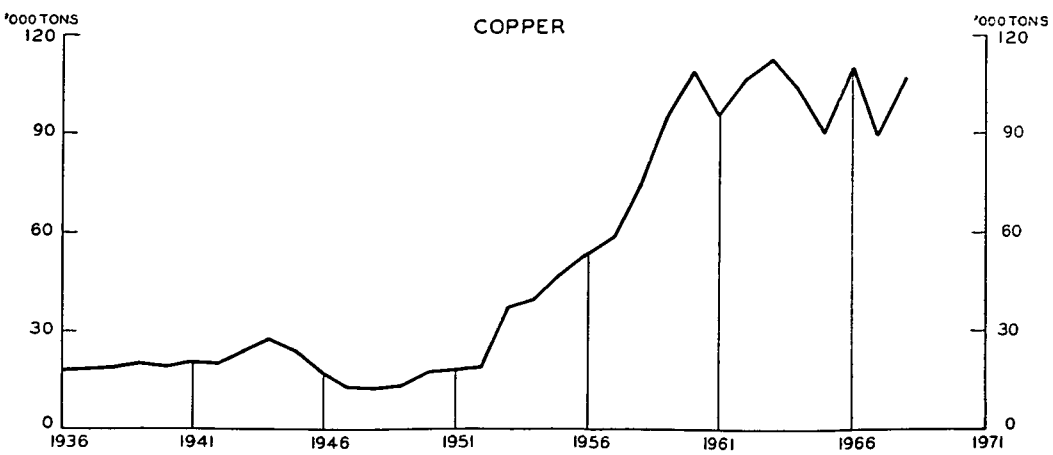


PLATE 50

MINE PRODUCTION OF PRINCIPAL METALS AND PRODUCTION OF COAL

(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1936 to 1968

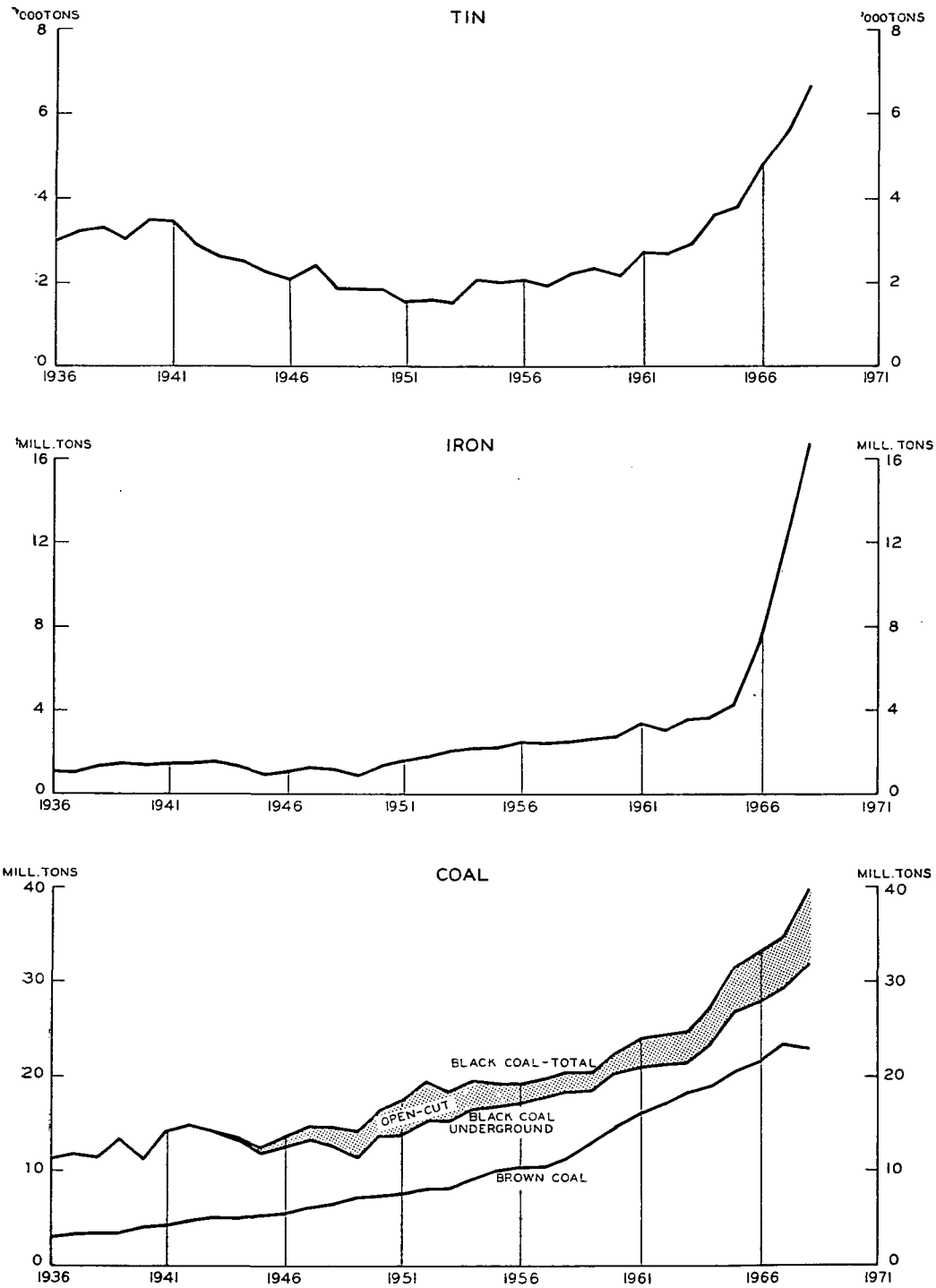


PLATE 51

Graphs showing details of the mine production of principal metals (metallic content) and coal from 1936 to 1968 are included on plates 50 and 51, pages 1021 and 1022.

Local value of minerals produced, 1963 to 1967

Particulars of the values of minerals (mine and quarry products) produced are shown in the following table. The values represent the selling value at the mine or quarry of minerals produced during the years concerned.

LOCAL VALUE OF MINERALS PRODUCED: AUSTRALIA, 1963 TO 1967
($'000)

Mineral	*1963*	*1964*	*1965*	*1966*	*1967*
Metallic minerals—					
Bauxite	1,748	3,064	4,600	(a)	(a)
Copper ore, concentrate, etc.	52,036	51,380	50,790	87,523	72,515
Gold ore, concentrate, other forms, etc.	29,556	26,666	25,619	26,371	24,456
Ilmenite concentrate	1,554	2,208	3,755	4,242	4,390
Iron ore	12,200	12,550	14,640	41,728	82,994
Lead and lead-silver ore and concentrate, lead-copper concentrate, etc.	56,320	80,806	87,947	76,831	73,654
Manganese ore	492	750	808	3,462	8,007
Pyrite concentrate	2,354	3,054	3,040	(a)	(a)
Rutile concentrate	12,114	12,080	15,038	17,088	19,615
Tin concentrate	5,784	10,224	12,237	14,332	15,011
Tungsten concentrates	900	1,420	2,692	4,469	4,509
Zinc ore and concentrate	16,468	35,456	36,818	32,890	29,354
Zircon concentrate	3,550	3,462	6,136	8,255	10,937
Other metallic minerals	432	522	548	610	4,023
Total, metallic minerals	*195,508*	*243,642*	*264,668*	*327,633*	*370,892*
Fuel minerals—					
Coal, black	118,260	128,038	143,703	151,380	160,099
Coal, brown	16,156	17,304	18,436	20,064	20,686
Other fuel minerals	(b)	2,164	5,344	9,229	21,286
Total, fuel minerals	*134,416*	*147,506*	*167,483*	*180,675*	*202,071*
Total, non-metallic minerals(c)	26,038	27,814	29,244	31,921	31,946
Total, construction materials(c)	60,720	73,244	80,183	83,449	91,789
Total, all minerals and construction materials	**416,682**	**492,208**	**541,578**	**623,678**	**696,701**

(a) Not available for publication. (b) Included with black coal. (c) Incomplete owing to difficulties of coverage. *See* scope and sources of statistics, page 1009.

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

Owing to the necessity of classifying individual mines according to the principal mineral produced, the values in the table on page 1015 for mining industry groups differ slightly in some cases from totals of the corresponding groups of mine products shown in the table above.

Overseas participation in Australian mining industry

Introduction

Any attempt to provide statistical information on the extent of overseas participation in local industry involves difficult problems of statistical concept and measurement. Broadly, there are two ways in which overseas participation may be measured. One is to examine the financial accounts of Australian companies and compare the value of *assets* of companies in which there is significant overseas investment with those other Australian companies. The other is to examine the *operations* (as expressed in terms of production, wages and salaries, output etc.) of establishments of Australian

companies in which there is significant overseas investment and compare their operations with those of establishments of other Australian companies. The second method has been adopted for a series of studies in overseas participation in the Australian mining industry.

Scope of the statistics

The statistics relate to the operations of establishments employing four or more persons in the mining and quarrying industry as defined for the annual mining and quarrying census except for establishments engaged in construction material quarrying and clay mining, which are excluded.

Classification of companies

The extent of overseas participation in the mining industry is measured by the operations of the establishments of companies in which there is direct investment from overseas (as determined by the annual survey of overseas investments). These are defined as follows.

(i) Companies in Australia in which at least 50 per cent of the ordinary shares (or voting stock) is held by individual shareholders or companies resident in one overseas country, or where 25 per cent or more of the ordinary shares (or voting stock) is held by one company, or a group of companies, incorporated in one overseas country.

(ii) Branches of companies incorporated overseas and registered in Australia as foreign companies.

(iii) Wholly and partly owned subsidiaries and sub-subsidiaries, etc., of companies included in (i) and (ii) above, provided that the proportion of their equity which is attributable to overseas ownership does not fall below the percentage limits specified in (i) above.

Investment in ordinary shares (or voting stock) of Australian companies (including companies in which there is direct investment from overseas) where the proportion of shares held in a single country falls below the percentages specified in (i) above is defined as portfolio investment. Because of the difficulties encountered in determining the proportion of ordinary shares (or voting stock) of individual Australian companies held by portfolio investors overseas, *the figures for overseas participation in the mining industry exclude participation by way of portfolio investment.*

Further information available

In the following tables the degree of overseas participation is expressed in terms of value of production only. Further details in terms of the value of power, fuel and materials used, value of output, value of additions and replacements to fixed assets, salaries and wages paid, and average number of persons employed, as well as the value of production, may be found in the mimeographed bulletin *Overseas Participation in Australian Mining Industry, 1967.*

OVERSEAS OWNERSHIP AND CONTROL

In analysing the extent of overseas participation in local industry it is usual to distinguish between two aspects, overseas ownership and overseas control.

Overseas ownership

Statistics which give a general indication of the degree of overseas ownership in terms of the value of production of Australian mining establishments are presented in the two following tables. In the compilation of these statistics the data for an establishment of a company in which there is no direct investment from overseas are allocated wholly to Australian ownership. The data relating to an establishment of a company in which there is direct investment from overseas are apportioned to overseas and Australian ownership according to the proportion of the ordinary shares (or voting stock) of the company that is held by the direct overseas investors.

However, an exception has been made to the strict application of the definition of direct overseas investment in the measurement of overseas ownership of the Australian mining industry. This exception is designed to take account of a small number of important cases of portfolio investment where overseas companies participated in a consortium of companies which made the initial decision to develop a major mining project. The participation of these companies in the initial decision for the development of the mining project implies a kind of participation different from that normally associated with portfolio investment and more akin to direct investment. Special arrangements have been made therefore, to include in the measurement of overseas ownership, investment by overseas companies whose participation is represented by 10 per cent or more of the ordinary shares of such projects. This participation is not taken into account in statistics of overseas control. This change has had a minor effect on statistics of overseas ownership of the Australian mining industry for 1966 and earlier years.

MINING(*a*): VALUE OF PRODUCTION APPORTIONED TO AUSTRALIAN AND DIRECT OVERSEAS OWNERSHIP, BY INDUSTRY, 1965 TO 1967

Industry and ownership	*Value ($'000)*			*Proportion Australian and overseas (per cent)*		
	1965	*1966*	*1967*	*1965*	*1966*	*1967*
Metal mining—						
Australian(*b*)	120,179	144,588	149,095	56.4	53.7	50.0
Overseas	92,876	124,622	149,013	43.6	46.3	50.0
Fuel mining—						
Australian(*b*)	106,594	109,844	118,253	79.8	76.9	74.4
Overseas	27,007	32,918	40,593	20.2	23.1	25.6
Non-metal (excluding fuel) mining—						
Australian(*b*)	10,015	10,830	10,870	82.8	81.1	80.4
Overseas	2,082	2,521	2,658	17.2	18.9	19.6
Total mining—						
Australian(*b*)	**236,789**	**265,262**	**278,218**	**66.0**	**62.4**	**59.1**
Overseas	**121,965**	**160,061**	**192,264**	**34.0**	**37.6**	**40.9**
Grand total	**358,754**	**425,323**	**470,483**	**100.0**	**100.0**	**100.0**

(*a*) Excludes construction material quarrying and clay mining. (*b*) Includes ownership by overseas portfolio investors.

MINING(*a*): VALUE OF PRODUCTION APPORTIONED TO DIRECT OVERSEAS OWNERSHIP(*b*), BY COUNTRY AND BY PROPORTION OF DIRECT OVERSEAS EQUITY, 1965 TO 1967

Country, and proportion of direct overseas equity	*Value ($'000)*			*Proportion(c) (per cent)*		
	1965	*1966*	*1967*	*1965*	*1966*	*1967*
Country—						
United Kingdom	74,777	79,891	90,095	20.8	18.7	19.2
United States of America	33,294	64,613	87,256	9.3	15.2	18.5
Other	13,894	15,557	14,913	3.9	3.7	3.2
Proportion of direct overseas equity—						
25 per cent but less than 50 per cent	2,987	3,094	7,527	0.8	0.7	1.6
50 per cent but less than 75 per cent	32,359	47,901	37,642	9.0	11.3	8.0
75 per cent and over	86,619	109,066	147,095	24.2	25.6	31.3
Total apportioned to direct overseas ownership	**121,965**	**160,061**	**192,264**	**34.0**	**37.6**	**40.9**

(*a*) Excludes construction material quarrying and clay mining. (*b*) Excludes ownership by overseas portfolio investors. (*c*) Of total value of mining production.

Overseas control

The statistics in the following tables provide an indication of the relative importance of mining establishments of companies in which there is direct overseas investment. The concept of direct overseas investment is directly related to the concept of overseas control, and the statistics in these tables provide a measure of the value of production of mining establishments of companies which can be regarded as subject to a degree of overseas control. The statistics have been derived by allocating data relating to each mining establishment wholly to either one or the other of the following categories: (i) establishments of direct overseas investment companies; (ii) other establishments.

The classification of establishments of companies in which 50 per cent of the voting stock is held in one overseas country (or 25 per cent by one overseas company) as subject to a degree of overseas control is, of course, based on a statistical convention. Such a convention is needed because of the lack of specific information as to the arrangements for managerial control of individual companies.

The convention adopted for this study (including the actual percentages used) is the one suggested by the International Monetary Fund for use in the absence of other information. There are avenues of control other than through direct equity interest, e.g. through franchise or patent rights, marketing arrangements, financial commitments, etc. Such arrangements, of course, also typically exist between companies in which there is direct investment and their overseas parent companies and associated companies. Further, ownership of less than 25 per cent of voting stock may, in some cases, be sufficient to achieve effective control of a company's activities, just as in other cases ownership of more than 25 per cent of voting stock may not constitute control. In addition, the relationship between overseas parent companies and their Australian branches and subsidiaries covered by the statistics in the following tables can be one of *potential* rather than *actual* control.

A special problem does exist, however, in the strict application of the definition of direct overseas investment described above to the measurement of overseas control. This occurs where a single overseas company has an equity interest in an Australian company which is 25 per cent or more but less than 50 per cent. In such cases, a single Australian company may have an equity interest which is greater than the equity interest of the direct overseas investment company. To overcome this problem, an examination has been made of all companies engaged in mining in which the direct overseas equity is 25 per cent or more but less than 50 per cent. Where an Australian company holds a greater proportion of the equity than the direct overseas investment company the company is not regarded as subject to a degree of overseas control and is classified to 'other establishments'. However, this departure from the strict application of the definition of direct overseas investment to the measurement of overseas control does not affect the statistics for 1966 and earlier years.

MINING(*a*): VALUE OF PRODUCTION OF ESTABLISHMENTS OF DIRECT OVERSEAS INVESTMENT COMPANIES AND OTHER ESTABLISHMENTS, BY INDUSTRY 1965 TO 1967

	Value ($'000)			*Proportion (per cent)*		
Industry	*1965*	*1966*	*1967*	*1965*	*1966*	*1967*
Metal mining—						
Establishments of direct overseas investment companies	122,908	167,191	193,531	57.7	62.1	64.9
Other establishments	90,147	102,019	104,577	42.3	37.9	35.1
Fuel mining—						
Establishments of direct overseas investment companies	34,021	40,927	51,703	25.5	28.7	32.5
Other establishments	99,580	101,835	107,143	74.5	71.3	67.5
Non-metal (excluding fuel) mining—						
Establishments of direct overseas investment companies	3,036	3,669	3,862	25.1	27.5	28.5
Other establishments	9,061	9,681	9,667	74.9	72.5	71.5
Total mining—						
Establishments of direct overseas investment companies	**159,966**	**211,788**	**249,096**	**44.6**	**49.8**	**52.9**
Other establishments	**198,788**	**213,535**	**221,387**	**55.4**	**50.2**	**47.1**
Grand total	**358,754**	**425,323**	**470,483**	**100.0**	**100.0**	**100.0**

(*a*) Excludes construction material quarrying and clay mining.

MINING(*a*): VALUE OF PRODUCTION OF ESTABLISHMENTS OF DIRECT OVERSEAS INVESTMENT COMPANIES, BY PROPORTION OF DIRECT OVERSEAS EQUITY 1965 TO 1967

	Value ($'000)			*Proportion(b) (per cent)*		
Proportion of direct overseas equity	*1965*	*1966*	*1967*	*1965*	*1966*	*1967*
25 per cent but less than 50 per cent	7,704	7,948	17,492	2.2	1.9	3.7
50 „ „ „ „ „ 75 „ „	62,851	91,913	72,851	17.5	21.6	15.5
75 „ „ and over	89,412	111,927	158,753	24.9	26.3	33.7
Total establishments of direct overseas investment companies	**159,966**	**211,788**	**249,096**	**44.6**	**49.8**	**52.9**

(*a*) Excludes construction material quarrying and clay mining. (*b*) Of total value of production.

Mineral exploration (other than for petroleum)

Definition

Mineral exploration 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 census of mining and quarrying.

Sources of statistics

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

Scope of mineral exploration collection

The scope of the mineral exploration collection is limited to private exploration on leases held for production and exploration purposes, and all government exploration. General exploration survey work and other exploration activity not connected with particular leases are excluded.

Leaseholders were instructed to report details of total exploration activity on areas held by them including exploration carried out on these areas by other companies or persons under joint venture agreements, options to purchase, etc. However, it appears that some leaseholders may not have reported details of exploration carried out by others under option.

The scope of the collection is divided into the following three sections.

(*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 government authorities. Mines included in this section of the mineral exploration collection are practically the same as those in the annual census of mining and quarrying (*see* Statistical Bulletin *Mining and Quarrying*, No. 16, 1967 for further details) with the exception of a limited number of itinerant prospectors and small mines for which information was not collected.

(*b*) *Private exploration in other areas*—relates to exploration carried out 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. Other commercial exploration, such as that carried out under option to purchase agreements, is excluded.

(*c*) *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.

Summary of operations

The following table shows the amounts expended, the man-weeks worked, and the footage drilled, etc. in mineral exploration other than for petroleum during the years 1965 to 1967.

MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)
SUMMARY OF OPERATIONS, AUSTRALIA, 1965 TO 1967

	1965	*1966*	*1967*
EXPLORATION EXPENDITURE(*a*)			
	$'000	$'000	$'000
On drilling	10,511	13,994	15,490
Other	15,071	17,693	23,903
Total	**25,582**	**31,687**	**39,393**
Payments to contractors(*b*)	6,372	8,380	12,181
MAN-WEEKS WORKED(*c*)			
	'000	'000	'000
By professional persons(*d*)	39.7	44.0	46.7
By non-professional persons(*e*)	68.0	90.3	96.0
Total	**107.7**	**134.3**	**142.7**
FOOTAGE DRILLED, SUNK, OR DRIVEN			
Drilling—	'000 feet	'000 feet	'000 feet
Core	1,139	1,645	1,727
Non-core	1,400	2,375	3,138
Total	**2,539**	**4,020**	**4,866**
Other(*f*)	68	59	30

(*a*) Expenditure whether charged as working expenses or capitalised. (*b*) Amounts paid to drilling contractors, geological consultants, technical advisers, etc., for exploration services. Included in total expenditure shown. (*c*) Operator and staff only (includes time spent on report writing and similar off-site activities associated with exploration); excludes contractors and their employees. (*d*) Geologists, geophysicists, engineers, etc., engaged on exploration work. (*e*) Drill operators, field hands, etc. (*f*) Includes shafts, winzes, etc., sunk, and drives, adits, etc., driven.

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 1965 to 1967.

MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)
STATES AND NORTHERN TERRITORY, 1965 TO 1967

EXPENDITURE(*a*)
($'000)

	1965	*1966*	*1967*
PRIVATE EXPLORATION			
New South Wales	4,460	4,872	4,594
Victoria	1,006	1,231	1,452
Queensland	4,372	8,340	11,657
South Australia	1,048	1,358	1,203
Western Australia	3,948	6,534	10,203
Tasmania	5,136	2,870	2,180
Northern Territory	2,389	2,909	3,532
Total	*22,360*	*28,115*	*34,822*
GOVERNMENT EXPLORATION			
Commonwealth(*b*)	1,525	1,923	2,803
State Mines Departments	1,697	1,649	1,768
Total	*3,223*	*3,572*	*4,571*
TOTAL EXPENDITURE			
Australia	**25,582**	**31,687**	**39,393**

EMPLOYMENT(*c*)
('000 man-weeks worked)

	1965	*1966*	*1967*
PRIVATE EXPLORATION			
New South Wales	17.0	19.2	22.5
Victoria	6.7	8.3	5.6
Queensland	26.0	35.6	27.2
South Australia	3.2	3.2	3.6
Western Australia	13.2	23.2	37.6
Tasmania	7.6	9.9	7.4
Northern Territory	10.0	8.8	8.8
Total	*83.6*	*108.2*	*112.6*
GOVERNMENT EXPLORATION			
Commonwealth(*b*)	8.3	11.1	14.2
State Mines Departments	15.8	15.0	15.9
Total	*24.1*	*26.1*	*30.1*
TOTAL			
Australia	**107.7**	**134.3**	**142.7**

For footnotes *see* next page.

FOOTAGE DRILLED, SUNK OR DRIVEN
('000 ft)

	1965	1966	1967
PRIVATE EXPLORATION			
New South Wales	767	946	908
Victoria	172	179	182
Queensland	600	1,515	2,029
South Australia	123	183	161
Western Australia	343	640	907
Tasmania	188	169	152
Northern Territory	221	248	259
Total	*2,413*	*3,880*	*4,598*
GOVERNMENT EXPLORATION			
Commonwealth(*b*)	8	6	6
State Mines Departments	186	194	290
Total	*194*	*200*	*296*
TOTAL FOOTAGE DRILLED, SUNK OR DRIVEN			
Australia	**2,607**	**4,080**	**4,896**

(*a*) Expenditure whether charged as working expenses or capitalised. (*b*) Bureau of Mineral Resources and Joint Coal Board. (*c*) Operator and staff only (includes time spent on report writing and similar off-site activities associated with exploration); excludes contractors and their employees.

Petroleum exploration

Definition

Petroleum exploration and development consists of the search for, and or development of, deposits of crude petroleum and or gas by geological, geophysical, geochemical, and other means, including drilling. Included in the expenditures are the costs of drilling both exploratory and developmental oil and or gas wells and the testing and completion (up to and including the wellhead fittings and valves to control flow—christmas tree—or pumping wells) of these 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, all of which are undertaken primarily for purposes of exploration for, and or development of, deposits of petroleum or natural gas. Details of expenditure on production facilities, and pipelines and production costs, etc. are excluded.

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), *The Australian Mineral Industry—Annual Review* and *Expenditures on Petroleum Exploration and Development*, 1965 (B.M.R. Record No. 1966 (205)).

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, 1963 TO 1967(a)

($'000)

	1963	1964	1965	1966	1967
PRIVATE SOURCES(a)					
Utilised in—					
New South Wales	3,726	1,956	3,640	1,706	1,284
Victoria	1,697	2,708	3,796	7,007	17,793
Queensland	12,256	13,620	17,292	14,213	6,096
South Australia	3,663	3,592	4,705	4,059	6,257
Western Australia	4,686	9,671	16,095	17,619	18,090
Tasmania	388	85	829	1,293	2,424
Northern Territory	1,787	3,415	6,759	6,578	6,978
Australia	*28,202*	*35,048*	*53,115*	*52,475*	*58,921*
GOVERNMENT SOURCES					
Payments under *Petroleum Search Subsidy Act* 1959–1964—					
Utilised in—					
New South Wales	1,147	573	633	724	516
Victoria	1,173	599	609	640	727
Queensland	5,123	4,105	3,818	2,194	1,767
South Australia	806	1,084	949	769	1,058
Western Australia	1,552	1,887	2,487	3,355	3,441
Tasmania	40	..	107	570	469
Northern Territory	399	481	1,157	1,365	1,657
Total subsidy payments, Australia	*10,240*	*8,729*	*9,759*	*9,617*	*9,635*
Utilised for—					
Geophysical	5,150	4,447	5,311	4,910	4,512
Drilling	5,090	4,282	4,448	4,707	5,123
Other Government sources—					
Commonwealth(a)	3,083	4,035	3,824	3,649	4,508
State Mines Departments	n.a.	809	711	767	466
Total other sources, Australia	*3,083*	*4,844*	*4,535*	*4,416*	*4,974*
Total Government sources, Australia	*13,323*	*13,573*	*14,294*	*14,033*	*14,609*
TOTAL FUNDS, PRIVATE AND GOVERNMENT					
Australia	**41,525**	**48,621**	**67,409**	**66,508**	**73,530**

(a) Excludes payments under the *Petroleum Search Subsidy Act* 1959–1964.

WELLS AND FOOTAGE DRILLED IN PETROLEUM EXPLORATION
STATES AND TERRITORIES, 1967

	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Total
Wells drilled(a)	9	10	40	15	194	5	1	274
Average total depth of wells drilled feet	4,020	7,371	5,460	7,115	5,444	2,516	..	5,573
Wells completed as potential oil producers	..	3	6	..	164	..	1	174
Wells completed as potential gas producers	..	1	6	4	2	..	..	13
Wells drilled or drilling over 10,000 feet	1	2	1	3	4	..	..	11
Footage drilled—								
Completed wells feet	21,882	74,553	202,696	104,993	561,324	11,881	8,750	986,079
Uncompleted holes(b) feet	11,140	6,768	12,330	7,930	7,714	..	7,980	53,862
Total footage drilled	*33,022*	*81,321*	*215,026*	*112,923*	*569,038*	*11,881*	*16,730*	*1,039,941*

(a) Number of holes which reached total depth during the year. (b) Uncompleted holes means wells suspended or drilling at 31 December 1967.

WELLS AND FOOTAGE DRILLED IN PETROLEUM EXPLORATION
STATES AND TERRITORIES TO 31 DECEMBER 1967

	To 31 December 1965		1966		1967		To 31 December 1967	
State or Territory	*Wells*	*Footage*	*Wells*	*Footage*	*Wells*	*Footage*	*Wells*	*Footage*
New South Wales	94	324,507	5	42,269	9	33,022	108	399,798
Victoria	175	444,718	6	31,265	10	81,321	191	557,304
Queensland	516	2,481,095	65	375,271	40	215,026	621	3,071,392
South Australia	128	341,814	13	66,925	15	112,923	156	521,662
Western Australia	158	718,763	37	200,129	194	569,038	389	1,487,930
Tasmania	22	21,717	1	6,607	5	11,881	28	40,205
Northern Territory	30	140,187	7	33,356	1	16,730	38	190,273
Total	..	..	*134*	*755,822*	*274*	*1,039,941*	..	..
Cumulative total	**1,123**	**4,472,801**	**1,257**	**5,228,623**	**1,531**	**6,268,564**	**1,531**	**6,268,564**

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 the chapter Manufacturing Industry, pages 1044–68 and 1077–82.

Principal products

The following table shows particulars of the production of certain important manufactured products of mineral origin during the years 1963–64 to 1967–68. Secondary metal is excluded from the metal production statistics except in the case of ingot steel. For blister copper and lead bullion the figures shown relate to the copper and lead content respectively.

PRODUCTION OF PRINCIPAL MANUFACTURED PRODUCTS OF MINERAL ORIGIN: AUSTRALIA, 1963-64 TO 1967-68

Commodity		*1963–64*	*1964–65*	*1965–66*	*1966–67*	*1967–68*
METALS						
Non-ferrous—						
Alumina	tons	94,448	175,398	227,077	474,716	1,136,208
Refined aluminium	,,	58,937	85,497	87,222	92,826	87,737
Blister copper(*a*)	,,	92,809	57,880	98,529	77,888	74,967
Refined copper	,,	89,222	53,441	91,588	74,313	71,952
Lead bullion (for export)(*a*)	,,	78,304	63,827	81,709	84,690	101,695
Refined lead	,,	217,292	199,032	188,197	192,429	186,908
Refined zinc	,,	186,389	189,395	196,534	197,030	187,565
Refined tin	,,	2,959	2,931	3,524	3,224	3,955
Ferrous—						
Pig iron	'000 tons	3,772	3,936	4,380	4,893	5,209
Steel ingots	,,	4,773	5,131	5,561	6,057	6,298
Precious—						
Refined gold(*b*)	'000 f oz	911	871	774	726	655
Refined silver	,,	9,392	8,939	8,766	9,825	9,597
FUELS						
Coal products—						
Metallurgical coke	'000 tons	2,915	3,118	3,179	3,365	3,678
Brown coal briquettes	,,	1,883	1,893	1,883	1,820	1,745
Petroleum products—						
Motor spirit	mill. gal	1,358	1,482	1,524	1,763	1,897
Furnace fuel	'000 tons	4,686	4,869	5,340	5,759	6,206
Automotive distillate	,,	1,616	1,603	1,829	2,167	2,344
Industrial diesel fuel	,,	917	862	859	901	984
BUILDING MATERIALS						
Clay bricks	millions	1,238	1,353	1,360	1,358	1,404
Portland cement	'000 tons	3,320	3,746	3,688	3,661	3,805
Plaster of paris	,,	260	277	266	261	278
Plaster sheets	'000 sq yd	(*c*)15,922	29,937	29,917	30,601	32,809
CHEMICALS						
Sulphuric acid	'000 tons	1,447	1,610	1,752	1,991	1,892
Caustic soda	tons	64,230	68,879	75,229	91,009	98,190
Superphosphate	'000 tons	3,347	3,703	4,265	4,430	3,934

(*a*) Metallic content. (*b*) Newly-won gold of Australian origin. (*c*) Fibrous plaster sheets only.

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 1965 to 1967 are shown in the following table.

EXPORTS AND IMPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS AUSTRALIA, 1965 TO 1967

Item		Quantity			Value ($'000 f.o.b.)		
		1965	1966	1967	1965	1966	1967
EXPORTS(a)							
Coal	tons	7,155,564	8,240,920	9,250,297	60,661	66,487	76,203
Copper—							
Ore and concentrate	,,	46,111	47,455	44,830	7,337	9,603	9,526
Ingots, pigs (refined)	,,	11,703	7,484	9,325	12,220	9,050	8,975
Rolled, drawn and extruded shapes	,,	11,721	11,907	7,043	11,444	12,896	8,102
Gold, refined	fine oz	745,125	752,782	537,922	23,265	23,583	16,942
Iron and steel—							
Iron ore	tons	149,824	2,011,979	9,017,084	1,239	16,863	75,372
Pig iron	,,	45,154	95,590	149,587	2,174	3,870	6,169
Ingots, blooms and slabs	,,	10,519	347,841	398,635	605	19,806	23,719
Tinplate	,,	71,363	87,945	56,252	9,282	10,651	7,452
Scrap	,,	308,648	378,673	475,056	9,773	8,510	14,226
Lead—							
Ore and concentrate	,,	108,256	109,134	124,016	20,829	19,386	23,166
Lead-silver bullion	,,	69,286	79,534	100,394	21,252	21,905	26,901
Pig	,,	156,545	159,504	147,558	43,502	37,786	30,282
Opals	..	..	..	..	5,324	7,652	8,620
Petroleum oils—							
Gasolenes and solvents	'000 gal	16,478	39,734	55,593	2,199	4,842	6,582
Kerosenes	,,	15,147	23,686	21,655	1,796	2,535	2,553
Automotive distillate	,,	41,458			3,836		
Industrial and marine diesel fuels and heavy distillate, n.e.i.	,,	165,571	91,881	62,964	7,760	7,287	5,310
Residual oils	,,		117,694	123,441		5,954	5,851
Lubricating oil	,,	15,697	17,654	28,664	4,776	5,557	8,577
Rutile concentrate	tons	239,454	231,289	258,791	17,134	17,844	19,692
Zinc—							
Ore and concentrate	,,	212,946	226,561	297,927	14,328	15,442	19,873
Refinery type shapes	,,	87,051	120,759	96,471	24,205	31,069	23,562
Zircon concentrate	,,	216,661	210,428	247,179	6,816	8,978	10,720
IMPORTS							
Alumina	tons	55,647	51,091	37,047	3,900	3,365	2,543
Aluminium, refined ingots	,,	357	461	361	312	351	232
Asbestos	short tons	51,719	55,152	52,584	5,859	6,437	6,436
Gold, unrefined bullion(b)	fine oz	137,143	151,462	145,929	4,252	4,104	3,992
Ferro-alloys	tons	32,587	20,019	23,491	6,908	4,496	6,689
Petroleum oils—							
Crude	'000 gal	3,399,992	3,653,396	4,038,853	155,851	160,139	167,008
Enriched crude and other refinery feedstock	,,	899,284	962,162	999,338	40,391	41,783	43,976
Gasolenes and solvents	,,	270,503	190,718	141,888	30,749	20,936	13,949
Kerosene	,,	79,820	47,143	33,563	8,503	4,973	3,515
Automotive distillate	,,	45,474			4,153		
Industrial and marine diesel fuels and heavy distillate, n.e.i.	,,	25,817	43,084	18,370	1,584	3,505	1,578
Residual oils	,,		10,116	23,973		536	1,149
Lubricating oil	,,	20,646	13,009	11,363	5,602	3,864	3,565
Phosphate rock	'000 tons	2,527	3,286	3,265	17,505	27,479	30,355
Sulphur	tons	387,869	434,045	513,962	7,496	11,930	17,296
Tin, refined	,,	1,582	203	693	5,259	661	2,066
Titanium oxide (pigments)	,,	2,167	1,349	1,110	870	525	449

(a) Australian produce. (b) Gold content.

Considerable quantities of metallic ores, concentrates, slags, and residues are exported from Australia for refining overseas. The following table shows the quantities of selected items exported during 1967 and their principal metallic content as estimated by assay.

PRINCIPAL METALLIC CONTENTS OF SELECTED ORES AND CONCENTRATES ETC., EXPORTED FROM AUSTRALIA, 1967

	Metallic contents—estimated from assay								
Ores and concentrates, etc.	*Copper*	*Lead*	*Zinc*	*Tin*	*Tungstic oxide*	*Iron*	*Manganese*	*Gold*	*Silver*
	tons	tons	tons	tons	tons	tons	tons	fine oz	'000 fine oz
Copper concentrate(*a*)	10,748	..	..	..	..	..	..	22,049	105
Blister copper	6,857	..	..	..	..	..	..	88,164	31
Copper matte, slags, etc.(*b*)	1,962	2,870	23	..	..	..	..	39	228
Lead concentrate	1,276	86,820	7,340	..	..	..	..	21,497	2,574
Lead-silver bullion	..	99,822	..	..	..	..	..	..	7,043
Lead slags and residues	181	1,868	53	61	..	..	..	..	19
Zinc concentrate	..	2,219	153,559	..	..	..	..	..	107
Zinc slags and residues	5	5	4,665	..	..	..	..	..	..
Tin concentrate	12	5	..	1,601	2	..	..	..	..
Wolfram concentrate	..	..	..	..	288	..	..	..	..
Scheelite concentrate	..	..	..	..	845	..	..	..	..
Iron ore	..	..	..	..	..	5,838,827	..	..	..
Manganese ore	..	..	..	..	..	..	150,214	..	..
Total metallic content	**21,041**	**193,609**	**165,640**	**1,662**	**1,135**	**5,838,827**	**150,214**	**131,749**	**10,106**

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

Direction of trade

The distribution of Australia's mineral exports according to principal destinations, and imports according to principal sources, for the years 1965 to 1967, are shown in the following table.

VALUE OF OVERSEAS MINERAL TRADE, BY COUNTRY OR REGION AUSTRALIA(*a*), 1965 TO 1967

	Value ($m f.o.b.)			*Percentage*		
Country or region	*1965*	*1966*	*1967*	*1965*	*1966*	*1967*
EXPORTS(*b*)						
Japan	92.4	124.2	208.3	32.5	37.5	49.9
Other Asian and Pacific	30.1	41.3	50.5	10.6	12.5	12.1
United Kingdom	68.2	65.3	63.5	24.0	19.7	15.2
European Economic Community	43.8	38.7	39.7	15.4	11.7	9.5
United States	42.5	46.0	37.5	14.9	13.9	9.0
Other	7.6	15.7	18.3	2.6	4.7	4.3
Total	**284.6**	**331.2**	**417.8**	**100.0**	**100.0**	**100.0**
IMPORTS						
Middle East	132.4	138.4	143.3	44.0	50.1	47.3
Indonesia	53.0	51.1	52.4	17.6	18.5	17.3
Other Asian	24.0	16.9	23.0	8.0	6.1	7.4
Pacific	14.3	19.9	23.1	4.8	7.2	7.6
United States	23.6	16.0	19.7	7.9	5.8	6.5
Canada	9.7	12.9	13.2	3.2	4.7	4.4
Europe (including United Kingdom and European Economic Community)	31.0	8.5	12.7	10.3	3.1	4.2
Other	12.6	12.7	15.5	4.2	4.5	5.1
Total	**300.6**	**276.4**	**302.9**	**100.0**	**100.0**	**100.0**

(*a*) Excludes gold movements. (*b*) Excludes alumina, details of which are not available for publication.

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.

General review, 1968

Expansion of the Australian mineral industry was maintained during 1968, with the preliminary value of mineral production increasing by 22 per cent from $697 million in 1967 to $853 million in 1968. The major reasons for this increase in the value of mineral production were continued expansion of iron ore mining, and the increased production of crude oil at Barrow Island, copper concentrates in Queensland and black coal in New South Wales and Queensland. The total value of mineral exports continued to increase, mainly because of the increase of iron ore and coal shipments to Japan.

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 1968 was a period of continued growth in the industry both in mining and processing as detailed below.

Bauxite production from deposits at Weipa, Queensland, has been increased to a rate of 6 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. It is expected that production will rise to 7 million tons in 1970. Approximately 1.9 million tons from Weipa will be used by the Gladstone, Queensland, alumina refinery, a further 110 thousand tons will be shipped to Bell Bay, Tasmania, and the remaining production will be exported.

Bauxite deposits at Gove, Northern Territory, covering reserves of the order of 250 million tons of bauxite, are being developed by a consortium of seven Australian and one overseas company. The consortium plans to construct an alumina plant at Gove by 1971 with an initial capacity of 500,000 metric tons per annum.

An agreement was signed in Perth in December 1968 with the Western Australian Government for the development of a bauxite/alumina project in the Admiralty Gulf area. The company involved has an option to submit proposals to the State Government before the end of 1969, for all the facilities required for bauxite mining and alumina refining.

Alumina

An alumina refinery with a capacity of 600,000 tons per annum at Gladstone, Queensland, which was completed at a cost of approximately $115 million, was commissioned in March 1967. A $45 million expansion programme was completed at the end of 1968, increasing the capacity of the refinery to 900,000 tons per annum; the plant will be further expanded to 1,275,000 tons yearly by mid-1971 and is scheduled to have an eventual capacity of 1,800,000 tons per annum. Plans were also announced to increase the capacity of the alumina refinery at Kwinana, Western Australia, from 620,000 metric tons to 830,000 metric tons per annum by the end of 1969 and further to 1,040,000 metric tons by the later half of 1970. Bauxite supplies for the Kwinana refinery are obtained from deposits 28 miles away at Jarrahdale, Western Australia, the reserves of which were recently re-assessed from 200 million tons to 500 million tons.

Aluminium

Initial construction of an aluminium smelter with a capacity of 50,000 tons per annum at Kurri Kurri near Newcastle, New South Wales, was commenced in 1967 for completion in 1969. An aluminium powder and paste plant, capable of supplying the whole of Australia's needs, was commissioned in 1968 at Bell Bay, Tasmania. A letter of intent has been received by the Western Australian Government regarding the possible establishment of an aluminium smelter at Kwinana in possibly ten to twelve years.

Copper

A $130 million expansion programme at Mount Isa was completed in 1966 with the commissioning of a new shaft and concentration plant. During the development period when lower grade ore was being extracted, the Mount Isa output was supplemented by ore from the Young Australia mine, fifty miles south of Cloncurry, Queensland, where mining operations were terminated at the end of 1967.

A new copper-gold ore body, the Warrego Mine, is being developed near Tennant Creek, Northern Territory. The first stage of development, which will cost $10 million, will have an installed mining capacity of 400,000 tons of ore per annum.

Since the beginning of 1967 the Australian Producers' price has been adjusted regularly to reflect movements in the London Metal Exchange daily settlement price, the price at the end of January 1969 being 53 cents per pound ($1,187.2 per ton) after reaching $1,350 per ton during February to April 1968.

Iron ore

During 1968, iron ore production expanded by 54 per cent with the largest increase in production being in Western Australia.

Substantial new commitments have been made with the Western Australian Government by the company currently mining at Mount Tom Price to develop the Paraburdoo iron ore deposits, 35 miles south of Mount Tom Price. In addition this company must be ready to produce iron ore from Paraburdoo at an annual rate of not less than 1 million tons between 1974–76. If the company is successful in finding world markets for metallised agglomerates, it is committed to produce 1 million tons by the end of 1972, 2 million tons by the end of 1977 and 3 million tons by the end of 1980.

The consortium has contracted to supply an additional 37,500,000 tons of iron ore to Japan from 1971 from the deposits at Mount Whaleback, Western Australia. In signing this contract, the consortium concerned agreed to deepen the harbour at Port Hedland so that vessels of 100,000 tons dwt could be used.

Total Australian iron ore contracts with Japanese steel mills now amount to about 400 million tons valued at over $3,000 million.

Lead and zinc

At Mount Isa the majority of projects associated with the K57 shaft were completed and production of lead in bullion rose by 15 per cent to 117,000 tons in 1968.

At the zinc refinery at Risdon, Tasmania, a fluid bed roaster is being installed as part of a programme to replace the present hearth and flash roasters. The same company has a prospect at Beltana, South Australia, where 730,000 tons of silicate ore have been proved assaying 37 per cent zinc and 97,000 tons assaying 24 per cent zinc.

Following the commissioning of a slag fuming plant at Port Pirie, plans to recover zinc from residue dumps at Mount Isa and Risdon have been announced.

During 1968 production was restricted by an industrial dispute at mines at Broken Hill.

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 1968 exports were 12.1 million tons valued at $103.5 million. These increased exports have been almost wholly 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 in Queensland.

Petroleum

Developments in the last few years were reviewed in previous issues of the Year Book, and the following is a summary of developments in 1968.

Australia now has seven proved commercial oil-fields. Moonie and Alton in Queensland began production in 1964 and 1966, and the Barrow Island field, Western Australia, was inaugurated in 1967. Off-shore Victoria, in the Gippsland Shelf, commercially producible oil has been discovered in the Kingfish, Halibut, Marlin and Barracouta fileds, and production from this area to the mainland is scheduled for early 1970.

Commercial production of natural gas on a substantial scale is now a reality. Construction of pipe-lines for the supply of natural gas and natural gas liquids from the Barracouta and Marlin fields to Melbourne has been completed. A 480-mile long 22-inch line from the Gidgealpa-Moomba fields to Adelaide is being constructed, and completion is expected in 1969. A 280-mile line from the Roma gas fields to Brisbane has been completed.

The provisional figure for footage drilled in petroleum exploration and development in 1968 was 1,106,804 feet, the second highest figure for any one year. Some 645,941 feet (58.4 per cent) of this total was attributed to exploration drilling. A tentative total of 226 wells were completed, of which ninety were exploration wells. Of these exploration wells, five were completed as potential producers, and nine had hydrocarbon shows.

A notable feature of 1968 was that off-shore drilling accounted for some 312,613 feet. This reflects the beginning of development drilling in the offshore Gippsland Shelf fields.

Nickel

Significant discoveries of nickel have been made near Kambalda, Western Australia. Mining operations at Kambalda commenced in mid-1967. Shipments of ore are being made according to a contract to sell 40,000 tons of contained nickel over ten years to Japan and Canada for refining at a rate of 1,500 tons of contained nickel per year. An agreement with the Western Australian Government providing for the erection of a refinery at Kwinana by 1971, with a minimum annual production capacity of 15,000 tons of metal, was signed in January 1968. Plans to begin mining and concentrating nickel ore from Scotia, Western Australia, about August 1969 were announced in November 1968. Exploration activities continued in the Kalgoorlie area and Blackstone Ranges in Western Australia and near Rockhampton and Greenvale in Queensland.

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 finished on a possible railway route between Lady Annie and the Gulf of Carpentaria, 800 miles away. Lady Annie is likely to be the first deposit developed. Transport and port facilities will be key factors in determining whether the project is to be undertaken.