

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. Two monthly statistical bulletins *Minerals and Mineral Products* and *The Gold Mining Industry, Australia* are 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 of 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 overlies large areas of the continent and reach their greatest development in central Queensland. Cainozoic rocks occur mainly in the southern parts of Victoria and South Australia and as residual basalt cappings over an extensive area of the Palaeozoic rocks of eastern Australia.

Economic geology

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

Oil and natural gas have been found in a number of sedimentary basins, and at present there are proved commercial fields at Moonie, and Alton (oil) and Roma (gas), Queensland, in the Gippsland Basin (oil and gas) off-shore in Bass Strait, at Gidgealpa and Moomba (gas) in north-east South Australia, and at Barrow Island (oil) off the coast of north-west Western Australia. The Moonie deposit is found in rocks of lower Jurassic age. Oil and gas in the Gippsland Basin come from Cretaceous and Tertiary strata. The Barrow Island field, which began production in 1967, is mainly of Cretaceous age, but oil and gas have also been found in underlying Jurassic rocks. Other discoveries of potential commercial significance have been made at Gilmore and Palm Valley (gas) in Queensland; at Mereenie (oil and gas) in the Northern Territory; and at Yardarino, Gingin, and Dongara (gas) in the Perth Basin, Western Australia.

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)

<i>Production</i>	<i>Reserves adequate</i>	<i>Reserves uncertain</i>	<i>Reserves negligible</i>
Production sufficient for domestic demand and exports	Barite Bauxite Cadmium Coal (black) Copper Gold Gypsum Iron ore Lead Manganese ore (metallurgical) Mineral sands(a) Nickel(b) Opal Salt Silver Tin Tungsten Zinc	Beryl Talc Tantalite	

For footnotes see next page.

RESERVES OF MINERALS: AUSTRALIA—*continued*

<i>Production</i>	<i>Reserves adequate</i>	<i>Reserves uncertain</i>	<i>Reserves negligible</i>
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	Lithium minerals Phosphate rock Sulphides (as source of sulphur)	Abrasives Antimony Bentonite China clay Chromite Cobalt Diatomite Fluorite Magnesite Manganese ore (chemical) Mineral pigments Petroleum Platinum	Asbestos (chrysotile) Bismuth Mercury Molybdenum
Production nil	Magnesium Potassium salts (from alunite muds)	Arsenic Asbestos (crocidolite)(c) Diamonds Graphite Vanadium Vermiculite	Borates Mercury Nitrates Sulphur

(a) Ilmenite, monazite, rutile, zircon. (b) Mine production commenced mid-1967. (c) Mine ceased operating during 1966.

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 200 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 up to 100 million tons has been identified 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 43.5 million tons in 1967. 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

Vigorous exploration activity continues to supply evidence that Australia may possess significant resources of crude oil. The Moonie-Alton fields in the Surat Basin in Queensland and the Barrow Island field in Western Australia are currently producing commercially, while the Marlin, Kingfish, and Halibut fields in off-shore Victoria are scheduled to begin commercial production in late 1969 and early 1970.

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 Talling Peak in Western Australia, and at Mt Bunday 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 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 off-shore Victoria, where reserves are estimated to be approximately 5 trillion cubic feet. Commercial production from these fields is scheduled to commence in the latter part of 1969.

In Queensland numerous gas fields have been discovered in the Roma area and to the north near Rollleston. The combined reserves estimate is approximately 4.5 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 trillion cubic feet. Nearby, Daralingie Well No. 1 has recently been completed as a gas producer, but the reserves in this structure are as yet unknown. In Western Australia significant discoveries have been made at Yardarino, Gingin, and Dongara. In the Northern Territory the Mereenie and Palm Valley fields show evidence of considerable natural 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 heavily depleted 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 3,130 short tons were possible but not proven.

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 overall 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 1963 to 1967. 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, 1963 TO 1967**

('000 acres)

Year	N.S.W. (a)	Vic.	Qld (b)	S.A. (a) (b)	W.A. (c)	Tas. (b)	N.T.	Total (d)
1963 . . .	425	46	2,185	5,753	201	44	62	8,716
1964 . . .	956	50	2,097	7,894	221	42	61	11,321
1965 . . .	1,015	60	2,494	6,621	263	41	61	10,555
1966 . . .	1,083	84	2,591	29,638	343	45	36	33,820
1967 . . .	1,177	74	2,304	15,508	372	54	37	19,526

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

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 essentially two basic forms of authorisation for exploration: (a) permit for surface survey; (b) licence for exploratory drilling (does not apply in the Northern Territory).

In most States the minimum permit area is 1,000 square miles and up to a maximum area of 10,000 square miles in the Northern Territory. There is no limit in most States on the number of permits that may be held by one company, syndicate or individual. The term of the initial permit varies between States from one year to five years, but in all cases there is provision for extensions with a maximum in most States of ten years and in the Northern Territory of fifteen years. A bond must be lodged, and in some States rent is payable. All permits contain obligations to carry out certain exploration work with a general provision that survey must be started within three to six months after a permit is granted.

In most States the maximum licence area is 200 square miles (in Papua-New Guinea it is 2,500 square miles) with no limit to the number of licences that may be held. The term of the initial licence varies from State to State and ranges from two to five years. Extensions are permissible with a maximum term ranging in most States from six to ten years. A bond is required in most States, and some States also charge a fee. All States charge a rental ranging from 10c to \$13 a square mile per annum. The obligations of a licence require a company, syndicate or individual to carry out more detailed survey work than at the permit stage and may also require a minimum drilling programme.

If exploration is successful, a lease would normally be granted which gives the right to produce petroleum. The maximum lease area is 100 square miles, except in the Northern Territory where the limit is 1,000 square miles and in Papua-New Guinea where it is 500 square miles. In most States there is no limit to the number of leases that may be held. When a lease is granted, the remaining portion of the licence area in which a lease is situated must in most cases be surrendered to the Crown, but surrender clauses vary from State to State.

The initial term of a lease in most cases is twenty-one years, and the lease may be renewed for a similar period. Also, one of the general obligations of a lease is that drilling for production must be commenced within six months. In some States the appropriate Minister has jurisdiction over the processing and marketing of the oil.

Legislation in most States requires the payment of rent at the rate of \$20 (\$30 in the Northern Territory and Papua-New Guinea) a square mile per annum, but this is deductible from any royalties payable on commercial production. All States and Territories have provisions requiring the operating company to guard against wasteful and dangerous practices and make provision for field development in accordance with sound oilfield practice.

Off-shore. Federal and State Ministers and Attorneys-General began a series of conferences in 1963 to determine the extent of their respective jurisdictions over rights to prospect for petroleum in Australian off-shore areas. In 1965 it was announced that agreement had been reached between the Federal and State Governments on a system of joint legislation to control and safeguard the exploration for, and the exploitation of, the petroleum resources on the territorial sea-bed and on the outer continental shelf. The continental shelf is described as submerged land not exceeding 200 metres in depth or beyond that limit to where the depth of the superjacent waters admits of exploitation of the natural resources of the shelf. After further conferences, and consideration of representations made by the off-shore exploration companies, legislation was presented to the several Parliaments at the end of 1967.

The State Governments administer the legislation and collect all rents and fees. Granting of tenements is subject to approval by the Federal Government in so far as its constitutional responsibilities are concerned, e.g. external affairs, defence, customs, and navigation. Standard royalties (10 per cent of value of production at the well-head) are divided on a 40-60 basis between the Federal Government and the adjacent State. Over-ride royalties, if applicable, and all rents and other fees are retained by the adjacent State.

The off-shore legislation provides for a two-stage system of granting authorities to explore and produce. A permit covers all stages of exploration, including drilling. A licence (equivalent to a lease on land) for production is issued for twenty-one years, with the licensee having the right of extensions for a further twenty-one years. Further extensions may be granted. The standard royalty of 10 per cent (plus over-ride royalty, if applicable) is payable for the first twenty-one years. Royalty rate for the whole of the second twenty-one year period will be fixed by the Parliaments at or before the time of granting a renewal, and in the absence of Parliamentary action to fix a new rate the previous rate will continue to apply for the period of the licence.

A graticular system of block areas has been established for off-shore exploration. The size of each graticular block is five minutes of arc of latitude by five minutes of arc of longitude. This results in graticular blocks ranging in area from a little over thirty square miles in northern Australia to approximately twenty-five square miles in southern Australia. Reduction in size is due to the fact that minutes of latitude decrease in length between the Equator and the South Pole. The maximum permit area is 400 blocks (approximately 10,000 to 12,000 square miles). There is no statutory limitation on the number of permits which may be granted to any individual company. Permits will be issued for an initial period of six years with rights of renewal for further successive periods, each of five years, subject to satisfactory compliance with the conditions of the permit and to the permittee surrendering half of the effective permit area at the end of each period. Furthermore, the legislation includes discretionary powers for the Minister to modify the requirement for compulsory reduction if this would result in a permit area being reduced below sixteen blocks.

Following a discovery of petroleum within a permit area the permit holder will be asked to nominate a block which will then become the centre of a group of nine blocks, called a location.

The permit holder has the option of applying for a licence over five of the blocks on which a standard royalty of 10 per cent is payable, with the remaining four blocks reverting to the Crown, or of taking all or some of the additional four blocks on payment of an additional over-ride royalty on all blocks taken up at the location. In the latter event, separate licences are granted over the five and four (or less) blocks, respectively. The rate of over-ride royalty will be negotiable between the adjacent State or Territory and the licensee within a range of 1 per cent to 2½ per cent. Where locations consist of less than nine blocks they will be split evenly between the licensee and the Crown if the number of blocks within the location is even, and the odd block will be available to the licensee if the number is uneven. The permit holder has at least two years, which may be extended to four years, in which to make his selection. Graticular blocks not selected by the permit holder will be excised from the permit area and may be disposed of by the State or Territory by tender. Existing titles which have been previously issued by the States or Territories will be honoured wherever possible.

Petroleum prospecting or exploring leases: areas occupied

**AREAS OCCUPIED UNDER AUTHORITIES TO PROSPECT OR EXPLORE FOR
PETROLEUM: STATES AND NORTHERN TERRITORY, 1963 TO 1967**

(*000 acres)

Year	N.S.W. (a)	Vic.	Qld	S.A. (a)	W.A.	N.T.	Total
1963	175,026	53,345	464,567	197,745	441,795	160,498	1,492,976
1964	156,543	53,345	379,562	228,234	529,594	147,839	1,495,117
1965	105,853	31,201	324,205	221,060	491,670	120,130	1,294,119
1966	113,276	31,174	389,252	237,591	429,994	239,519	1,440,806
1967	83,893	33,155	252,213	240,791	425,979	221,666	1,257,697

(a) Year ended 30 June.

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 except Tasmania 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(a) AND NORTHERN TERRITORY
1962-63 TO 1966-67**

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State or Territory	1962-63	1963-64	1964-65	1965-66	1966-67
New South Wales	1,633,640	5,090,622	19,946,772	24,317,168	16,326,973
Victoria	(b)85,004	(b)94,072	39,996	71,072	70,964
Queensland	486,938	642,560	1,201,264	1,183,046	2,241,575
South Australia	727,207	860,371	926,984	985,560	1,091,582
Western Australia	248,646	243,182	291,354	478,295	2,639,895
Northern Territory	61,982	68,682	80,894	88,727	110,574

(a) No mineral royalties are collected in Tasmania.

(b) 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 in all forms (including concentrates) containing zircon, rutile or ilmenite; manganese ores; beryllium ores and concentrates.

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

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

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.

In November 1964, as a result of the closure of the copper smelter at Mount Isa, an emergency ban was imposed on the export of copper and copper scrap. The ban did not include copper concentrates or fabricated copper products. These restrictions were lifted as from 1 September 1965. On 20 December 1965, another ban on the exports of copper scrap and ingots, and copper alloy scrap and ingots, and exports controls on primary copper refinery shapes and copper rod were announced. As from 1 May 1966 the ban was extended to include the following materials from which copper may be obtained—residues, speiss, slag, dross, scale, sweepings, ash, sludge, slime, dust, and wastes. In addition, it was announced that export permits would not be issued for copper and copper alloy cakes, billets and similar shapes produced from scrap.

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 1039.

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. The metals or minerals to which this concession applies are as follows: asbestos, bauxite, chromite, emery, fluor spar, graphite, ilmenite, kyanite, magnesite, manganese oxides, mica, monazite, pyrite, quartz crystals (piezo-electric quality), radio-active ores, rutile, sillimanite, vermiculite, and zircon; and ores of antimony, arsenic, beryllium, bismuth, cobalt, columbium, copper, lithium, mercury, molybdenum, nickel, osmiridium, platinum, selenium, strontium, tantalum, tellurium, tin, tungsten, and vanadium.

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.

Income attributable to uranium obtained from working a mining property in Australia or the Territory of Papua and New Guinea, or from the treatment of ore in Australia or the Territory of Papua and New Guinea, is exempt from tax for residents of Australia and the Territory of Papua and New Guinea. The exemption is, however, conditional upon the uranium recovered being owned by the Commonwealth or disposed of to a person approved by the Commonwealth.

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

Valuable assistance has been given in the form of certain taxation concessions to encourage the search for petroleum. Resident investigators are permitted, for tax purposes, to deduct from their assessable income all sums paid for shares issued by petroleum exploration companies in respect of application, allotment, and call moneys. These deductions are allowable only if a petroleum exploration company elects to forgo an equivalent amount when, in the event of commercial production, capital expenditure is claimed as a deduction for tax purposes. Most Australian petroleum exploration companies 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. 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.

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 1967-68 contained an appropriation of \$13.6 million for subsidies under the Act. Payments under this Act in each of the years 1963 to 1967 are shown in the table on page 1039.

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 subsequently recommended that Australian crude oil should be valued at \$US 2.48 a barrel at the nearest refining centre, plus a differential for the quality of the oil produced. The Board also recommended an additional margin of 25 cents a barrel to provide an incentive for increased exploration activity. The Government adopted the Tariff Board's recommendations, but raised the incentive margin to 75 cents. As a result, the price for Moonie crude is \$US 3.50 a barrel delivered Brisbane, made up as follows: crude oil value, \$US 2.48; incentive margin, \$US 0.75; quality differential, \$US 0.27. This pricing structure will operate for five years, but the Government will consider reviewing the valuation during this period if it considers that the incentive to exploration has proved inadequate.

In order to ensure that local crude oil is used in Australian refineries, the Government has 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 those 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.

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.

The rate of subsidy payable under the original Act was increased under amendments enacted on 22 October 1957 and 22 May 1959. The Act was again amended on 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 reduced by the amount of the excess. Prior to 1 July 1965 subsidy payable to large producers was subject also to a limiting provision that the annual net profit of a producer was not, with the addition of the subsidy, to exceed 10 per cent of the capital used in the production and sale of gold. This limitation has now been removed. The latest amendments also provided for the removal of two other

restrictive provisions. A large producer's entitlement to subsidy is no longer subject to reduction if the amount of expenditure on development included in costs exceeds a certain amount, or if the grade of ore being mined falls below a certain level. On the other hand, the Act now provides that subsidy may be adjusted if it is considered that operations are not conducted in accordance with good mining practice. With effect from 1 July 1965 a large producer is able to include in his costs for subsidy purposes one-half of net costs incurred in approved exploratory diamond drilling elsewhere than on his mining property. Payments under the amended Act are to 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 1963 to 1967 are shown in the table on page 1039.

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 1963 to 1967 are shown on page 1039. 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 1963 to 1967 are shown in the table on page 1039.

Payments to producers of phosphate fertilisers. The *Phosphate Fertilizers Bounty Act 1963-1966* 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. 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 \$6 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 \$30 for each ton of contained phosphorus pentoxide. Bounty in respect of ammonium phosphate is payable at the rate of \$30 for each ton of the phosphorus pentoxide content of the ammonium phosphate. In addition to standard grade superphosphate, 'double' and 'triple' superphosphate, containing 40 per cent and 50 per cent phosphorus pentoxide respectively, are produced in Australia, and bounty on these products is payable at the rate of \$12 a ton and \$15 a ton respectively. The intention of this Act is to assist consumers of superphosphate (primary producers). The Act is due to expire on 31 October 1969. Payments under the above Act in each of the years 1963 to 1967 are shown in the following table.

COMMONWEALTH GOVERNMENT PAYMENTS TO THE MINERAL INDUSTRY
AUSTRALIA, 1963 TO 1967

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Year	Petroleum exploration (a)	Gold mining (b)	Copper mining (c)	Pyrites mining (d)	Sulphuric acid production (e)	Phosphate fertiliser production (f)
1963	10,519,208	1,614,600	1,297,704	960,334	2,590,248	1,908,252
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

(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 pages 1041-2 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 1966-67 \$500,000 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. A survey of the State's underground water resources is in progress, in conjunction with the development of town water supplies from underground sources.

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 boring plant and mining equipment, boring and testing of mineral deposits, financial loans 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, mineralogical 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. In 1966-67 the Tasmanian Government, under the *Iron Ore (Savage River) Agreement Act 1965*, advanced \$1.5 million to the companies establishing an iron ore industry in the State (the total loan not to exceed \$4 million). The loan, repayable over twenty years, was specifically for the development of Port Latta on Brickmakers Bay as an outlet for pelletised iron ore. Concentrated ore in the form of a slurry is pumped by pipeline over fifty miles from the Savage River Mines to a pelletising plant at Port Latta.

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

Research investigations into mineral problems are undertaken by the Australian Mineral Development Laboratories in Adelaide. This organisation is sponsored by the Commonwealth Government, the South Australian Government and the Australian Mineral Industries Research Association (*see* Research by private enterprise next page). These sponsors furnished work for the laboratories, or guarantee finance, in the proportions 25 : 50 : 25 respectively. The Laboratories have sections dealing with mineralogy, petrology, chemical analysis, ore-dressing, ceramic and extractive and physical metallurgy, industrial chemistry, 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 1042). 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 geo-physical interpretation by means of model testing.

For details for the functions of the Bureau of Mineral Resources, Geology and Geophysics, *see* page 1039.

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 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 Mineralogical Investigations laboratory of the Division has become a general reference point in C.S.I.R.O.

for examination of minerals and for advice on problems concerning their nature and origin. The Division of Mineral Chemistry is undertaking research aimed at more complete 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 mineral processing and has continued to serve industry on problems arising from the processing of particular Australian minerals. 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 coal utilisation research programmes in Australia, and 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 coal producing and consuming industries. In the first two years of operation, additional funds of \$520,000 have been made available in each year for increased coal utilisation research, bringing total expenditure on coal utilisation research in Australia to nearly \$2.5 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 all the current activities of the Australian Coal Association (Research) Limited, which was financed largely by the coal producing industry. This new company has available additional funds from the coal producing and consuming industries and from State and Commonwealth Governments to permit the expansion of the former work of the Australian Coal Association (Research) Limited in the particular direction of coal utilisation research. The constitution of the Advisory Committee and the establishment of the new laboratories unit have brought into effect the 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 1966-67 was \$76,928.

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 on the next page.

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.

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, 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. The Group provides opportunities for inter-governmental consultations on international trade in lead and zinc and for studies of the world situation in lead and zinc having regard especially to the desirability of providing continuous accurate information regarding the supply and demand position and its probable development.

MINERAL INDUSTRY STATISTICS

Statistics presented in this chapter refer mainly to 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 on page 1044.

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 1966 and in Australia for the years 1962 to 1966.

NUMBER OF MINES AND QUARRIES: STATES AND TERRITORIES, 1966

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	21	10	23	..	114	..	11	..	179
Silver-lead-zinc	12	..	4	3	8	1	2	..	30
Copper-gold	15	2	81	3	12	1	10	..	124
Tin	54	3	240	..	25	29	12	..	363
Mineral sands	13	..	6	..	4	..	..	..	23
Other metal	20	1	12	2	21	3	4	..	63
<i>Total, metal mining</i>	135	16	366	8	184	34	39	..	782
Fuel mining—									
Black coal—									
Underground	86	2	52	..	2	3	..	..	145
Openpit	6	..	4	1	1	1	..	..	13
<i>Total, black coal</i>	92	2	56	1	3	4	..	..	158
Brown coal . . . . .	..	5	..	..	..	..	..	..	5
Other fuel . . . . .	..	..	3	..	1	..	..	..	4
<i>Total, fuel mining</i>	92	7	59	1	4	4	..	..	167
Non-metal (excluding fuel) mining(a)	600	61	115	111	59	27	..	..	973
<i>Total, all mining</i>	827	84	540	120	247	65	39	..	1,922
Construction material quarrying(a)	377	378	56	238	58	117	41	11	1,276
<i>Total, all mining and quarrying</i>	1,204	462	596	358	305	182	80	11	3,198

(a) Incomplete, owing to difficulties of coverage. See Coverage, page 1044.

NUMBER OF MINES AND QUARRIES: AUSTRALIA, 1962 TO 1966

Industry	1962	1963	1964	1965	1966
Metal mining—					
Gold	286	257	246	193	179
Silver-lead-zinc	22	13	20	32	30
Copper-gold	107	98	86	75	124
Tin	344	300	371	391	363
Mineral sands	20	18	20	21	23
Other metal	87	62	56	53	63
<i>Total, metal mining</i>	866	748	799	765	782
Fuel mining—					
Black coal	198	185	179	168	158
Brown coal	6	6	7	6	5
Other fuel . . . . .	..	2	3	3	4
<i>Total, fuel mining</i>	204	193	189	177	167
Non-metal (excluding fuel) mining(a)	731	792	756	802	973
<i>Total, all mining</i>	1,801	1,733	1,744	1,744	1,922
Construction material quarrying(a)	1,107	1,044	1,148	1,234	1,276
<i>Total, all mining and quarrying</i>	2,908	2,777	2,892	2,978	3,198

(a) Incomplete. See Coverage, page 1044.

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 1966 and in Australia for the years 1962 to 1966. The figures show the average number of persons employed during the whole year, including working proprietors.

**MINING AND QUARRYING: EMPLOYMENT^(a)
STATES AND TERRITORIES, 1966**

<i>Industry</i>	<i>N.S.W.</i>	<i>Vic.</i>	<i>Qld</i>	<i>S.A.</i>	<i>W.A.</i>	<i>Tas.</i>	<i>N.T.</i>	<i>A.C.T.</i>	<i>Aust.</i>
Metal mining—									
Gold	11	123	(b)	..	4,056	..	(b)	..	4,447
Silver-lead-zinc	4,632	..	4,177	3	(b)	(b)	76	..	8,681
Copper-gold	309	6	530	2	(b)	(b)	360	..	2,554
Tin	248	6	..	..	222	517	27	..	1,550
Mineral sands	1,518	..	579	..	337	..	..	..	2,434
Other metal	42	1	(b)	417	1,168	(b)	(b)	..	2,295
<i>Total, metal mining</i>	<i>6,760</i>	<i>136</i>	<i>5,630</i>	<i>422</i>	<i>5,930</i>	<i>2,339</i>	<i>744</i>	<i>..</i>	<i>21,961</i>
Fuel mining—									
Black coal—									
Underground	11,345	129	(b)	..	(b)	57	..	..	(c)14,178
Opencut	200	..	(b)	280	(b)	..	..	..	991
<i>Total, black coal</i>	<i>11,545</i>	<i>129</i>	<i>(c)2,345</i>	<i>280</i>	<i>(c)813</i>	<i>57</i>	<i>..</i>	<i>..</i>	<i>(c)15,169</i>
Brown coal . . . . .	..	1,760	..	..	..	..	..	..	1,760
<i>Total, fuel mining</i>	<i>11,545</i>	<i>1,889</i>	<i>2,345</i>	<i>280</i>	<i>813</i>	<i>57</i>	<i>..</i>	<i>..</i>	<i>16,929</i>
Non-metal (excluding fuel) mining^(d)									
.	1,304	253	336	426	521	90	..	..	2,930
<i>Total, all mining</i>	<i>19,609</i>	<i>2,278</i>	<i>8,311</i>	<i>1,128</i>	<i>7,264</i>	<i>2,486</i>	<i>744</i>	<i>..</i>	<i>41,820</i>
Construction material quarrying^(d)									
.	1,913	2,001	369	860	331	330	70	83	5,957
<i>Total, all mining and quarrying</i>	<i>21,522</i>	<i>4,279</i>	<i>8,680</i>	<i>1,988</i>	<i>7,595</i>	<i>2,816</i>	<i>814</i>	<i>83</i>	<i>47,777</i>

(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 1044.

MINING AND QUARRYING: EMPLOYMENT, AUSTRALIA, 1962 TO 1966

Industry	1962	1963	1964	1965	1966
Metal mining—					
Gold	5,290	5,287	4,753	4,525	4,447
Silver-lead-zinc	7,958	7,946	7,811	7,269	8,681
Copper-gold	2,242	2,288	2,341	2,312	2,554
Tin	1,157	1,116	1,191	1,402	1,550
Mineral sands	1,408	1,565	1,734	2,000	2,434
Other metal	968	1,168	1,348	2,251	2,295
<i>Total, metal mining</i>	<i>19,023</i>	<i>19,370</i>	<i>19,178</i>	<i>19,759</i>	<i>21,961</i>
Fuel mining—					
Black coal	16,312	(a)15,636	(a)15,364	(a)15,391	(a)15,169
Brown coal	1,453	1,613	1,673	1,710	1,760
<i>Total, fuel mining</i>	<i>17,765</i>	<i>17,249</i>	<i>17,037</i>	<i>17,101</i>	<i>16,929</i>
Non-metal (excluding fuel) mining(b)	2,838	2,823	2,783	2,795	2,930
<i>Total, all mining</i>	<i>39,626</i>	<i>39,442</i>	<i>38,998</i>	<i>39,655</i>	<i>41,820</i>
Construction material quarrying(b)	5,599	5,406	5,814	6,217	5,957
Total, all mining and quarrying	45,225	44,848	44,812	45,872	47,777

(a) Includes other fuel mining. (b) Incomplete, see Coverage, page 1044.

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 1966.

NUMBER OF MINES AND QUARRIES AND PERSONS EMPLOYED, BY AVERAGE NUMBER EMPLOYED: STATES AND TERRITORIES, 1966

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	923	280	441	252	201	131	70	2,298
Persons	1,677	490	694	431	709	240	184	4,425
From 4 to 20 persons—								
Establishments	166	156	97	91	64	36	15	625
Persons	1,334	1,278	906	730	483	238	150	5,119
From 21 to 200 persons—								
Establishments	87	25	56	13	30	12	5	228
Persons	6,753	1,137	3,437	627	2,110	784	363	15,211
More than 200 persons—								
Establishments	28	1	2	2	10	3	1	47
Persons	13,069	1,652	4,089	604	4,653	1,809	347	26,223
Total—								
Establishments	1,204	462	596	358	305	182	91	3,198
Persons	22,833	4,557	9,126	2,392	7,955	3,071	1,044	50,978

(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 1966, 52 persons were recorded as killed and 1,229 as injured in mining (excluding quarrying) accidents. Recorded deaths and injuries in that year in black coal mines were 21 and 453, respectively, silver-lead-zinc mines 15 and 272, gold mines 6 and 242, and mineral sands mining 1 and 42. Persons killed and injured in the construction material quarrying industry numbered 13 and 137 respectively in 1966.

Salaries and wages paid

Salaries and wages paid in the mining and quarrying industries in Australia during each year 1962 to 1966 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 281) and also in the *Labour Report*.

MINING AND QUARRYING: SALARIES AND WAGES PAID(a), AUSTRALIA
1962 TO 1966
(\$'000)

<i>Industry</i>	<i>1962</i>	<i>1963</i>	<i>1964</i>	<i>1965</i>	<i>1966</i>
Metal mining—					
Gold	13,068	13,072	11,812	11,974	12,409
Silver-lead-zinc	24,454	25,678	29,948	34,397	44,651
Copper-gold	5,702	6,200	6,834	7,415	8,205
Tin	2,100	2,502	2,648	3,313	4,156
Mineral sands	3,478	4,156	4,706	5,837	7,673
Other metal	2,376	3,184	4,038	7,241	8,601
<i>Total, metal mining</i>	<i>51,178</i>	<i>54,792</i>	<i>59,986</i>	<i>70,177</i>	<i>85,696</i>
Fuel mining—					
Black coal	49,698	(b)49,230	(b)52,204	(b)55,942	(b)60,191
Brown coal	3,942	4,634	5,144	5,503	5,672
<i>Total, fuel mining</i>	<i>53,640</i>	<i>53,864</i>	<i>57,348</i>	<i>61,445</i>	<i>65,863</i>
Non-metal (excluding fuel) mining(c)	5,796	5,764	6,248	6,388	6,821
<i>Total, all mining</i>	<i>110,614</i>	<i>114,420</i>	<i>123,582</i>	<i>138,010</i>	<i>158,380</i>
Construction material quarrying(c)	8,762	8,684	9,364	10,751	11,256
<i>Total, all mining and quarrying</i>	<i>119,376</i>	<i>123,104</i>	<i>132,946</i>	<i>148,761</i>	<i>169,636</i>

(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) Includes other fuel mining. (c) Incomplete. See Coverage, page 1044.

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

**MINING AND QUARRYING: VALUE OF POWER, FUEL, LIGHT, AND
OTHER MATERIALS AND STORES USED, AUSTRALIA, 1962 TO 1966**
(\$'000)

<i>Industry</i>	<i>1962</i>	<i>1963</i>	<i>1964</i>	<i>1965</i>	<i>1966</i>
Metal mining—					
Gold	9,894	9,758	8,334	8,433	8,207
Silver-lead-zinc	17,342	21,590	22,688	21,009	22,265
Copper-gold	6,768	7,232	7,698	8,365	9,535
Tin	1,274	1,508	1,854	2,115	3,095
Mineral sands	3,676	5,052	5,496	6,138	7,569
Other metal	2,484	2,850	3,162	4,366	6,084
<i>Total, metal mining</i>	<i>41,438</i>	<i>47,990</i>	<i>49,234</i>	<i>50,427</i>	<i>56,756</i>
Fuel mining—					
Black coal	26,692	(a)27,002	(a)29,114	(a)31,718	(a)35,746
Brown coal	1,344	1,478	1,532	2,108	2,082
<i>Total, fuel mining</i>	<i>28,036</i>	<i>28,480</i>	<i>30,648</i>	<i>33,827</i>	<i>37,828</i>
Non-metal (excluding fuel) mining(b)	5,636	5,534	5,342	5,720	5,641
<i>Total, all mining</i>	<i>75,110</i>	<i>82,004</i>	<i>85,226</i>	<i>89,974</i>	<i>100,224</i>
Construction material quarrying(b)	9,000	9,060	9,728	11,067	12,072
<i>Total, all mining and quarrying</i>	<i>84,110</i>	<i>91,064</i>	<i>94,952</i>	<i>101,041</i>	<i>112,297</i>

(a) Includes other fuel mining. (b) Incomplete. See Coverage, page 1044.

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, 1962 TO 1966**
(\$'000)

<i>Industry</i>	<i>1962</i>	<i>1963</i>	<i>1964</i>	<i>1965</i>	<i>1966</i>
Metal mining—					
Gold	3,216	2,024	1,365	1,094	1,195
Silver-lead-zinc	7,046	14,154	20,071	10,939	12,535
Copper-gold	2,730	5,066	7,419	5,333	6,085
Tin	540	1,548	4,459	6,583	9,798
Mineral sands	3,752	2,436	3,592	6,729	11,103
Other metal	5,154	4,476	5,556	33,328	47,753
<i>Total, metal mining</i>	<i>22,438</i>	<i>29,702</i>	<i>42,462</i>	<i>64,006</i>	<i>88,469</i>
Fuel mining—					
Black coal	26,096	(b)20,668	(b)19,952	(b)28,695	(b)45,442
Brown coal	6,122	6,610	5,416	6,115	5,107
<i>Total, fuel mining</i>	<i>32,218</i>	<i>27,278</i>	<i>25,368</i>	<i>34,810</i>	<i>50,548</i>
Non-metal (excluding fuel) mining(c)	1,408	1,742	3,497	2,109	3,638
<i>Total, all mining</i>	<i>56,064</i>	<i>58,722</i>	<i>71,327</i>	<i>100,925</i>	<i>142,654</i>
Construction material quarrying(c)	3,902	3,898	5,867	7,303	5,273
<i>Total, all mining and quarrying</i>	<i>59,966</i>	<i>62,620</i>	<i>77,194</i>	<i>108,228</i>	<i>147,927</i>

(a) Excludes mines and quarries employing less than four persons. (b) Includes other fuel mining. (c) Incomplete. See Coverage, page 1044.

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 1966 and earlier years.

MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION^(a)
STATES AND TERRITORIES, 1966
 (\$'000)

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust..
Metal mining—									
Gold	8	688	(b)	..	23,430	..	(b)	..	26,551 ^c
Silver-lead-zinc	81,405	..	79,997	12	(b)	(b)	(b)	..	160,079 ^c
Copper-gold	5,032	4	..	7	(b)	(b)	7,956	..	37,320 ^c
Tin	3,941	55	4,884	..	2,052	3,565	69	..	14,566 ^c
Mineral sands	19,141	..	6,909	..	5,166	..	..	..	31,216 ^c
Other metal	329	6	(b)	13,404	34,016	(b)	(b)	..	59,875 ^c
<i>Total, metal mining</i>	<i>109,857</i>	<i>752</i>	<i>97,889</i>	<i>13,423</i>	<i>65,368</i>	<i>30,187</i>	<i>12,132</i>	..	<i>329,607</i>
Fuel mining—									
Black coal	117,626	497	25,221	3,228	4,448	362	..	..	151,383 ^c
Brown coal	..	20,064	..	..	..	..	..	..	20,064 ^c
Other fuel	..	..	9,230	..	..	..	..	..	9,230 ^c
<i>Total, fuel mining</i>	<i>117,626</i>	<i>20,561</i>	<i>34,451</i>	<i>3,228</i>	<i>4,448</i>	<i>362</i>	..	..	<i>180,676</i>
Non-metal (excluding fuel) mining—									
Clays(c)	2,978	3,090	264	693	388	114	..	..	7,528 ^c
Gypsum	216	244	..	1,476	70	..	..	..	2,005 ^c
Limestone	3,213	(b)	1,914	2,414	(b)	(b)	..	..	10,601 ^c
Salt	..	(b)	(b)	2,078	(b)	..	..	..	2,627 ^c
Other non-metal mining(c)	2,035	36	(b)	4,442	(b)	(b)	..	..	9,301 ^c
<i>Total, non-metal mining</i>	<i>8,443</i>	<i>5,887</i>	<i>2,668</i>	<i>11,103</i>	<i>3,229</i>	<i>732</i>	..	..	<i>32,062^c</i>
<i>Total, all mining</i>	<i>235,925</i>	<i>27,201</i>	<i>135,008</i>	<i>27,754</i>	<i>73,046</i>	<i>31,281</i>	<i>12,132</i>	..	<i>542,346^c</i>
Construction material quarrying(c)	27,826	25,905	3,475	14,200	6,462	3,280	1,151	1,074	83,372 ^c
<i>Total, all mining and quarrying</i>	<i>263,751</i>	<i>53,105</i>	<i>138,483</i>	<i>41,954</i>	<i>79,507</i>	<i>34,561</i>	<i>13,283</i>	<i>1,074</i>	<i>625,718</i>

(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 1044.

MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION^(a)
STATES AND TERRITORIES, 1962 TO 1966
 (\$'000)

Year	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust..
1962	159,928	40,016	74,198	30,774	46,490	17,806	5,926	375,138
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 ^c
1965	267,674	48,924	98,964	39,466	49,072	28,998	9,273	542,371 ^c
1966	263,751	53,105	138,483	41,954	79,507	34,561	14,357	625,718 ^c

(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 1966 and earlier years.

**MINING AND QUARRYING: NET VALUE OF PRODUCTION^(a)
STATES AND TERRITORIES, 1966
(\$'000)**

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	4	495	(b)	..	15,874	..	(b)	..	18,344
Silver-lead-zinc	69,791	..	68,020	8	(b)	(b)	(b)	..	137,814
Copper-gold	4,599	1	..	5	(b)	(b)	6,437	..	27,785
Tin	3,502	51	3,678	..	1,555	2,650	35	..	11,471
Mineral sands	14,655	..	4,797	..	4,195	..	..	..	23,647
Other metal	304	5	(b)	11,415	31,187	(b)	(b)	..	53,790
Total, metal mining	92,855	554	82,165	11,429	53,221	22,529	10,097	..	272,851
Fuel mining—									
Black coal	89,230	388	(c)28,650	2,681	3,633	285	..	..	(c)124,866
Brown coal . . . . .	..	17,983	..	..	..	..	..	..	17,983
Total, fuel mining	89,230	18,370	28,650	2,681	3,633	285	..	..	142,849
Non-metal (excluding fuel) mining—									
Clays(d)	2,623	3,020	233	608	257	104	..	..	6,845
Gypsum	169	199	..	1,280	56	..	..	..	1,704
Limestone	2,325	(b)	1,237	2,133	(b)	(b)	..	..	7,666
Salt . . . . .	..	(b)	(b)	1,759	(b)	(b)	..	..	2,227
Other non-metal mining(d)	1,875	36	(b)	4,266	(b)	(b)	..	..	7,979
Total, non-metal mining	6,993	4,878	1,910	10,046	2,069	526	..	..	26,422
Total, all mining	189,078	23,803	112,725	24,155	58,924	23,340	10,097	..	442,121
Construction material quarrying(d)	27,826	19,585	2,646	12,095	4,887	2,488	973	800	71,300
Total all mining and quarrying	216,904	43,388	115,370	36,250	63,811	25,828	11,070	800	513,421

(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 1044.

**MINING AND QUARRYING: NET VALUE OF PRODUCTION^(a)
STATES AND TERRITORIES, 1962 TO 1966**

Year	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust.
NET VALUE OF PRODUCTION (\$'000)								
1962	125,218	32,394	58,006	26,414	32,244	12,234	4,518	291,028
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	39,957	79,742	33,979	35,192	20,309	6,378	441,328
1966	216,904	43,388	115,370	36,250	63,811	25,828	11,870	513,421

**NET VALUE OF PRODUCTION PER HEAD OF POPULATION
(\$)**

1962	31.14	10.76	37.10	26.45	41.48	34.16	38.77	26.83
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	50.77	13.35	68.34	32.84	74.02	69.07	75.12	43.85

(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 1044. Particulars relating to uranium bearing minerals are excluded.

The following tables show particulars of the quantity of the principal minerals produced during 1966 and earlier years.

**QUANTITIES OF PRINCIPAL MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1966**

<i>Mineral</i>		<i>N.S.W.</i>	<i>Vic.</i>	<i>Qld</i>	<i>S.A.</i>	<i>W.A.</i>	<i>Tas.</i>	<i>N.T.</i>	<i>Aust.</i>
METALLIC MINERALS									
Antimony concentrate	tons	150	..	..	..	..	..	..	150
Bauxite	"	17,906	..	973,250	..	807,105	..	..	1,798,261
Beryllium ore	"	39	..	..	..	13	..	..	52
Copper ore(a)	"	117	..	40,665	141	962	11,112	466	53,463
Copper concentrate	"	26,788	36	352,661	..	3,268	55,981	39,253	477,987
Copper precipitate	"	145	..	1	..	..	66	511	723
Gold(b)	oz	238	21,644	42,979	5	947,306	84	66,331	1,078,587
Ilmenite concentrate	tons	11,710	..	3,453	..	497,848	..	..	513,011
Iron ore(c)	'000 tons	..	..	..	4,787	6,766	..	..	11,553
Lead ore(d)	tons	2,689	..	14,413	20	2,037	..	62	19,221
Lead concentrate	"	365,812	..	134,628	..	644	14,462	27	515,573
Lead-copper concentrate . . . . .	"	..	..	..	..	..	12,083	..	12,083
Lead-zinc concentrate	"	14,254	..	..	..	..	..	..	14,254
Leucoxene concentrate . . . . .	"	..	..	..	..	756	..	..	756
Manganese ore	"	30	..	5,500	..	183,209	..	123,801	312,540
Monazite concentrate	"	465	..	173	..	1,346	..	..	1,984
Pyrite concentrate . . . . .	"	..	..	7,815	101,041	76,136	61,006	..	245,998
Rutile concentrate	"	172,531	..	70,751	..	576	..	..	243,858
Tantalite-columbite concentrate	lb	..	..	..	..	10,550	..	..	10,550
Tin concentrate	tons	2,625	26	2,417	..	973	1,510	53	7,604
Tungsten concentrates—									
Scheelite concentrate . . . . .	"	..	..	..	..	1	1,307	..	1,308
Wolfram concentrate . . . . .	"	..	..	1	..	..	497	..	498
Zinc concentrate	"	490,481	..	64,518	..	..	83,761	28	638,788
Zircon concentrate	"	153,795	..	56,695	..	25,159	..	..	235,649
FUEL MINERALS									
Coal, black—									
Semi-anthracite	'000 tons	..	..	43	..	..	2	..	45
Bituminous	"	25,470	36	4,460	..	..	80	..	30,045
Sub-bituminous . . . . .	"	..	..	161	2,021	1,061	..	..	3,243
<i>Total coal, black</i>	"	25,470	36	4,664	2,021	1,061	83	..	33,334
Coal, brown (lignite)	"	..	21,783	..	..	..	..	..	21,783
Natural gas	'000 cu ft	..	..	142,978	..	..	..	..	142,978
Natural gas condensate	barrels	..	..	121	..	..	..	..	121
Crude oil	'000 barrels	..	..	3,389	..	..	..	..	3,389

For footnotes see next page.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1966—*continued*

Mineral		N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Aust.
NON-METALLIC (EXCLUDING FUEL) MINERALS									
Asbestos	short tons	494	..	..	..	12,974	..	..	13,468
Barite	tons	633	..	..	11,281	1,810	..	..	13,724
Clays—									
Brick clay and shale	'000 tons	2,209	1,459	429	451	411	160	..	5,118
Other(e) . . . . .	..	478	253	82	102	166	40	..	1,121
Diatomite	tons	1,718	969	(f)	..	(f)	..	..	7,148
Dolomite(g) . . . . .	..	5,042	..	10,075	238,280	5	2,606	..	256,008
Felspar . . . . .	..	4,237	..	..	1,740	1,282	..	..	7,259
Gypsum . . . . .	..	44,962	111,293	..	603,413	41,884	..	..	801,552
Limestone(g)	'000 tons	2,695	1,807	(f)	1,455	(f)	(f)	..	7,730
Magnesite	tons	18,915	..	..	506	135	..	..	19,556
Phosphate rock . . . . .	..	..	..	..	5,715	..	..	..	5,715
Salt, crude . . . . .	..	..	(f)	(f)	519,623	(f)	..	..	644,817
Silica (glass, chemical, etc.)(e) . . . . .	..	220,942	..	47,010	45,442	28,312	5,417	..	347,123
Talc . . . . .	..	1,665	..	..	6,507	9,155	..	..	17,327

CONSTRUCTION MATERIALS(e)

Sand	'000 tons	4,179	4,287	n.a.	1,586	n.a.	228	} (h)967	{	10,691
River gravel	2,435	3,274	n.a.	857	n.a.	1,426				} (h)505	{	8,549
Dimension stone . . . . .	..	44	10	2	31	147	1	} (h)505	{	241
Crushed and broken stone	8,301	19,102	3,124	10,805	2,963	2,115				} (h)505	{	46,796
Other (decomposed rock, etc) . . . . .	..	19,028	2,359	414	n.a.	n.a.	303	} (h)505	{	22,216

(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 1044. (f) Not available for publication. (g) Excludes quantities used directly as building or road material. (h) Includes Australian Capital Territory which is not available for publication by individual items.

**QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA
1962 TO 1966**

Mineral		1962	1963	1964	1965	1966
METALLIC MINERALS						
Antimony ore and concentrate	tons	100	115	414	55	150
Bauxite . . . . .	..	29,547	354,206	783,900	1,167,671	1,798,261
Beryllium ore . . . . .	..	223	110	111	38	52
Chromite . . . . .	..	369	160	72	23	..
Copper ore(a) . . . . .	..	110,777	82,035	59,686	41,325	53,463
Copper concentrate . . . . .	..	395,427	434,368	427,258	389,398	477,987
Copper precipitate . . . . .	..	216	504	264	299	723
Gold(b)	'000 oz	(c)	1,231	1,150	1,119	1,079
Ilmenite concentrate	tons	178,867	200,983	303,628	441,034	513,011
Iron ore(d)	'000 tons	4,843	5,515	5,669	6,695	11,553
Lead ore(e)	tons	13,197	16,249	25,174	24,906	19,221
Lead concentrate . . . . .	..	522,278	584,462	536,213	503,356	515,573
Lead-copper concentrate . . . . .	..	11,192	9,309	10,214	10,424	12,083
Lead-zinc concentrate . . . . .	..	..	..	..	..	14,254
Leucoxene concentrate . . . . .	..	627	547	656	380	756
Manganese ore . . . . .	..	71,646	36,061	61,109	100,369	312,540
Monazite concentrate . . . . .	..	814	1,992	1,981	2,305	1,984
Pyrite concentrate . . . . .	..	148,566	194,059	220,078	204,011	245,998
Rutile concentrate . . . . .	..	119,195	183,260	182,371	217,330	243,858
Tantalite-columbite concentrate	lb	43,097	30,889	33,600	25,581	10,550
Tin concentrate	tons	3,842	4,132	5,314	6,237	7,604
Tungsten concentrates—						
Scheelite concentrate . . . . .	..	995	958	1,020	1,150	1,308
Wolfram concentrate . . . . .	..	492	394	380	487	498
Zinc concentrate . . . . .	..	572,900	594,861	588,840	604,211	638,788
Zircon concentrate . . . . .	..	133,844	184,830	184,082	226,863	235,649

For footnotes see next page.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA
1962 TO 1966—continued

Minerals	1962	1963	1964	1965	1966
FUEL MINERALS					
Coal, black—					
Semi-anthracite . . . '000 tons	69	61	79	70	45
Bituminous "	22,006	22,268	24,477	28,228	30,045
Sub-bituminous "	2,394	2,528	2,845	3,140	3,243
<i>Total coal, black</i> "	<i>24,470</i>	<i>24,856</i>	<i>27,401</i>	<i>31,439</i>	<i>33,334</i>
Coal, brown (lignite) "	17,137	18,456	19,035	20,659	21,783
Natural gas '000 cu ft	56,361	95,725	106,490	143,402	142,978
Natural gas condensate barrels	63	123	245	122	121
Crude oil '000 barrels	..	..	1,491	2,621	3,389
NON-METALLIC (EXCLUDING FUEL) MINERALS					
Asbestos short tons	18,416	13,374	13,654	11,566	13,468
Barite tons	12,534	8,220	12,302	11,976	13,724
Clays—					
Brick clay and shale . . . '000 tons	4,383	4,549	5,163	5,056	5,118
Other (f) "	913	984	1,039	1,008	1,121
Diatomite tons	7,312	5,133	8,732	6,958	7,148
Dolomite(g) "	180,697	214,339	236,068	258,661	256,008
Felspar "	8,513	8,842	9,021	8,726	7,259
Gypsum "	630,910	725,444	795,003	833,521	801,552
Limestone(g) '000 tons	6,415	6,721	7,223	7,516	7,730
Magnesite tons	62,191	56,946	31,250	26,362	19,556
Phosphate rock "	4,385	4,925	5,689	4,519	5,715
Salt, crude "	536,019	581,537	545,491	654,533	644,817
Silica (glass, chemical, etc.)(f)	218,544	247,928	322,269	320,937	347,123
Talc "	14,060	13,106	15,695	19,719	17,327
CONSTRUCTION MATERIALS(f)					
Sand '000 tons	7,535	9,050	10,757	11,444	10,691
River gravel "	5,912	7,625	8,117	7,760	8,549
Dimension stone "	379	629	590	467	241
Crushed and broken stone "	27,944	29,768	34,175	39,733	46,796
Other (decomposed rock, etc.) "	17,310	20,830	23,460	21,363	22,216

(a) Includes cupreous ore for fertiliser. (b) Bullion, alluvial, retorted gold, etc. (c) Gross weight not available.
(d) Iron oxide for metal extraction. (e) Includes lead-silver-zinc ore. (f) Incomplete, owing to difficulties of coverage.
See Coverage, page 1044. (g) Excludes quantities used directly as building or road material.

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

Contents of metallic minerals produced

The following tables show the contents of metallic minerals produced in 1966 and earlier years.

**CONTENTS OF METALLIC MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1966**

<i>Content of metallic minerals produced</i>	<i>N.S.W.</i>	<i>Vic.</i>	<i>Qld</i>	<i>S.A.</i>	<i>W.A.</i>	<i>Tas.</i>	<i>N.T.</i>	<i>Aust.</i>
Alumina (Al ₂ O ₃) tons	6,822	..	569,351	..	363,197	..	..	939,370
Antimony "	971	..	..	..	..	..	..	971
Beryllium oxide (BeO) units(a)	490	..	..	..	147	..	..	637
Bismuth lb	650	..	..	..	67	..	..	717
Cadmium tons	1,005	..	132	..	75	..	..	1,212
Cobalt "	84	..	..	..	..	..	..	84
Copper "	9,242	5	72,643	28	814	17,005	9,800	109,537
Gold fine oz	9,078	21,005	139,202	5	627,052	36,502	84,141	916,985
Iron(b) '000 tons	..	..	..	3,068	4,317	..	..	7,385
Lead tons	283,044	..	65,541	7	706	15,578	22	364,898
Manganese(c) "	6,130	..	..	..	86,885	254	58,132	151,401
Manganese dioxide (MnO ₂)(d) "	22	..	3,663	..	50	..	356	4,091
Molybdenum disulphide (MoS ₂) lb	5,549	..	..	..	..	..	..	5,549
Monazite oz	395	..	162	..	1,279	..	..	1,836
Platinum "	13	..	..	..	..	..	..	13
Silver '000 fine oz	10,544	..	6,192	..	237	1,833	81	18,888
Sulphur(e) tons	210,312	..	24,491	40,770	33,198	62,796	..	371,567
Tantalite-columbite (Ta ₂ O ₅ + Nb ₂ O ₅) lb	..	..	..	..	5,698	..	..	5,698
Tin tons	1,367	18	1,692	..	667	1,031	32	4,807
Titanium dioxide (TiO ₂) "	171,364	..	70,182	..	275,199	..	..	516,745
Tungstic oxide (WO ₃) . . . . . "	..	..	..	..	..	1,307	..	1,307
Zinc "	275,191	..	43,588	55	644	49,851	12	369,341
Zircon "	152,257	..	56,128	..	24,518	..	..	232,903

(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 (U₃O₈) are not available for publication.

CONTENTS OF METALLIC MINERALS PRODUCED: AUSTRALIA, 1962 TO 1966

<i>Content of metallic minerals produced</i>	<i>1962</i>	<i>1963</i>	<i>1964</i>	<i>1965</i>	<i>1966</i>
Alumina (Al ₂ O ₃) tons	13,250	154,499	396,329	613,337	939,370
Antimony "	874	1,007	1,116	944	971
Beryllium oxide (BeO) units(a)	2,586	1,278	1,279	457	637
Bismuth lb	97	..	..	..	717
Cadmium tons	992	1,109	1,050	1,155	1,212
Chromic oxide (Cr ₂ O ₃) "	185	72	32	10	..
Cobalt "	78	86	73	90	84
Copper "	106,972	112,967	104,050	90,388	109,537
Gold fine oz	1,068,837	1,023,970	963,834	877,643	916,985
Iron(b) '000 tons	3,119	3,558	3,655	4,297	7,385
Lead tons	370,110	410,291	374,856	362,137	364,898
Manganese(c) "	39,413	23,951	36,564	55,280	151,401
Manganese dioxide (MnO ₂)(d) "	1,512	1,228	1,033	1,652	4,091
Molybdenum disulphide (MoS ₂) lb	2,332	21,645	..	41,911	5,549
Monazite tons	772	1,875	1,848	2,165	1,836
Platinum oz	2	4	..	..	13
Silver '000 fine oz	17,554	19,642	18,427	17,281	18,888
Sulphur(e) tons	312,803	345,636	346,502	345,554	371,567
Tantalite-columbite (Ta ₂ O ₅ + Nb ₂ O ₅) lb	18,879	12,935	12,499	10,281	5,698
Tin tons	2,715	2,860	3,642	3,849	4,807
Titanium dioxide (TiO ₂) "	215,494	288,050	342,646	448,318	516,745
Tungstic oxide (WO ₃) "	1,042	960	996	1,176	1,307
Zinc "	337,532	351,470	344,600	349,231	369,341
Zircon "	132,109	182,112	182,174	224,654	232,903

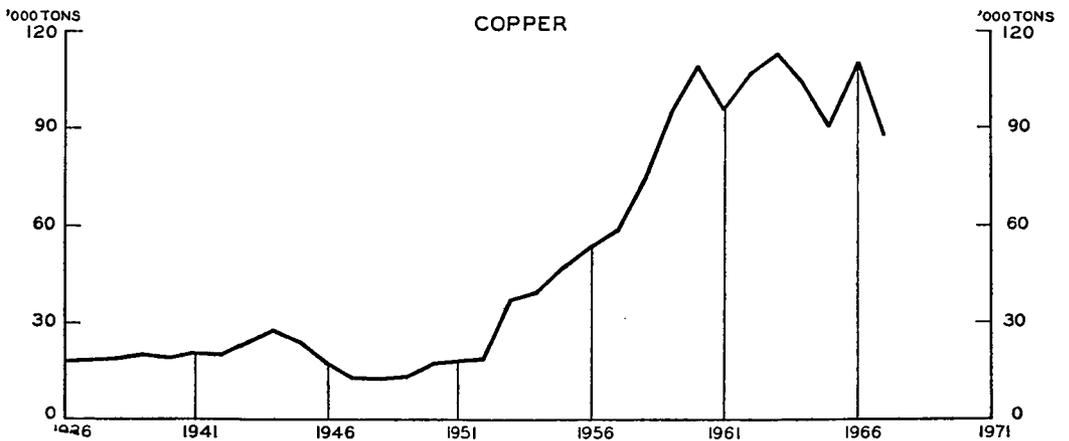
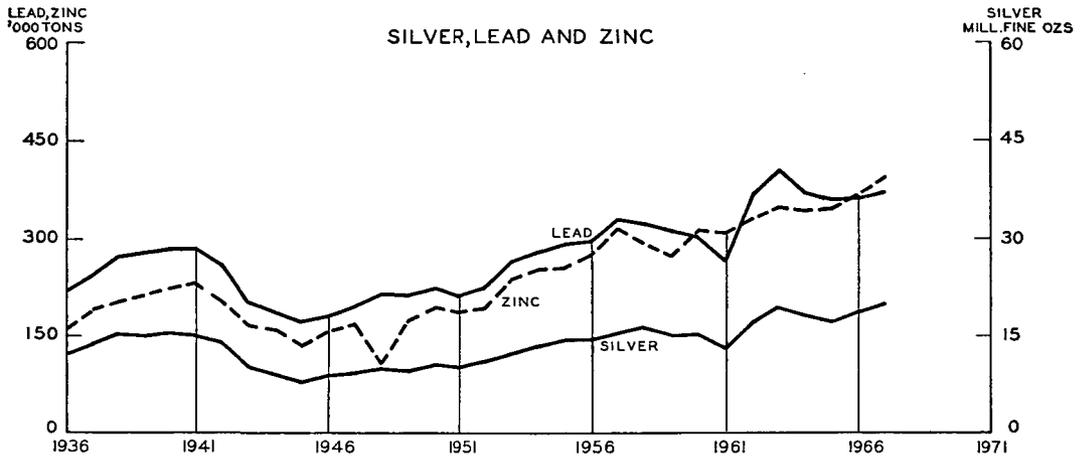
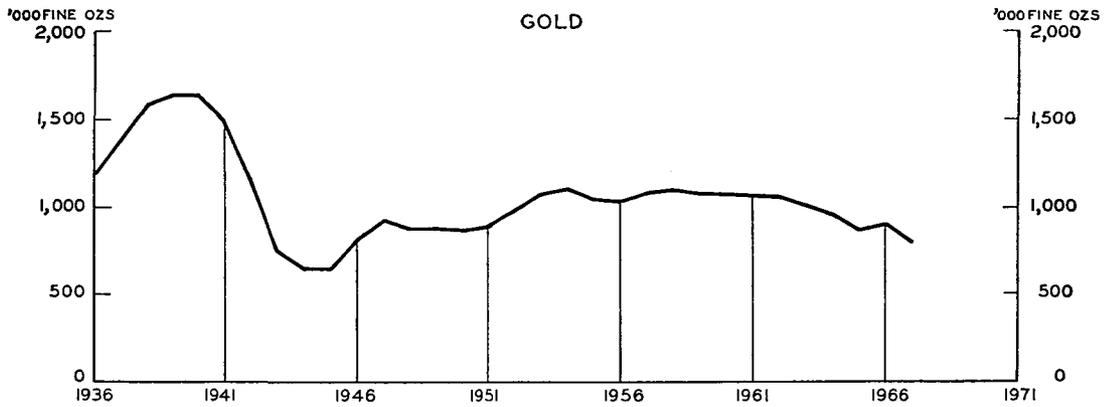
(a) 1 unit = 22.4 lb. (b) Iron oxide for metal extraction. (c) Content of metallurgical grade manganese ore and zinc concentrate. (d) Content of manganese ore of other than metallurgical grade. (e) Sulphur content of pyrite and other minerals from which sulphur is extracted.

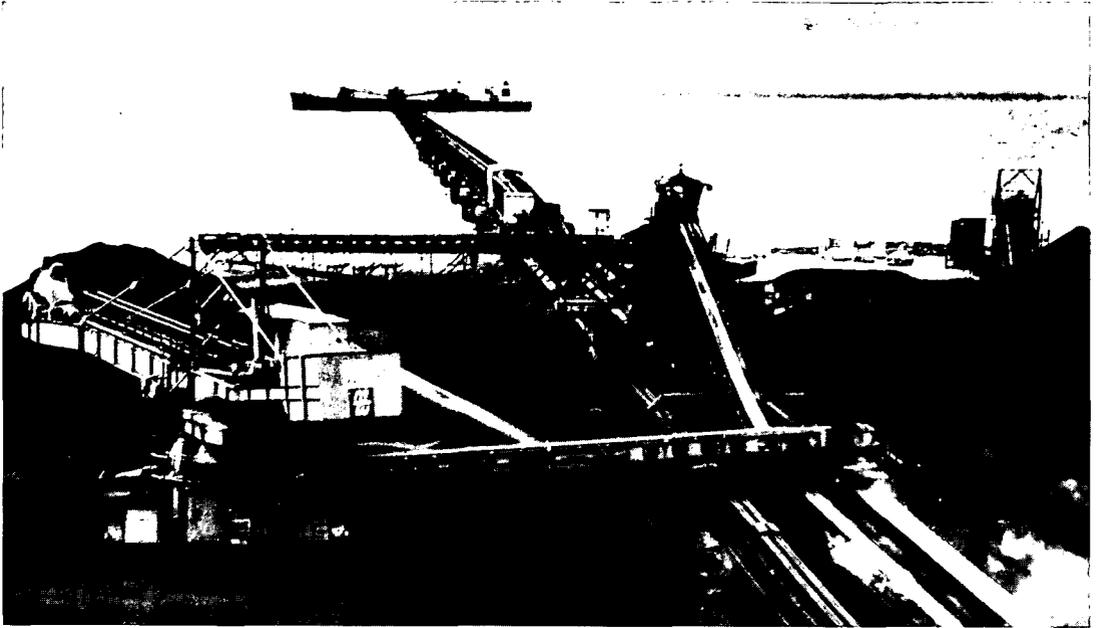
NOTE. Particulars of production of uranium oxide (U₃O₈) are not available for publication.

MINE PRODUCTION OF PRINCIPAL METALS: AUSTRALIA

(METALLIC CONTENT OF MINERALS)

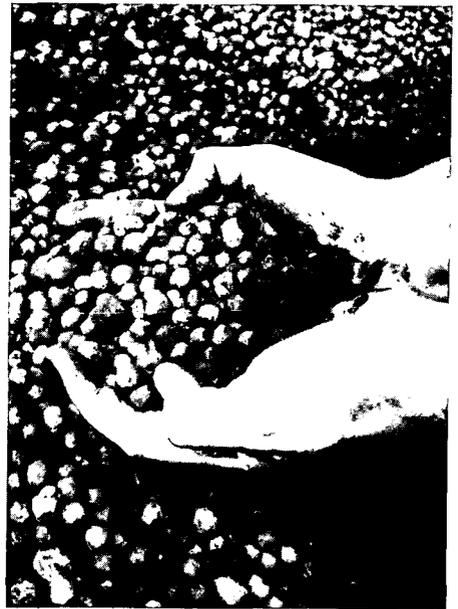
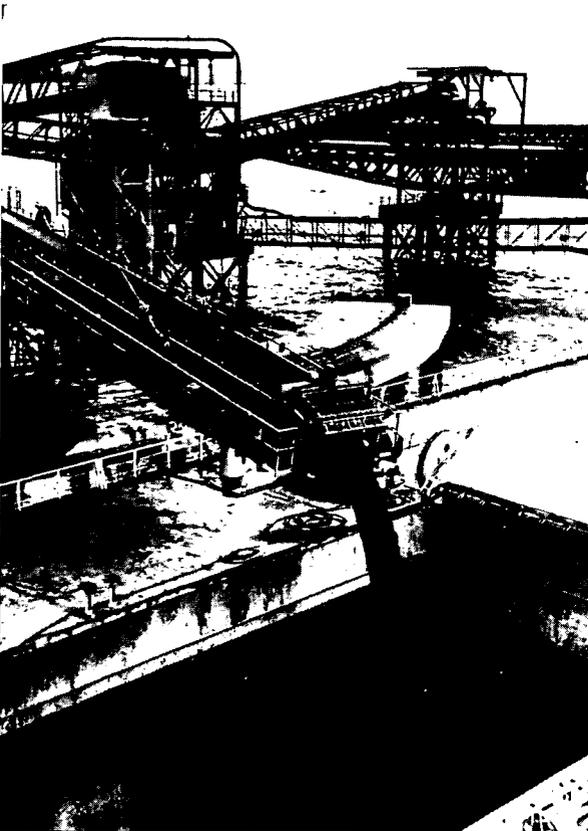
1936 TO 1967





Above and below: Iron ore pellet ship loading facilities, Port Latta, Tasmania

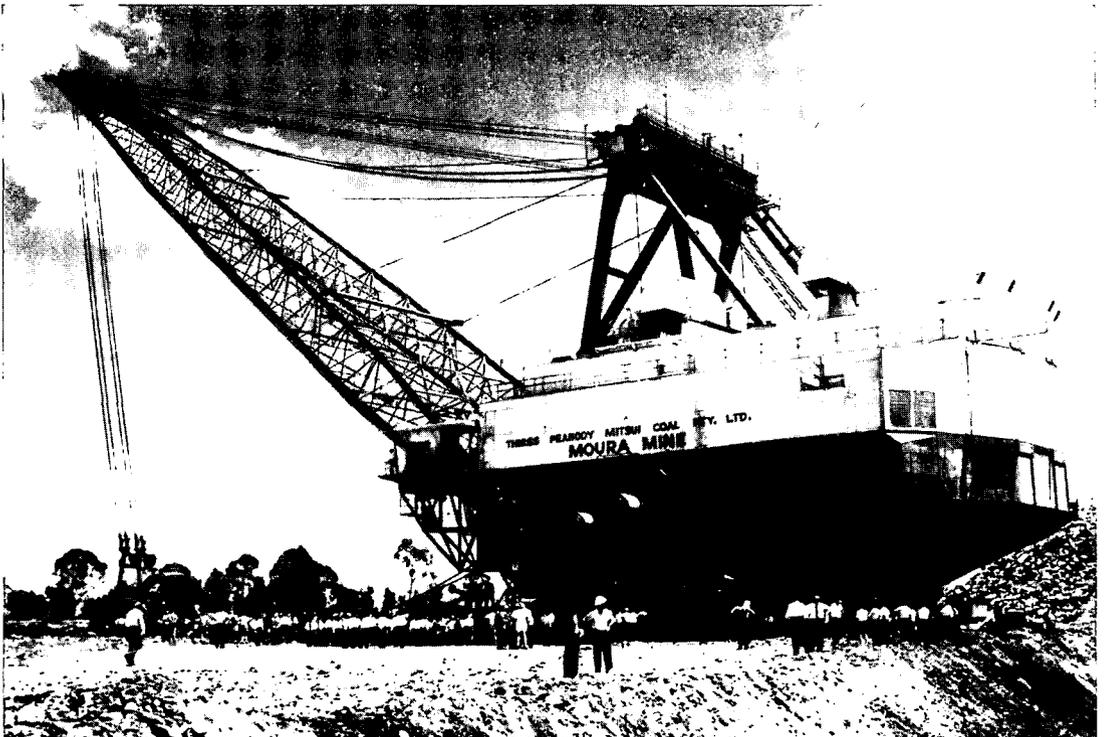
Right: Iron ore pellets



*Photographs for plates 63 and 64
by courtesy of Australian News and Information
Bureau.*



*Above: Open-cut coalfield, Moura, Queensland
Below: World's largest walking dragline,
Moura, Queensland*



MINE PRODUCTION OF PRINCIPAL METALS AND PRODUCTION OF COAL

(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1936 to 1967

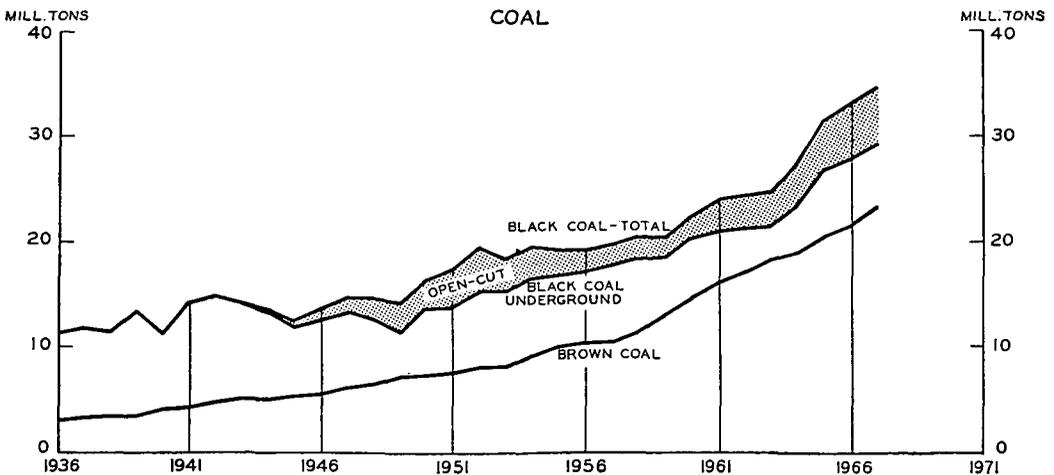
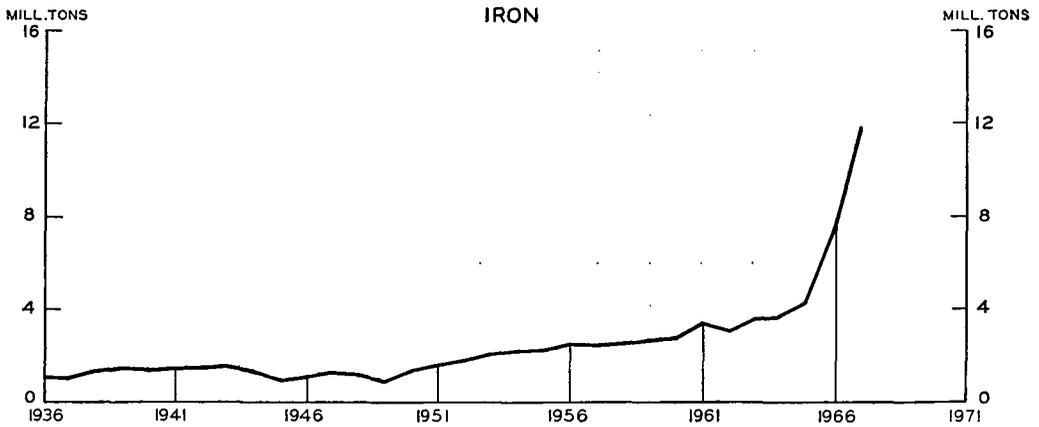
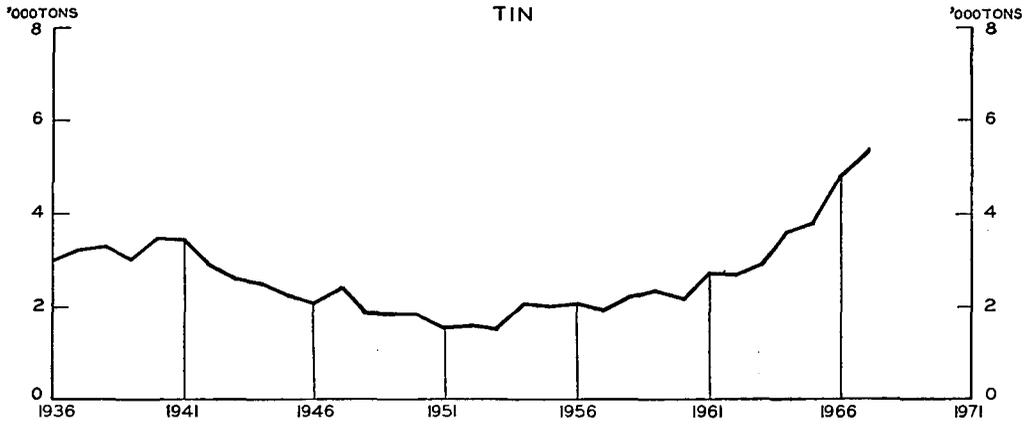


PLATE 65

Graphs showing details of the mine production of principal metals (metallic content) and coal from 1936 to 1967 are included on plates 62 and 65, pages 1056 and 1057.

Local value of minerals produced, 1962 to 1966

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, 1962 TO 1966 (\$'000)

<i>Mineral</i>	<i>1962</i>	<i>1963</i>	<i>1964</i>	<i>1965</i>	<i>1966</i>
Metallic minerals—					
Bauxite	136	1,748	3,064	4,600	7,087
Copper ore, concentrate, etc.	48,604	52,036	51,380	50,790	87,523
Gold ore, concentrate, other forms, etc.	31,254	29,556	26,666	25,619	26,371
Ilmenite concentrate	1,298	1,554	2,208	3,755	4,242
Iron ore	10,650	12,200	12,550	14,640	42,317
Lead and lead-silver ore and concentrate, lead-copper concentrate, etc.	39,096	56,320	80,806	87,947	76,831
Manganese ore	960	492	750	808	3,462
Pyrite concentrate	2,230	2,354	3,054	3,040	2,745
Rutile concentrate	7,038	12,114	12,080	15,038	17,088
Tin concentrate	5,668	5,784	10,224	12,237	14,332
Tungsten concentrates	1,118	900	1,420	2,692	4,469
Zinc ore and concentrate	9,110	16,468	35,456	36,818	32,890
Zircon concentrate	2,582	3,550	3,462	6,136	8,255
Other metallic minerals	460	432	522	548	610
<i>Total, metallic minerals</i>	<i>160,204</i>	<i>195,508</i>	<i>243,642</i>	<i>264,668</i>	<i>328,222</i>
Fuel minerals—					
Coal, black	119,078	118,202	128,038	143,703	151,380
Coal, brown	15,682	16,156	17,304	18,436	20,064
Other fuel minerals	n.a.	58	2,164	5,344	9,229
<i>Total, fuel minerals</i>	<i>134,760</i>	<i>134,416</i>	<i>147,506</i>	<i>167,483</i>	<i>180,675</i>
<i>Total, non-metallic minerals(a)</i>	<i>24,320</i>	<i>26,038</i>	<i>27,814</i>	<i>29,241</i>	<i>31,951</i>
<i>Total, construction materials(a)</i>	<i>55,854</i>	<i>60,720</i>	<i>73,244</i>	<i>80,183</i>	<i>83,477</i>
Total, all minerals and construction materials	375,138	416,682	492,208	541,575	624,325

(a) Incomplete owing to difficulties of coverage. See scope and sources of statistics, page 1044.

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 1050 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

These statistics on overseas participation in the Australian mining industry were obtained from the first of a series of studies of overseas participation in Australian industry, and were published in the mimeographed bulletin *Overseas Participation in Australian Mining Industry, 1963 to 1965*.

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 this series.

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, 1963 to 1965*.

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.

MINING(a): VALUE OF PRODUCTION APPORTIONED TO AUSTRALIAN AND DIRECT OVERSEAS OWNERSHIP, BY INDUSTRY, 1963 TO 1965

<i>Industry and ownership</i>	<i>Value (\$'000)</i>			<i>Proportion Australian and overseas (per cent)</i>		
	<i>1963</i>	<i>1964</i>	<i>1965</i>	<i>1963</i>	<i>1964</i>	<i>1965</i>
Metal mining—						
Australian(b)	87,964	114,918	120,412	61.0	59.5	56.5
Overseas	56,250	78,179	92,873	39.0	40.5	43.5
Fuel mining—						
Australian(b)	94,024	100,833	107,717	88.8	86.4	80.6
Overseas	11,842	15,939	25,885	11.2	13.6	19.4
Non-metal (excluding fuel) mining—						
Australian(b)	9,043	10,203	10,015	85.2	84.1	82.8
Overseas	1,574	1,926	2,082	14.8	15.9	17.2
Total mining—						
Australian(b)	191,031	225,954	238,144	73.3	70.2	66.3
Overseas	69,666	96,044	120,840	26.7	29.8	33.7
Grand total	260,697	321,998	358,984	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, 1963 TO 1965

<i>Country, and proportion of direct overseas equity</i>	<i>Value (\$'000)</i>			<i>Proportion(c) (per cent)</i>		
	<i>1963</i>	<i>1964</i>	<i>1965</i>	<i>1963</i>	<i>1964</i>	<i>1965</i>
Country—						
United Kingdom	42,778	62,708	74,777	16.4	19.5	20.8
United States of America	22,224	28,754	33,292	8.5	8.9	9.3
Other	4,664	4,582	12,770	1.8	1.4	3.6
Proportion of direct overseas equity—						
25 per cent but less than 50 per cent	3,745	3,067	2,990	1.4	0.9	0.9
50 per cent but less than 75 per cent	22,421	27,450	35,243	8.6	8.5	9.8
75 per cent and over	43,500	65,527	82,606	16.7	20.4	23.0
Total apportioned to direct overseas ownership	69,666	96,044	120,840	26.7	29.8	33.7

(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.

OVERSEAS PARTICIPATION IN AUSTRALIAN MINING INDUSTRY 1061

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.

MINING(a): VALUE OF PRODUCTION OF ESTABLISHMENTS OF DIRECT OVERSEAS INVESTMENT COMPANIES AND OTHER ESTABLISHMENTS, BY INDUSTRY 1963 TO 1965

Industry	Value (\$'000)			Proportion (per cent)		
	1963	1964	1965	1963	1964	1965
Metal mining—						
Establishments of direct overseas investment companies	76,323	101,744	122,880	52.9	52.7	57.6
Other establishments	67,892	91,353	90,406	47.1	47.3	42.4
Fuel mining—						
Establishments of direct overseas investment companies	16,391	21,512	33,943	15.5	18.4	25.4
Other establishments	89,474	95,260	99,658	84.5	81.6	74.6
Non-metal (excluding fuel) mining—						
Establishments of direct overseas investment companies	2,146	2,565	3,036	20.2	21.1	25.1
Other establishments	8,471	9,565	9,061	79.8	78.9	74.9
Total mining—						
Establishments of direct overseas investment companies	94,860	125,820	159,860	36.4	39.1	44.5
Other establishments	165,837	196,178	199,124	63.6	60.9	55.5
Grand total	260,697	321,998	358,984	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 1963 TO 1965

Proportion of direct overseas equity	Value (\$'000)			Proportion(b) (per cent)		
	1963	1964	1965	1963	1964	1965
25 per cent but less than 50 per cent	8,770	7,356	7,717	3.4	2.3	2.1
50 " " " " " 75 " "	40,388	49,359	62,651	15.5	15.3	17.5
75 " " and over	45,702	69,105	89,492	17.5	21.5	24.9
Total establishments of direct overseas investment companies	94,860	125,820	159,860	36.4	39.1	44.5

(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* were derived from the first annual general mineral exploration collection (excluding petroleum exploration), that for 1965, which was 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. 15, 1966 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 petroleum during the years 1965 and 1966.

**MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)
SUMMARY OF OPERATIONS, AUSTRALIA, 1965 AND 1966**

	1965	1966	<i>Increase 1965-66</i>
EXPLORATION EXPENDITURE(a)			
	\$'000	\$'000	Per cent
On drilling	10,511	13,994	33.1
Other	14,932	17,544	17.5
Total	25,443	31,539	24.0
Payments to contractors(b)	6,627	8,542	28.9
MAN-WEEKS WORKED(c)			
	'000	'000	Per cent
By professional persons(d)	38.8	43.2	11.3
By non-professional persons(e)	67.6	89.9	33.0
Total	106.5	133.0	24.9
FOOTAGE DRILLED, SUNK, OR DRIVEN			
	'000 feet	'000 feet	Per cent
Drilling—			
Core	1,139.1	1,645.1	44.4
Non-core	1,399.9	2,375.3	69.7
Total	2,539.0	4,020.4	58.3
Other(f)	67.9	59.5	-12.4

(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.

Minus sign (-) denotes decrease.

Footage drilled, etc., States and Northern Territory

The following table shows the footage drilled, etc. on mineral exploration other than for petroleum in each State and the Northern Territory during the years 1965 and 1966.

**MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)
FOOTAGE DRILLED, SUNK, OR DRIVEN, STATES AND
NORTHERN TERRITORY, 1965 AND 1966**
(^{'000} feet)

	1965		1966	
	Drilling	Other (a)	Drilling	Other (a)
PRIVATE EXPLORATION(b)				
New South Wales	764.2	2.6	943.0	3.5
Victoria	167.0	4.5	167.7	11.4
Queensland	592.2	8.0	1,507.9	6.9
South Australia	121.0	2.5	182.0	0.9
Western Australia	303.4	39.6	629.6	9.9
Tasmania	183.4	4.5	165.4	3.3
Northern Territory	214.3	6.2	224.7	23.6
<i>Total</i>	<i>2,345.4</i>	<i>67.9</i>	<i>3,820.4</i>	<i>59.5</i>
GOVERNMENTS				
Commonwealth(c)	7.6	..	5.6	..
State Mines Departments.	186.0	..	194.3	..
<i>Total</i>	<i>193.6</i>	<i>..</i>	<i>200.0</i>	<i>..</i>
TOTAL FOOTAGE DRILLED, SUNK, OR DRIVEN				
Australia	2,539.0	67.9	4,020.4	59.5

(a) Includes shafts, winzes, etc., sunk and drives, adits, etc., driven. (b) Includes State government business undertakings. (c) Includes Joint Coal Board.

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, 1966(a)

<i>Origin of expenditure</i>	<i>Expenditure</i>	<i>Percentage contribution</i>
	\$'000	
Private enterprise—		
Funds of Australian origin	14,898	22.4
Funds of overseas origin	37,577	56.5
<i>Total, private enterprise</i>	52,475	78.9
State Government departments	767	1.1
Commonwealth Government departments (excluding subsidy payments)	3,649	5.5
Commonwealth Government subsidy payments	9,617	14.5
<i>Total expenditure</i>	66,508	100.0

(a) Excludes expenditure in Papua and New Guinea.

EXPENDITURE ON PETROLEUM EXPLORATION BY PRIVATE ENTERPRISE AND BY COMMONWEALTH, STATE, AND BRITISH GOVERNMENTS TO 31 DECEMBER 1966(a)

<i>Origin of expenditure</i>	<i>Expenditure</i>	<i>Percentage contribution</i>
	\$'000	
Private enterprise—		
To end of 1966—		
Funds of Australian origin	134,597	30.6
Funds of overseas origin	214,105	48.7
<i>Total, private enterprise</i>	348,702	79.4
Government—		
Prior to 1946—		
State Government	3,084	0.7
British Government	50	..
Commonwealth Government—Grants	324	0.1
Other	1,051	0.2
1946 to 1966—		
State and Territory Departments of Mines	7,072	1.6
Commonwealth Government—subsidy payments	52,179	11.9
Department of National Development (excluding subsidy payments)	26,307	5.9
Department of Interior—topographic surveys, oil search	610	0.2
<i>Total, Government</i>	90,678	20.6
<i>Total expenditure</i>	439,379	100.0

(a) Includes expenditure in Papua and New Guinea

**WELLS AND FOOTAGE DRILLED IN PETROLEUM EXPLORATION
STATES AND TERRITORIES, 1966**

	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	T.P. N.G.	Total
Wells drilled(a)	5	6	65	13	37	1	7	..	134
Average total depth of wells drilled feet	5,544	5,330	6,169	4,439	6,449	5,910	6,262	..	6,155
Wells completed as potential oil producers	..	..	..	..	12	..	..	..	12
Wells completed as potential gas producers	..	2	5	2	5	..	..	..	14
Wells drilled or drilling over 10,000 feet	1	1	9	..	7	..	1	..	19
Footage drilled—									
Completed wells feet	26,922	26,266	367,578	57,214	178,681	5,910	24,470	..	687,041
Uncompleted holes(b) feet	15,347	4,999	7,693	9,711	21,448	697	8,886	..	68,781
Total footage drilled	42,269	31,265	375,271	66,925	200,129	6,607	33,356	..	755,822

(a) Number of holes which reached total depth during the year. (b) Uncompleted holes means wells suspended or drilling at 31 December 1966.

**WELLS AND FOOTAGE DRILLED IN PETROLEUM EXPLORATION
STATES AND TERRITORIES TO 31 DECEMBER 1966**

State or Territory	To 31 December 1964		1965		1966		To 31 December 1966	
	Wells	Footage	Wells	Footage	Wells	Footage	Wells	Footage
New South Wales	83	275,441	11	49,066	5	42,269	99	366,776
Victoria	166	375,213	9	69,505	6	31,265	181	475,983
Queensland	388	1,807,101	128	673,994	65	375,271	581	2,856,366
South Australia	120	292,272	8	49,542	13	66,925	141	408,739
Western Australia	121	504,165	37	214,598	37	200,129	195	918,892
Tasmania	21	14,000	1	7,717	1	6,607	23	28,324
Northern Territory	16	63,435	14	76,752	7	33,356	37	173,543
Papua and New Guinea	44	217,234	1	12,015	..	..	45	229,249
Total	..	..	209	1,153,189	134	755,822	..	..
Cumulative total.	959	3,548,861	1,168	4,702,050	1,302	5,457,872	1,302	5,457,872

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 1078–1102 and 1111–16.

Principal products

The following table shows particulars of the production of certain important manufactured products of mineral origin during the years 1962–63 to 1966–67. 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, 1962-63 TO 1966-67**

Commodity	1962-63	1963-64	1964-65	1965-66	1966-67
METALS					
Non-ferrous—					
Alumina tons	38,519	94,448	175,398	227,907	474,716
Refined aluminium "	26,870	58,937	85,497	87,222	92,826
Blister copper(a) "	88,901	92,809	57,880	98,529	77,888
Refined copper "	85,652	89,222	53,441	91,588	74,313
Lead bullion (for export)(a) "	78,299	82,440	63,827	81,709	84,690
Refined lead "	208,946	217,292	199,032	188,197	192,429
Refined zinc "	175,850	186,389	189,395	196,534	197,030
Refined tin "	2,714	2,959	2,931	3,537	3,237
Ferrous—					
Pig iron '000 tons	3,400	3,772	3,936	4,380	4,893
Steel ingots "	4,260	4,773	5,131	5,561	6,065
Precious—					
Refined gold(b) '000 f oz	1,006	911	871	774	726
Refined silver "	8,514	9,392	8,939	8,683	9,661
FUELS					
Coal products—					
Metallurgical coke '000 tons	2,759	2,915	3,118	3,179	3,365
Brown coal briquettes "	1,805	1,883	1,893	1,883	1,819
Petroleum products—					
Motor spirit mill. gal	1,263	1,358	1,482	1,524	1,763
Furnace fuel '000 tons	4,629	4,686	4,869	5,340	5,759
Automotive distillate "	1,654	1,616	1,603	1,829	2,167
Industrial diesel fuel "	981	917	862	859	901
BUILDING MATERIALS					
Clay bricks millions	1,059	1,238	1,353	1,360	1,358
Portland cement '000 tons	2,942	3,320	3,746	3,688	3,639
Plaster of paris "	241	260	277	266	262
Plaster sheets '000 sq yd	(c)15,932	(c)15,922	29,937	29,917	30,984
CHEMICALS					
Sulphuric acid '000 tons	1,256	1,447	1,610	1,752	1,979
Caustic soda tons	56,481	64,230	68,879	75,229	90,985
Superphosphate '000 tons	2,862	3,347	3,703	4,265	4,596

(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 1964 to 1966 are shown in the following table.

**EXPORTS AND IMPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS
AUSTRALIA, 1964 TO 1966**

Item	Quantity			Value (\$'000 f.o.b.)			
	1964	1965	1966	1964	1965	1966	
EXPORTS(a)							
Coal	tons	4,805,953	7,155,564	8,240,920	41,047	60,661	66,487
Copper—							
Ore and concentrate	„	47,255	46,111	47,455	6,484	7,337	9,603
Ingots, pigs (refined)	„	13,817	11,703	7,484	8,315	12,220	9,050
Rolled, drawn and extruded shapes	„	5,077	11,721	11,907	4,265	11,444	12,896
Gold, refined	fine oz	427,318	745,125	752,782	13,382	23,265	23,583
Iron and steel—							
Iron ore	tons	12,471	149,824	2,011,979	76	1,239	16,863
Pig iron	„	55,940	45,154	95,590	2,622	2,174	3,870
Ingots, blooms and slabs	„	8,507	10,519	347,842	529	605	19,805
Tinplate	„	65,435	71,363	87,945	9,028	9,282	10,651
Scrap	„	392,408	308,648	378,673	10,114	9,773	8,510
Lead—							
Ore and concentrate	„	112,194	108,256	109,134	17,614	20,829	19,386
Lead-silver bullion	„	76,061	69,286	79,534	20,094	21,252	21,901
Pig	„	156,305	156,545	159,504	35,267	43,502	37,786
Opals . . . . .	„	..	..	..	5,398	5,324	7,652
Petroleum oils—							
Gasolenes and solvents	'000 gal	51,656	16,478	42,238	5,448	2,199	4,986
Kerosenes	„	12,690	15,147	23,686	1,578	1,796	2,535
Automotive distillate	„	74,183	41,458	..	7,442	3,836	..
Industrial and marine diesel fuels and heavy distillate, n.e.i.	„	233,953	165,571	97,599	13,064	7,760	13,642
Residual oils . . . . .	„	..	..	117,694	..	..	..
Lubricating oil	„	14,342	15,697	17,654	4,444	4,776	5,557
Rutile concentrate	tons	193,893	239,454	231,289	14,080	17,134	17,844
Zinc—							
Ore and concentrate	„	224,117	212,946	226,561	15,684	14,328	15,442
Refinery type shapes	„	80,184	87,051	120,759	21,226	24,205	31,069
Zircon concentrate	„	198,664	216,661	210,428	5,124	6,816	8,978
IMPORTS							
Alumina	tons	71,437	55,647	51,091	4,818	3,900	3,365
Aluminium, refined ingots	„	565	357	461	372	312	353
Asbestos	short tons	42,896	51,719	55,152	4,873	5,859	6,437
Gold, unrefined bullion(b)	fine oz	143,144	137,143	151,462	4,466	4,252	4,104
Ferro-alloys	tons	19,271	32,587	20,007	4,171	6,909	4,495
Petroleum oils—							
Crude	'000 gal	3,253,862	3,399,992	3,653,396	147,356	155,851	160,139
Enriched crude and other refinery feedstock	„	692,727	899,284	962,162	32,974	40,391	41,783
Gasolenes and solvents	„	290,258	270,503	190,719	32,242	30,749	20,936
Kerosene	„	59,312	79,820	47,143	6,268	8,503	4,973
Automotive distillate	„	34,348	45,474	..	3,218	4,153	..
Industrial and marine diesel fuels and heavy distillate, n.e.i.	„	53,345	25,817	43,084	3,862	1,584	4,670
Residual oils . . . . .	„	..	..	21,713	..	..	..
Lubricating oil	„	47,031	20,646	13,009	12,616	5,602	3,864
Phosphate rock	'000 tons	2,355	2,527	3,286	16,236	17,505	27,479
Sulphur	tons	376,639	387,869	434,045	6,508	7,496	11,930
Tin, refined	„	1,283	1,582	203	3,798	5,259	661
Titanium oxide (pigments)	„	2,875	2,167	1,349	1,231	870	525

(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 1966 and their principal metallic content as estimated by assay.

**PRINCIPAL METALLIC CONTENTS OF SELECTED ORES AND CONCENTRATES
ETC., EXPORTED FROM AUSTRALIA, 1966**

<i>Ores and concentrates, etc.</i>	<i>Quantity exported</i>	<i>Metallic contents—estimated from assay</i>							
		<i>Anti-mony</i>	<i>Copper</i>	<i>Gold</i>	<i>Lead</i>	<i>Silver</i>	<i>Tin</i>	<i>Tungstic oxide</i>	<i>Zinc</i>
	<i>tons</i>	<i>tons</i>	<i>tons</i>	<i>fine oz</i>	<i>tons</i>	<i>'000 fine oz</i>	<i>tons</i>	<i>tons</i>	<i>tons</i>
Copper—									
Ore, concentrate and precipitate	47,822	..	10,657	23,421	..	79	..	..	..
Copper-lead dross and speiss	3,487	..	834	..	2,073	125	..	..	..
Other slags and residues	368	..	154	..	4	..	4	..	1
Blister	6,538	..	6,509	112,449	..	35	..	..	..
Matte	6,298	8	2,159	53	2,976	235	..	..	..
Lead—									
Ore and concentrate(a)	109,134	120	1,265	23,774	75,722	2,390	..	..	6,990
Slags and residues	3,981	52	262	..	2,371	33	37	..	101
Lead-silver bullion	79,534	..	..	..	79,015	5,289	..	..	..
Tin concentrate	2,606	..	5	..	1	..	1,285	..	..
Tungsten—									
Scheelite ore and concentrate	1,295	..	..	..	..	..	..	881	..
Wolfram ore and concentrate	520	..	..	..	..	..	..	380	..
Zinc—									
Ore and concentrate	226,560	..	..	..	2,493	111	..	..	116,278
Slags and residues	6,529	..	43	..	1	..	..	..	4,643
Total metallic content	..	180	21,888	159,697	164,656	8,298	1,326	1,261	128,013

(a) Includes lead-copper concentrate.

Direction of trade

The distribution of Australia's mineral exports according to principal destinations, and imports according to principal sources, for the years 1964 to 1966, are shown in the following table.

**VALUE OF OVERSEAS MINERAL TRADE, BY COUNTRY OR REGION
AUSTRALIA(a), 1964 TO 1966**

<i>Country or region</i>	<i>Value (\$m f.o.b.)</i>			<i>Percentage</i>		
	<i>1964</i>	<i>1965</i>	<i>1966</i>	<i>1964</i>	<i>1965</i>	<i>1966</i>
EXPORTS(b)						
Japan	72.6	92.4	124.2	32.1	32.5	37.5
Other Asian and Pacific	25.8	30.1	41.3	11.4	10.6	12.5
United Kingdom	68.4	68.2	65.3	30.2	24.0	19.7
European Economic Community	27.8	43.8	38.7	12.3	15.4	11.7
United States	27.0	42.5	46.0	11.9	14.9	13.9
Other	5.0	7.6	15.7	2.1	2.6	4.7
Total	226.6	284.6	331.2	100.0	100.0	100.0
IMPORTS						
Middle East	126.8	132.4	138.4	50.6	44.0	50.1
Indonesia	44.6	53.0	51.1	17.8	17.6	18.5
Other Asian	14.8	24.0	16.9	5.9	8.0	6.1
Pacific	15.6	14.3	19.9	6.2	4.8	7.2
United States	17.2	23.6	16.0	6.9	7.9	5.8
Canada	8.0	9.7	12.9	3.2	3.2	4.7
Europe (including United Kingdom and European Economic Community)	12.0	31.0	8.5	4.8	10.3	3.1
Other	11.6	12.6	12.7	4.6	4.2	4.5
Total	250.6	300.6	276.4	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, 1967

Expansion of the Australian mineral industry was maintained during 1967, with the preliminary value of mineral production increasing by 12 per cent from \$626 million in 1966 to \$700 million in 1967. The major reasons for this increase in the value of mineral production were continued expansion of iron ore mining and the commencement of production of crude oil at Barrow Island and nickel concentrates at Kambalda, both in Western Australia. The total value of mineral exports continued to increase, in particular 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 1967 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 3 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 nearly 5 million tons by the early 1970s. Approximately half the output from Weipa will be used by the Gladstone, Queensland, alumina refinery, a further 96 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 150 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.

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. Plans have already been announced to increase the capacity of the refinery to 900,000 tons per annum, with 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 410,000 metric tons to 830,000 metric tons per annum by the end of 1969. 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 36,000 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, is to be established 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 August 1966 the Australian Producers' price has been adjusted regularly to reflect movements in the London Metal Exchange and New York Merchants' prices, the price at the end of April 1968 being \$1,100 per ton after reaching \$1,350 per ton during February to April 1968.

Iron ore

During 1967 iron ore output expanded by 60 per cent, with production doubling in Western Australia. Iron ore mined at Frances Creek, Northern Territory, was exported through Darwin, commencing June 1967.

Large scale production began during 1967 from deposits at Koolyanobbing, Western Australia. Ore is transported on a standard gauge railway 304 miles to the coast at Kwinana, where a 600,000 tons per annum blast furnace was commissioned in May 1968.

Pelletising plants at Dampier, Western Australia, Whyalla, South Australia, and Port Latta, Tasmania have a combined rated capacity of 5.75 million tons per annum. Shipment of pellets from these plants began in 1968.

In March 1968 plans for a 'metallised agglomerates' plant at Dampier were announced. The product would bypass the conventional blast furnace method of iron smelting and would be utilised directly in the making of steel.

In mid-1967 plans were announced for the development of deposits at Mount Newman, Western Australia, by a consortium of companies from Australia, the United States of America, Japan, and the United Kingdom. Contracts were signed to supply 100 million tons of ore to Japan over fifteen years at an approximate value of \$820 million. The project involves the construction of a 265-mile railway from Mount Newman to Port Hedland together with associated loading and port facilities.

Investigation and negotiations for export contracts continued with respect to deposits at Robe River and Nimingarra in Western Australia. Deposits were also being investigated in Western Australia at Mount Gibson, Northam, in the Robinson Ranges and near Wittenoom.

Lead and zinc

Following an extensive expansion programme, output of lead bullion at Mount Isa increased sharply in 1967. Ultimately, this smelter is to produce 140,000 tons of lead bullion a year.

At Port Pirie, South Australia, a new zinc refinery commenced production in December 1967. This plant is refining zinc contained in the slags accumulated from lead refining; the rated annual capacity is 40,000 tons of refined metal.

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 1967 exports were 9.3 million tons valued at \$76.2 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 there are indications that a further rich deposit of coking coal has 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 1967 and 1968.

Petroleum exploration in Australia continued to expand in 1967 and 1968, and encouraging discoveries during this period have been a stimulus to further exploration. In 1967 the footage drilled for development and exploration was 1,079,756 feet, the second highest annual total. Of the 87 exploratory wells drilled in 1967, nine can be classed as discoveries, giving a success ratio of 1:9.7, which is high by international standards.

Australia now has three commercial oilfields, Moonie and Alton in Queensland (connected by pipeline to Brisbane, Queensland) and at Barrow Island, Western Australia, together capable of supplying about 8 per cent of the nation's requirements. The oilfield at Barrow Island was commissioned in April 1967, when the first shipment of oil was despatched to Kwinana, Western Australia, for refining. In addition, small amounts of oil totalling some 200 barrels per day are produced from individual wells in the Roma and Bennett areas in Queensland.

Commercial production of natural gas, currently restricted to a few wells in the Roma area in Queensland, where the gas is used as fuel for the local hospital and electrical power house, is planned for deposits at Gidgealpa and Moomba in South Australia and off-shore Victoria, in the Gippsland basin. Expansion of production from the Roma field is expected. A 10-inch pipeline from the Roma field to Brisbane, at a cost of \$11 million, is to be completed by the end of 1968. A 22-inch pipeline is planned from Gidgealpa and Moomba field 500 miles to Adelaide. Pipelines from the off-shore Barracouta and Marlin gas fields on the Gippsland shelf of Victoria will connect with a 30-inch pipeline to Dandenong, which was begun in December 1967. The Melbourne gas system is to receive gas through this line in early 1969. An absorption plant is under construction at Sale, Victoria, and off-shore platforms for drilling production wells have been built and production drilling is in progress.

Considerable attention has been given recently to off-shore exploration, particularly off the Victorian coast where several substantial gas and oil flows have been discovered. Several off-shore drilling rigs of various types have been transported from other countries, and a semi-submersible rig has been constructed at the shipbuilding works at Whyalla, South Australia.

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. 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 in north-west Queensland. The deposits are large by world standards, and feasibility studies are still in progress.