

CHAPTER 26

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* and *Value of Production* issued by this Bureau and in *The Australian Mineral Industry—Annual Review* and other publications issued by the Bureau of Mineral Resources, Geology and Geophysics, which also issues, in 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* and *Minerals and Mineral Products* 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*.

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, 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 510,000 square miles and contain marine and continental sedimentary rocks ranging in maximum thickness from 1,000 to about 50,000 feet and including rocks of all ages from Proterozoic to Palaeozoic.

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, but the only proved commercial fields at present are at Moonie, Alton and Conloi in the Surat Basin in south-east Queensland and Barrow Island off the coast of north-west Western Australia. The Moonie deposit is found in rocks of lower Jurassic age. The Barrow Island field, which began production in 1967, is mainly of Cretaceous age, but minor oil shows have been recorded from the underlying Jurassic rocks. Other discoveries of potential commercial significance have been made in the Gippsland Basin, off shore from eastern Victoria (natural gas and oil); at Richmond and Gilmore in Queensland (gas); at Mereenie in the Northern Territory (gas); and at Moomba and Gidgealpa in South Australia (gas).

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.

Most of the larger mineral deposits now being mined in Australia are shown in the following table, according to the age of the geological formation in which they are found.

PRINCIPAL AUSTRALIAN MINERAL DEPOSITS

Age of geological formation in which located	Metal or mineral	State or Territory	Locality
Precambrian (more than 520 million years old)	Copper . . .	Queensland . . .	Mount Isa
	Gold . . .	Northern Territory	Tennant Creek
		Western Australia .	Kalgoorlie and other localities
	Iron . . .	South Australia . .	Middleback Ranges
Palaeozoic (between 200 and 520 million years old)	Lead-silver-zinc	Western Australia .	Yampi Sound and Pilbara
		New South Wales . .	Broken Hill
		Queensland . . .	Mount Isa
	Black coal . . .	New South Wales . .	Hunter Valley, Lithgow, South Coast
		Queensland . . .	Kianga-Moura, Baralaba, Bowen, etc.
		Western Australia .	Collie
	Copper-gold . .	Queensland . . .	Mount Morgan
		Tasmania . . .	Mount Lyell
	Lead-silver-zinc	Tasmania . . .	Mount Read and Rosebery
	Tin (lode) . . .	Queensland . . .	Herberton
Mesozoic (between 75 and 200 million years old)		Tasmania . . .	North-east of State
	Tungsten . . .	Tasmania . . .	King Island and north-east of State
	Black coal . . .	Queensland . . .	Ipswich
		South Australia . .	Leigh Creek
Cainozoic (less than 75 million years old)	Manganese . . .	Northern Territory	Groote Eylandt
	Bauxite . . .	Queensland . . .	Weipa
		Western Australia .	Darling Range
	Brown coal . . .	Victoria . . .	Gippsland
	Mineral sands(a)	New South Wales . .	North coast
		Queensland . . .	South coast
		Western Australia .	South-west coast
	Tin (alluvial) . .	New South Wales . .	Tingha
		Queensland . . .	Herberton
		Tasmania . . .	North-east of State

(a) Derived from granites of Palaeozoic age and sandstones of Mesozoic age in eastern Australia and from granites of Precambrian age in Western Australia.

Mineral resources

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

RESERVES OF MINERALS: AUSTRALIA

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

Production	Reserves adequate	Reserves uncertain	Reserves negligible
Production sufficient for domestic demand and exports	Barite Bauxite Cadmium Coal (black) Copper Gold Gypsum Iron ore Lead Manganese ore (metallurgical) Mineral sands(a) Nickel(b) Opal Salt Silver Tin Tungsten Zinc	Beryl Talc Tantalite	
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 Sulphides (as source of sulphur)(c)	Abrasives Antimony Bentonite China clay Chromite Cobalt Diatomite Fluorite Magnesite Manganese ore (chemical) Mineral pigments Petroleum Phosphate rock Platinum	Asbestos (chrysotile) Bismuth Molybdenum
Production nil	Magnesium Potassium salts (from alunite muds)	Arsenic Crocidolite asbestos(d) Diamonds Graphite Vanadium Vermiculite	Borates Mercury Nitrates Sulphur

(a) Ilmenite, monazite, rutile, zircon. (b) Mine production commenced mid-1967. (c) At a price disadvantage as compared with imported brimstone for the manufacture of sulphuric acid. (d) Mine ceased operating during 1966.

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 in excess of 27 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 investigation of a large lead-zinc ore body in the McArthur River area is proceeding.

Copper

The principal deposit of this metal is at Mt Isa, where ore reserves were estimated at 33 to 35 million tons in 1965. Recent discoveries have indicated very large additional reserves at Mt Isa and further exploration and testing is proceeding. Other important deposits are situated at Mt Morgan, Queensland, and Mt Lyell, Tasmania. Small deposits at Ravensthorpe, Western Australia, and Tennant Creek, Northern Territory, have also been developed. In New South Wales exploration at Cobar has resulted in the opening of a new operation at a previously abandoned mine, and ore reserves in this area are now estimated to be in excess of 18 million tons.

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 probably 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, with a reasonable indication of a further 100 million tons. In addition, another potentially significant deposit has been identified in the Kimberley district of Western Australia.

Tin

The main deposits of tin now being exploited are in the Herberton field inland from Cairns, Queensland, in north and central Tasmania, in south-west Western Australia, and in the New England area and Ardlethan in New South Wales. Exploration and expansion of known deposits is expected to result in Australia again becoming self sufficient in tin by 1969.

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 to be about 12 million tons in 1965, with a gold content of between 3.90 and 5.40 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, in the Pilbara region of Western Australia, are currently being developed. The first shipments to fulfil long-term contracts were made to Japan early in 1966. A deposit in the Savage River region of north-west Tasmania is also under development. 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 in excess of 15,000 million tons.

Manganese

Australia's known reserves of manganese, which is highly important for the iron and steel industry, are on a more restricted scale than the deposits of iron ore. 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 believed to be substantial, and testing of the deposits is continuing. The first shipment of ore from Groote Eylandt was made in March 1966.

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.

Mineral sands

Ores of titanium (rutile and ilmenite), zircon (zirconium) and thorium (monazite) occur in beach sands over extensive areas of the north coast of New South Wales, the south coast of Queensland and the south-western coast of Western Australia. Resources are large and easily workable. Australia's reserves of rutile represent the bulk of the world's reserves of this mineral.

Nickel

Deposits of nickel have been discovered in Western Australia, central Australia and Queensland. At Kambalda, near Kalgoorlie in Western Australia, reserves of 4.5 million tons of 3.6 per cent nickel have been established and mining has commenced.

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. It was estimated during 1964 that total Australian known commercial reserves of uranium ore contained 10,950 short tons of U_3O_8 . The Mary Kathleen deposit is estimated to contain in excess of three million tons of uranium-bearing ore.

Coal

Australia has adequate coal resources in relation to present and estimated future needs. These resources include coal of all types, except pure anthracite. The table below shows that the major part of the black coal reserves is bituminous. Australia's coal reserves are concentrated mainly in the mainland eastern States. The bituminous coal is located mainly in New South Wales and, to a lesser degree, in Queensland; Victoria has very substantial brown coal reserves in the Latrobe Valley.

AUSTRALIAN COAL RESERVES

(Source: Joint Coal Board, Eighteenth Annual Report, 1964-65)

State	Type of coal	Reserves (in million tons)	
		Measured and indicated	Inferred
New South Wales . . .	Bituminous	2,951	Very large(a)
Queensland	Bituminous-sub-bituminous	1,243	Very large(a)
Western Australia . . .	Sub-bituminous	282	1,597
South Australia	Sub-bituminous	49	Very small
Tasmania	Bituminous	Very small(b)	137(c)
Victoria	Bituminous	20	11
Victoria	Brown	54,700	43,000
South Australia	Lignite	530	..

(a) Inferred reserves are more than 10,000 million tons. (b) Measured reserves in Tasmania amount only to several thousand tons. (c) This figure includes both indicated and inferred reserves.

Crude petroleum

Continued exploration is slowly accumulating evidence that Australia may possess significant resources of petroleum and natural gas. The Surat Basin (Moonie) in south-east Queensland and the Barrow Island field are Australia's only existing commercial oil fields. Other possible commercial fields have been discovered, however, the most important being off-shore Victoria.

Natural gas

Several discoveries of natural gas deposits have been made in Queensland, Western Australia, Northern Territory, South Australia, and off-shore Victoria. In some areas reserves are extensive but commercial development will depend on the availability of markets and related capital costs. Two major offshore wells Gippsland Shelf Nos 1 and 2 were completed as potential gas producers; together they constitute the Barracouta natural gas field which is to supply natural gas to Melbourne. There are indications that the Sydney-Newcastle-Wollongong area will also be supplied with natural gas within a few years, but its source has not yet been determined.

History

The mineral industry has been an important factor in the growth of the Australian economy since the middle of the nineteenth century, when the discovery of gold attracted population to Australia and thus provided a valuable impetus to economic development. Over the years the mineral industry has been a substantial earner of foreign exchange, and has in general provided ample supplies of raw materials for Australia's developing manufacturing industries. In addition, earnings from mineral production have provided capital for the development of important manufacturing industries such as iron and steel production.

The history of mineral discovery and development in Australia, however, has not been one of continuous growth, and the growth of the industry may be divided into several episodes of activity which to some extent overlap. Probably the first mining in Australia was for coal, following discoveries in the northern and southern portions of the Sydney coal basin in 1796 and 1797. Metal mining first began in the 1840's in South Australia, where small deposits of silver-lead and copper were mined. In 1851 Edward Hargreaves discovered gold near Bathurst, New South Wales, and shortly afterwards several other gold strikes were made in Victoria and Queensland. Thus began the first gold-rush in Australian history, and a rapid development of gold mining followed. Gold production for the ten years 1851-1860 was nearly 25 million ounces. However, by the mid-1860's gold mining had declined and the average annual gold production fell to less than 2 million ounces.

Subsequently a number of important discoveries of other minerals were made, and the development of these deposits revitalised the mining industry. These finds included the discoveries of copper, tin and lead-zinc from 1870 to the late 1890's (including Mount Bischoff in 1871, the Broken Hill Lode in 1883 and Mount Lyell in 1890) and the gold discoveries in Western Australia, beginning about 1884 (including Coolgardie 1892 and Kalgoorlie 1893). These discoveries were followed by large increases in the production of gold, silver-lead, copper, tin, and coal. Indeed, for a considerable period prior to 1900 Australia was the major gold-producing country in the world. In addition, from 1890 to 1910 Australia was the leading tin-producing country. This resurgence of the mineral industry, which began in the late 1880's, reached a peak in 1907 with a value of output being achieved which was not surpassed until 1937.

During the period 1908 to 1931 the industry underwent a period of decline, with a concomitant reduction in mineral exploration activity in Australia. This reduction has been attributed to the rapid expansion of the gold mining industry in South Africa about this time. British mining capital which had been channelled into Australia was diverted to another area of the world, and the limited amount of local capital was reserved mainly for agricultural and other less speculative activities. Despite this, a few very important mineral discoveries were made—the Mount Isa lead-zinc deposit in 1923 (and subsequently the copper deposit in 1929-31) and the Aberfoyle tin and wolfram deposits in 1926. During the period 1931-1941 the mineral industry experienced a period of recovery. Major production increases in gold and coal occurred for a short period. However, during the latter years of the second World War another period of decline occurred and gold production fell once again.

The immediate post-war period saw the beginning of a major era of expansion and diversification of the industry, which has continued, with little interruption, to the present. Since 1950 the value of mining and quarrying output has doubled, while the output of manufacturing industries processing and treating minerals has expanded even more rapidly. The expansion of mineral processing in Australia (smelting and refining of metals, the processing of non-metallic minerals, etc.) is one of the most important features of the post-war expansion of the industry. A considerable part of the diversification and development which has occurred, or which is under way at present, can be attributed to the number of important mineral discoveries which have been made in Australia in the post-war period.

These discoveries include the following major finds:

Uranium—Mary Kathleen (Qld), Rum Jungle and South Alligator River (N.T.);

Bauxite—Weipa (Qld), Gove (N.T.), Darling Range (W.A.), Kalumburu (W.A.);

Iron ore—Pilbara (W.A.), Savage River (Tas.);

Manganese—Groote Eylandt (N.T.);

Nickel—Kambalda (W.A.);

Oil and gas—Moonie, Roma area (Qld), Barrow Island, Gingin and Yardarino (W.A.), Mereenie (N.T.), Moomba and Gidgealpa (S.A.), off-shore Gippsland area (Vic.).

Developments which have occurred in the last few years have important implications for the future of the industry. Most attention at present is being focussed on the large iron ore deposits which have been discovered, the expansion of the aluminium industry, the revitalisation of the coal mining industry, and the results of an increasing rate of exploration, particularly petroleum exploration. One notable feature of these recent developments is that the industry is becoming much more involved in export trade, and its contribution to export earnings is expected to increase considerably in the next few years. Japan has emerged as the major market for Australia's minerals.

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 which 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, which 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 limiting 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 1962 to 1966. 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 TERRITORIES, 1962 TO 1966
(⁰000 acres)

Year	N.S.W. (a)	Vic.	Qld (b)	S.A. (a) (b)	W.A. (c)	Tas. (b)	N.T.	Total (d)
1962 . .	492	55	2,335	5,364	166	45	38	8,495
1963 . .	425	46	2,185	7,894	201	44	62	10,857
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			45		

(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 may 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, it was announced in April 1967 that it was expected that legislation would be presented to the several Parliaments before the end of 1967.

Under the draft legislation 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 draft 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.

There is provision for the establishment over off-shore areas of a graticular system of block areas. 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 square miles). There will be 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's surrendering half of the effective permit area at the end of each period. Furthermore, the draft legislation will include 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 (i.e. approximately 400 square miles).

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 (an area of approximately 125 square miles), 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 (making a total area of up to 225 square miles) 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 permittee 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 permittee and the Crown if the number of blocks within the location is even, and the odd block will be available to the permittee 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 State or Territories by tender. Existing tenements which have been previously issued by 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, 1962 TO 1966 (*000 acres)

Year	N.S.W. (a)	Vic.	Qld	S.A. (a)	W.A.	N.T.	Total
1962	127,658	53,310	563,795	199,409	471,856	67,366	1,483,394
1963	175,026	53,345	464,567	228,235	441,795	160,498	1,523,466
1964	156,543	53,345	379,562	228,235	529,594	147,839	1,495,118
1965	105,853	31,201	324,205	221,059	491,670	120,130	1,294,118
1966	113,276	31,174	389,252	224,226			

(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, 1961-62 TO 1965-66
 (\$)

State or Territory	1961-62	1962-63	1963-64	1964-65	1965-66
New South Wales . . .	2,901,734	1,633,640	5,090,622	19,946,772	24,317,168
Victoria . . .	(b) 76,732	(b) 85,004	(b) 94,072	(b) 39,996	71,072
Queensland . . .	727,688	486,938	642,560	1,201,264	1,183,046
South Australia . . .	789,310	756,156	895,540	962,668	985,560
Western Australia . . .	239,454	248,646	243,182	291,354	478,295
Northern Territory . . .	65,960	61,982	68,682	80,894	88,727

(a) No mineral royalties are collected in Tasmania. (b) Includes, in addition to mineral royalty 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; lithium ores and concentrates; 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.

Subsequently another ban on the export of copper scrap and copper alloy scrap was announced on 20 December 1965. 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 given on page 1074.

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, fluorspar, 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 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 to recover uranium concentrates, 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 exempt 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 investors 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 1959-1961* was amended in June 1964 to extend Commonwealth subsidy for a further three years. The *Petroleum Search Subsidy Act 1959-1964* provides subsidy for approved geophysical surveys and test and stratigraphic drilling operations; bore-hole surveys, off-structure 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 1959-1964 Act also specifies that exploration for petroleum on the Australian continental shelf is eligible for subsidy retrospective to 1959. The Federal budget for 1966-67 contained an appropriation of \$11.9 million for subsidies under the Act. Payments under this Act in each of the years 1962 to 1966 are shown in the table on page 1074.

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. The Commonwealth Government, subsequent to a Tariff Board Inquiry during 1965, established a basic price for Australian crude oil of \$US 2.48 a barrel at the nearest refining centre, plus a differential for the quality of the oil produced, plus an exploration incentive of 75 U.S. cents a barrel. In the case of Moonie crude oil, the quality differential is 27 U.S. cents a barrel, and the price for Moonie crude oil delivered Brisbane is \$US 3.50.

In order to ensure that local crude oil is used in Australian refineries, the Government will impose penal import duties of 0.8c a gallon on crude oil and 2.4c a gallon on motor spirit to be paid by those companies which do not take their share of local crude oil. A more detailed discussion on the pricing of Australian crude oil is included on page 1102.

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 1962 to 1966 are shown in the table on page 1074.

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. In recent years these reserves had declined to the extent that the long-term prospects of the industry were jeopardised. The Act, which applied to 1962-63 and the next two financial years, provided that a development allowance was payable to a mine approved for the purposes of the scheme equal to the amount by which its allowable expenditure on development in a year, as defined in the Act, exceeded a defined base amount which would normally be the average annual amount spent by the mine on development during the three years preceding 1962-63. The payment of allowance was also subject to a number of other conditions and limits provided for in the Act. 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 1962 to 1966 are shown on page 1074. 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 1962 to 1966 are shown in the table on page 1074.

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 1962 to 1966 are shown in the following table.

COMMONWEALTH GOVERNMENT PAYMENTS TO THE MINERAL INDUSTRY
AUSTRALIA, 1962 TO 1966

(\$)

Year	Petroleum exploration (a)	Gold mining (b)	Copper mining (c)	Pyrites mining (d)	Sulphuric acid production (e)	Phosphate fertiliser production (f)
1962 .	5,930,752	1,351,394	1,372,868	686,680	1,865,314	..
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 .	10,154,171	3,758,757	1,314	288,319	1,397,679	25,817,516

(a) *Petroleum Search Subsidy Act 1959-1964.* (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 1959-1964* and is also engaged in the assessment of sedimentary basins in Australia and its Territories. The establishment of the Bureau is 586 officers, of whom 291 are professional. The budget for the financial year 1966-67 was \$17.6 million, of which \$11.9 million was provided for payment under the *Petroleum Search Subsidy Act 1959-1964*.

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

Commonwealth Scientific and Industrial Research Organization. The activities of this body with respect to the mineral industry are discussed on page 1076 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 1965-66 \$400,000 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, and purchase of basic metal ores from prospectors; (ii) geological examination of mineral deposits, water supply, dam foundation and drainage problems, guidance on mining legislation, and publication and issue of geological bulletins and maps. It also provides, through the Australian Mineral Development Laboratories, chemical and metallurgical and analytical and assay investigation, testing and treatment of ores and minerals, and petrographic, mineragraphic and radiometric determinations. Pilot scale metallurgical and chemical treatment plants are maintained and operated for the development of mineral extraction processes.

Western Australia. Prospectors receive assistance of either \$15 or \$17.50 a week according to the prospecting locality. North of the 26th parallel and within a defined area south of this lying largely outside the agricultural areas assistance is given to the extent of \$17.50 a week. In the remainder of the State prospectors receive \$15 a week. Provision is also made for the supply of some tools required for prospecting. There are twenty State batteries operating intermittently throughout the goldfields for the treatment of ore from prospectors and small mine-owners at a nominal charge. A cartage subsidy is also granted to such operators sending ore to State batteries for treatment. Provision is made for loans to mine-owners who require assistance to develop mines. The Government also has a drilling scheme, financing mine-owners on a \$1 for \$1 basis.

Tasmania. The Department of Mines provides financial assistance to mining lessees for the purchase of plant and machinery, for sinking, repairing or de-watering of shafts, for construction of dams and water races, for testing and proving a deposit of any mining product, for developmental work, and for diamond and other types of drilling. The Department has available for hire percussion and diamond drills for exploration, as well as a complete plant for small shaft sinking and tunnelling. Other assistance is rendered to the industry in the form of geological and engineering advice, through ore-dressing research into metallurgical recoveries, and the selection and design of treatment plant. In consequence of a serious fall in world tungsten prices the *King Island Scheelite Agreement Act 1963 (No. 1)* was passed. This Act permitted the Tasmanian Government to provide financial assistance until the end of August 1963 so that production of scheelite on King Island could be continued. A second Act (*King Island Scheelite Agreement Act 1963 (No. 2)*) gave authority for advances in the period to 31 May 1964. In October 1964 the price of tungsten on world markets moved above the level at which repayments under the subsidy agreement apply, and repayments to the Tasmanian Government, in accordance with a formula related to monthly production, were commenced by the operating company. In April 1966 a final repayment liquidated the remaining liability (the total advanced was \$397,910).

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 developmental work. 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-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.

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, and the production of high-calorific-value gas by direct hydro-gasification of coal at high pressures and temperatures. The Ore Dressing Investigations laboratory, which is under the joint control of C.S.I.R.O. and the University of Melbourne, 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.

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 furnish 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, 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 1077*). 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.

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 forty-three 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 1965-66 was \$51,897.

International relations

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

International Tin Agreement

The First International Tin Agreement (of the post-war period) was in operation for five years from 1 July 1956 to 30 June 1961. This Agreement was subsequently replaced by the Second International Tin Agreement, which came into force provisionally on 1 July 1961 and definitively on 21 February 1962.

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

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

- (b) to prevent excessive fluctuations in the price of tin and to achieve a reasonable degree of stability of price;
- (c) to ensure adequate supplies of tin at prices which are fair to consumers and provide a reasonable return to producers; and
- (d) to provide a framework for the consideration of measures to promote the progressively more economic production of tin, while protecting deposits of tin from unnecessary waste or premature abandonment, thus facilitating expansion in world consumption of tin; and to keep under review the long-term need for the development of new deposits of tin.

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

- (a) to ensure conditions which will help achieve a dynamic and rising rate of production of tin on the basis of a remunerative return to producers, which will help secure an adequate supply at prices fair to consumers and which will help provide a long-term equilibrium between production and consumption;
- (b) in the event of a serious shortage of supplies of tin occurring or being expected to occur, to take steps to secure an increase in the production of tin and a fair distribution of tin metal at equitable prices.

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

The Agreement is operated by the International Tin Council, which is made up of the following Governments: Australia, Austria, Belgium, Bolivia, Canada, Czechoslovakia, Democratic Republic of the Congo, Denmark, France, India, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Federation of Nigeria, Spain, Thailand, Turkey, United Kingdom. Member Governments participate as producing or consuming countries. The producing countries hold a total of 1,000 votes, distributed so that each country receives five initial votes and an additional number corresponding to its percentage as laid down by the Agreement. The consuming countries hold a total of 1,000 votes also distributed so that each country receives five initial votes and an additional number proportionate to tonnages. The allocation of votes in each category is periodically reviewed.

The International Tin Agreement establishes floor and ceiling prices for tin and, by the medium of a buffer stock and remedial trading on the London Metal Exchange, aims at confining the price within these limits. The buffer stock was established with contributions from producing countries, equivalent to 10,000 tons of metal, wholly made in cash at £stg1,000 a ton; a further £10 million remains on call from the producer members and a standby-credit facility of £10 million from a consortium of banks. Existing buffer stock price range is: 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, since the Third Agreement came into operation prices have in general been maintained in the range £1,200 to £1,300 in which the buffer stock does not operate.

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 and Zinc Study Group which was established in January 1960. The Study Group comprises the following Governments: Algeria, Australia, Austria, Belgium, 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.

Tungsten Conference

During 1963 meetings were held by the United Nations *ad hoc* Committee on Tungsten and by the Committee's Technical Working Group to assess the world tungsten situation and to consider methods for dealing with the depressed state of the market, and action has been taken to collate world data. The Working Group recommended that the Tungsten Committee be put on a regular rather than an *ad hoc* basis; this recommendation was adopted by the Committee at its fourth session held in May 1965. The necessity of obtaining comprehensive, uniform and timely world statistics was also formally recognised. However, in view of the recent buoyant marketing conditions for tungsten, no direct action to influence the world market for tungsten has been taken.

Scope and sources of statistics

Scope of statistics

Statistics presented in this chapter refer mainly to mining and quarrying, although 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.

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. Ore-dressing and elementary smelting of metallic minerals (e.g. in the case of gold) and miscellaneous treatment of non-metallic minerals, where these are carried out in an associated plant at or near the mine, are included in the mining industry. However, establishments primarily engaged in smelting and/or refining (including the smelting and refining sections of the large plants operated at Mount Morgan and Mount Isa in Queensland and at Mount Lyell in Tasmania) are excluded from the statistical definition of the mining industry and are classified to the manufacturing industry.

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.

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. Values of Australian overseas trade shown throughout this chapter are expressed as \$ f.o.b. port of shipment.

Mineral exploration

In recent years mineral exploration in Australia has expanded considerably compared with earlier periods. Exploration for extensions of known reserves in producing localities has increased, and some important additions to known reserves have been made (e.g. at Mt Isa). In addition, exploration for new deposits has continued and, as outlined earlier, a number of important new finds have been made in recent years.

Some important features of exploration for minerals in Australia in this period have been the uranium exploration boom in the mid-1950's, the expansion of petroleum exploration since 1960, and the even more recent upsurge in general mineral exploration which has been marked by an influx of overseas companies and capital. Currently there is more active mineral exploration being carried out in Australia than at any earlier time.

The pattern of exploration at present is that, in terms of expenditure and footage drilled, exploration for petroleum is the most important activity. Exploration for other minerals, although expanding rapidly, is not on as large a scale as petroleum exploration. The range of minerals sought is diverse, with probably most attention being devoted to the base metals and phosphate rock.

Petroleum exploration

During the post-war period there has been a very great increase in exploration for petroleum in Australia, and this increase has been particularly notable since 1961. In the years 1946 to 1965 more than \$358 million was spent on petroleum exploration in Australia and Papua and New Guinea out of a total expenditure to the end of 1965 of almost \$370 million. Until recently, exploration was concentrated in the sedimentary basins on the land mass, but increased attention is now being paid to the off-shore areas of the continental shelf, with promising results. Up to the end of 1965 the bulk of expenditure related to exploration in Queensland, Western Australia and Papua and New Guinea. Footage drilled has been greatest in Queensland, Western Australia and Victoria, with footage drilled in Papua and New Guinea being comparatively low. The growth of expenditures and drilling footage over recent years is shown in the following tables. These statistics have been derived from the Bureau of Mineral Resources, Geology and Geophysics. Recent developments in the search for petroleum are discussed on page 1102, and particulars of areas occupied under authorities to prospect or explore for petroleum are given on page 1069.

EXPENDITURE ON PETROLEUM EXPLORATION BY PRIVATE ENTERPRISE AND BY GOVERNMENTS: AUSTRALIA, 1965

Origin of expenditure	Expenditure	Percentage contribution
Private enterprise—	\$'000	
Funds of Australian origin	20,409	30.3
Funds of overseas origin	32,706	48.5
<i>Total, private enterprise</i>	<i>53,115</i>	<i>78.8</i>
State Government departments	711	1.1
Commonwealth Government departments (excluding subsidy payments)	3,824	5.7
Commonwealth Government subsidy payments	9,759	14.4
Total expenditure	67,409	100.0

**TOTAL EXPENDITURE ON PETROLEUM EXPLORATION BY PRIVATE ENTERPRISE
AND BY COMMONWEALTH, STATE AND BRITISH GOVERNMENTS
TO 31 DECEMBER 1965**

Origin of expenditure	Expenditure	Percentage contribution
	\$'000	
Private enterprise—		
To end of 1965—		
Funds of Australian origin	118,993	32.2
Funds of overseas origin	174,837	47.2
<i>Total, private enterprise</i>	293,830	79.4
Government—		
Prior to 1946—		
State Government	3,084	0.8
British Government	50	..
Commonwealth Government—Grants	324	0.1
Other	1,051	0.3
1946 to 1965—		
State and Territory Departments of Mines	6,305	1.7
Commonwealth Government—subsidy payments	42,025	11.4
Department of National Development (excluding subsidy payments)	22,868	6.2
Department of Interior—topographic surveys, oil search	400	0.1
<i>Total, Government</i>	76,107	20.6
<i>Total expenditure</i>	369,937	100.0

SUMMARY OF WELLS AND FOOTAGE DRILLED: STATES AND TERRITORIES, 1965

	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	T.P. N.G.	Total
Wells drilled(a)	11	9	128	8	37	1	14	1	209
Average total depth of wells drilled feet	4,896	6,634	5,253	8,433	5,394	7,717	4,070	12,015	5,433
Wells completed as potential oil producers . . . . .	..	..	11	..	14	..	..	..	25
Wells completed as potential gas producers . . . . .	..	2	12	1	2	..	3	..	20
Wells drilled or drilling over 10,000 feet . . . . .	..	..	7	2	5	..	2	1	17
Footage drilled—									
Completed wells feet	48,271	59,116	651,905	49,542	183,786	7,717	56,988	12,015	1,069,340
Uncompleted holes(b) feet	795	10,389	22,089	..	30,812	..	19,764	..	83,849
<i>Total footage drilled</i>	49,066	69,505	673,994	49,542	214,598	7,717	76,752	12,015	1,153,189

(a) Number of holes which reached total depth during the year. (b) Uncompleted holes means wells suspended or drilling at 31 December 1965.

**WELLS AND FOOTAGE DRILLED IN PETROLEUM EXPLORATION
STATES AND TERRITORIES TO 31 DECEMBER 1965**

State or Territory	To 31 December 1963		1964		1965		To 31 December 1965	
	Wells	Footage	Wells	Footage	Wells	Footage	Wells	Footage
New South Wales . . .	69	214,556	14	60,885	11	49,066	94	324,507
Victoria . . .	159	333,618	7	41,595	9	69,505	175	444,718
Queensland . . .	232	1,062,666	156	744,435	128	673,994	516	2,481,095
South Australia . . .	106	208,313	14	83,959	8	49,542	128	341,814
Western Australia . . .	105	404,193	16	99,972	37	214,598	158	718,763
Tasmania . . .	21	14,000	..	..	1	7,717	22	21,717
Northern Territory . .	10	33,169	6	30,266	14	76,752	30	140,187
Papua and New Guinea	43	212,985	1	4,249	1	12,015	45	229,249
<i>Total</i> . . .	..	..	214	1,065,361	209	1,153,189	..	..
Cumulative total . .	745	2,483,500	959	3,548,861	1,168	4,702,050	1,168	4,702,050

Other mineral exploration

As a result of the influx of overseas companies and an increase in exploration by the major Australian mining companies, exploration for minerals other than petroleum is also at a very high level and is expanding rapidly. It has been estimated that this exploration is about equally divided between areas in which mineral discoveries were made fifty to seventy years ago and geologically favourable areas where sub-surface exploration is being carried out for the first time. Statistics relating to this exploration are not available at present, but statistical coverage of these activities is being established and a basic range of statistics will be available shortly.

Mining and quarrying

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 lead-silver-zinc sector rather than to the copper-gold sector.

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

Statistics relating to the structure of the industry, employment, production costs, value of additions and replacements to fixed assets, and value of output and production are given 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 1965 and in Australia for the years 1961 to 1965.

NUMBER OF MINES AND QUARRIES: STATES AND TERRITORIES, 1965

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	17	19	33	..	113	2	9	..	193
Lead-silver-zinc	13	..	4	1	12	1	1	..	32
Copper-gold	14	2	31	4	19	1	4	..	75
Tin	48	4	275	..	21	27	16	..	391
Mineral sands	11	..	5	..	5	..	..	..	21
Other metal	19	2	7	2	17	3	3	..	53
Total, metal mining	122	27	355	7	187	34	33	..	765
Fuel mining—									
Black coal—									
Underground	88	2	60	..	3	6	..	..	159
Opencut	3	..	4	1	1	..	..	..	9
Total, black coal	91	2	64	1	4	6	..	..	168
Brown coal . . . . .	..	6	..	..	..	..	..	..	6
Other fuel . . . . .	..	..	3	..	..	..	..	..	3
Total, fuel mining	91	8	67	1	4	6	..	..	177
Non-metal (excluding fuel) mining(a)	445	63	104	104	59	26	1	..	802
Total, all mining	658	98	526	112	250	66	34	..	1,744
Construction material quarrying(a)	383	371	52	209	57	118	33	11	1,234
Total, all mining and quarrying	1,041	469	578	321	307	184	67	11	2,978

(a) Incomplete, owing to difficulties of coverage. See Scope and sources of statistics, page 1079.

NUMBER OF MINES AND QUARRIES: AUSTRALIA, 1961 TO 1965

Industry	1961	1962	1963	1964	1965
Metal mining—					
Gold	295	286	257	246	193
Lead-silver-zinc	27	22	13	20	32
Copper-gold	111	107	98	86	75
Tin	266	344	300	371	391
Mineral sands	21	20	18	20	21
Other metal	85	87	62	56	53
Total, metal mining	805	866	748	799	765
Fuel mining—					
Black coal	202	198	185	179	168
Brown coal	6	6	6	7	6
Other fuel . . . . .	..	..	2	3	3
Total, fuel mining	208	204	193	189	177
Non-metal (excluding fuel) mining(a)	755	731	792	756	802
Total, all mining	1,768	1,801	1,733	1,744	1,744
Construction material quarrying(a)	1,056	1,107	1,044	1,148	1,234
Total, all mining and quarrying	2,824	2,908	2,777	2,892	2,978

(a) Incomplete. See Scope and sources of statistics, page 1079.

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.

In the following table, which shows particulars collected in the population censuses of Australia at 30 June 1947, 1954 and 1961, the numbers of persons whose industry statements were classified to 'mining and quarrying' are shown together with the numbers engaged in all primary industries and the total work force.

**PERSONS ENGAGED IN MINING AND QUARRYING: AUSTRALIA
1947 TO 1961**

	Census, 30 June—		
	1947	1954	1961
Persons engaged in—			
Mining and quarrying . . .	57,574	62,107	54,401
All primary industries . . .	563,607	560,100	513,286
Total work force . . .	3,196,431	3,702,022	4,225,096
Persons engaged in mining and quarrying as a proportion of—			
All primary industries . . . %	10.2	11.1	10.6
Total work force . . . %	1.8	1.7	1.3

An adjustment was made to the 1947 and 1954 industry data by distributing over the range of recorded industry the number of persons whose industry was not stated. No such adjustment was made to the 1961 figures.

The following table is derived from mining census data and shows the average numbers engaged in the various mining industries in each State or Territory in 1965.

**MINING AND QUARRYING: EMPLOYMENT(a)
STATES AND TERRITORIES, 1965**

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold . . .	12	137	103	..	4,108	..	163	..	4,523
Lead-silver-zinc . . .	4,516	..	(b)	..	40	(b)	..	..	7,269
Copper-gold . . .	239	5	(b)	..	108	(b)	355	..	2,312
Tin . . .	226	5	513	..	147	488	23	..	1,402
Mineral sands . . .	1,264	..	390	..	346	..	..	..	2,000
Other metal . . .	49	4	(b)	401	1,325	(b)	78	..	2,251
Total, metal mining . . .	6,306	151	4,093	401	6,075	2,112	619	..	19,757
Fuel mining—									
Black coal—									
Underground . . .	11,520	200	(b)	..	(b)	70	..	..	c14,541
Opencut . . .	158	..	(b)	278	(b)	..	..	..	850
Total, black coal . . .	11,678	200	c 2,429	278	736	70	..	..	c15,391
Brown coal . . .	..	1,710	..	..	..	..	..	..	1,710
Total, fuel mining . . .	11,678	1,910	2,429	278	736	70	..	..	17,101
Non-metal (excluding fuel) mining(d) . . .	1,188	257	315	452	488	95	..	..	2,793
Total, all mining . . .	19,172	2,318	6,837	1,131	7,299	2,277	619	..	39,653
Construction material quarrying(d) . . .	2,122	2,006	368	932	364	270	69	86	6,217
Total, all mining and quarrying . . .	21,294	4,324	7,205	2,063	7,663	2,547	688	86	45,870

(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 Scope and sources of statistics, page 1079.

The following table shows particulars of mining employment in Australia for the years 1961 to 1965. The figures show the average number of persons employed during the whole year, including working proprietors.

MINING AND QUARRYING: EMPLOYMENT, AUSTRALIA, 1961 TO 1965

Industry	1961	1962	1963	1964	1965
Metal mining—					
Gold	5,438	5,290	5,287	4,753	4,523
Lead-silver-zinc	8,158	7,958	7,946	7,811	7,269
Copper-gold	2,322	2,242	2,288	2,341	2,312
Tin	1,131	1,157	1,116	1,191	1,402
Mineral sands	1,141	1,408	1,565	1,734	2,000
Other metal	1,097	968	1,168	1,348	2,251
<i>Total, metal mining</i>	<i>19,287</i>	<i>19,023</i>	<i>19,370</i>	<i>19,178</i>	<i>19,757</i>
Fuel mining—					
Black coal	16,957	16,312	<i>a</i> 15,636	<i>a</i> 15,364	<i>a</i> 15,391
Brown coal	1,441	1,453	1,613	1,673	1,710
<i>Total, fuel mining</i>	<i>18,398</i>	<i>17,765</i>	<i>17,249</i>	<i>17,037</i>	<i>17,101</i>
Non-metal (excluding fuel) mining(<i>b</i>)	2,942	2,838	2,823	2,783	2,795
<i>Total, all mining</i>	<i>40,627</i>	<i>39,626</i>	<i>39,442</i>	<i>38,998</i>	<i>39,653</i>
Construction material quarrying(<i>b</i>)	5,498	5,599	5,406	5,814	6,217
Total, all mining and quarrying	46,125	45,225	44,848	44,812	45,870

(a) Includes other fuel mining.

(b) Incomplete, see Scope and sources of statistics, page 1079.

Size classification of mines and quarries. Most of the mines and quarries worked during 1965 employed less than four persons, including working proprietors. However, more than half of the persons engaged in mining and quarrying were in the 49 mines each employing 200 persons or more. The following table shows the distribution of the total number of mines into various size groups according to the average number of persons employed during the period worked by each mine in 1965.

NUMBER OF MINES AND QUARRIES AND PERSONS EMPLOYED, BY AVERAGE NUMBER EMPLOYED: STATES AND TERRITORIES, 1965

Mines and quarries employing on the average(<i>a</i>)—	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust.
Less than 4 persons—								
Establishments	748	282	428	222	200	138	59	2,077
Persons	1,168	524	652	390	626	248	161	3,769
From 4 to 20 persons—								
Establishments	184	156	77	84	72	33	11	617
Persons	1,460	1,226	692	793	564	251	108	5,094
From 21 to 200 persons—								
Establishments	81	29	71	13	23	11	7	235
Persons	6,565	1,124	3,379	706	1,580	868	337	14,559
More than 200 persons—								
Establishments	28	2	2	2	12	2	1	49
Persons	12,511	1,819	3,595	584	5,499	1,425	305	25,738
Total—								
Establishments	1,041	469	578	321	307	184	78	2,978
Persons	21,704	4,693	8,318	2,473	8,269	2,792	911	49,160

(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 1965, 44 persons were recorded as killed and 1,233 as injured in mining (excluding quarrying) accidents. Recorded deaths and injuries in that year in black coal mines were 19 and 301, respectively, silver-lead-zinc mines 4 and 226, gold mines 8 and 268, and mineral sands mining 3 and 59. Persons killed and injured in the construction material quarrying industry numbered 2 and 86 respectively in 1965.

Salaries and wages paid

Salaries and wages paid in the mining and quarrying industries in Australia during each year 1961 to 1965 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 317) and also in the *Labour Report*.

MINING AND QUARRYING: SALARIES AND WAGES PAID^(a), AUSTRALIA 1961 TO 1965 (\$'000)

Industry	1961	1962	1963	1964	1965
Metal mining—					
Gold	13,182	13,068	13,072	11,812	11,962
Lead-silver-zinc	26,522	24,454	25,678	29,948	34,397
Copper-gold	5,830	5,702	6,200	6,834	7,415
Tin	1,892	2,100	2,502	2,648	3,313
Mineral sands	2,948	3,478	4,156	4,706	5,837
Other metal	2,554	2,376	3,184	4,038	7,241
<i>Total, metal mining</i>	<i>52,928</i>	<i>51,178</i>	<i>54,792</i>	<i>59,986</i>	<i>70,165</i>
Fuel mining—					
Black coal	50,920	49,698	(b)49,230	(b)52,204	(b)55,942
Brown coal	3,846	3,942	4,634	5,144	5,503
<i>Total, fuel mining</i>	<i>54,766</i>	<i>53,640</i>	<i>53,864</i>	<i>57,348</i>	<i>61,445</i>
Non-metal (excluding fuel) mining ^(c)	5,750	5,796	5,764	6,248	6,388
<i>Total, all mining</i>	<i>113,444</i>	<i>110,614</i>	<i>114,420</i>	<i>123,582</i>	<i>137,998</i>
Construction material quarrying ^(c)	8,036	8,762	8,684	9,364	10,751
<i>Total, all mining and quarrying</i>	<i>121,480</i>	<i>119,376</i>	<i>123,104</i>	<i>132,946</i>	<i>148,749</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 Scope and sources of statistics, page 1079.

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

**MINING AND QUARRYING: VALUE OF POWER, FUEL, LIGHT, AND
OTHER MATERIALS AND STORES USED, AUSTRALIA, 1961 TO 1965**
(**\$'000**)

Industry	1961	1962	1963	1964	1965
Metal mining—					
Gold	9,958	9,894	9,758	8,334	8,433
Lead-silver-zinc	20,606	17,342	21,590	22,688	21,009
Copper-gold	7,006	6,768	7,232	7,698	8,365
Tin	1,202	1,274	1,508	1,854	2,115
Mineral sands	3,594	3,676	5,052	4,906	5,114
Other metal	2,516	2,484	2,850	3,162	4,366
<i>Total, metal mining</i>	<i>44,882</i>	<i>41,438</i>	<i>47,990</i>	<i>48,644</i>	<i>49,402</i>
Fuel mining—					
Black coal	24,818	26,692	(a)27,002	(a)29,114	(a)31,718
Brown coal	1,244	1,344	1,478	1,532	2,108
<i>Total, fuel mining</i>	<i>26,062</i>	<i>28,036</i>	<i>28,480</i>	<i>30,648</i>	<i>33,827</i>
Non-metal (excluding fuel) mining(b)	5,016	5,636	5,534	5,342	5,720
<i>Total, all mining</i>	<i>75,960</i>	<i>75,110</i>	<i>82,004</i>	<i>84,636</i>	<i>88,949</i>
Construction material quarrying(b)	9,852	9,000	9,082	9,752	11,520
<i>Total, all mining and quarrying</i>	<i>85,812</i>	<i>84,110</i>	<i>91,086</i>	<i>94,388</i>	<i>100,468</i>

(a) Includes other fuel mining. (b) Incomplete. See Scope and sources of statistics, page 1079.

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, 1961 TO 1965**
(**\$'000**)

Industry	1961	1962	1963	1964	1965
Metal mining—					
Gold	1,556	3,216	2,024	1,365	1,073
Lead-silver-zinc	6,850	7,046	14,154	20,071	10,939
Copper-gold	1,690	2,730	5,066	7,419	5,333
Tin	522	540	1,548	4,459	6,583
Mineral sands	1,456	3,752	2,436	3,592	6,729
Other metal	2,276	5,154	4,476	5,556	21,053
<i>Total, metal mining</i>	<i>14,350</i>	<i>22,438</i>	<i>29,702</i>	<i>42,462</i>	<i>51,711</i>
Fuel mining—					
Black coal	23,070	26,096	b 20,668	b 19,952	b 28,695
Brown coal	5,446	6,122	6,610	5,416	6,115
<i>Total, fuel mining</i>	<i>28,516</i>	<i>32,218</i>	<i>27,278</i>	<i>25,368</i>	<i>34,810</i>
Non-metal (excluding fuel) mining(c)	2,548	1,408	1,742	3,498	2,109
<i>Total, all mining</i>	<i>45,414</i>	<i>56,064</i>	<i>58,722</i>	<i>71,328</i>	<i>88,630</i>
Construction material quarrying(c)	4,562	3,902	3,898	5,868	7,303
<i>Total, all mining and quarrying</i>	<i>49,976</i>	<i>59,966</i>	<i>62,620</i>	<i>77,194</i>	<i>95,933</i>

(a) Excludes mines and quarries employing less than four persons. (b) Includes other fuel mining.
(c) Incomplete. See Scope and sources of statistics, page 1079.

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 1965 and earlier years.

MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION(a)
STATES AND TERRITORIES, 1965
 (\$'000)

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	5	(b)	(b)	(c)	22,542	(c)	2,320	..	26,031
Lead-silver-zinc	98,061	..	4	51,717	372	(b)	1	..	156,425
Copper-gold	1,156	..	..	..	359	(b)	4,775	..	19,310
Tin	3,535	24	..	3,713	1,548	3,446	74	..	12,340
Mineral sands	15,137	..	..	5,582	4,448	..	..	..	25,167
Other metal	257	(b)	(b)	11,760	6,965	(b)	10	..	25,401
<i>Total, metal mining</i> . .	<i>118,152</i>	<i>727</i>	<i>65,262</i>	<i>11,771</i>	<i>36,234</i>	<i>25,349</i>	<i>7,180</i>	<i>..</i>	<i>264,675</i>
Fuel mining—									
Black coal	112,103	516	23,092	3,264	4,299	430	..	..	143,704
Brown coal . . . . .	..	18,435	..	..	..	..	..	..	18,435
Other fuel . . . . .	..	..	5,345	..	..	..	..	..	5,345
<i>Total, fuel mining</i> . .	<i>112,103</i>	<i>18,951</i>	<i>28,437</i>	<i>3,264</i>	<i>4,299</i>	<i>430</i>	<i>..</i>	<i>..</i>	<i>167,484</i>
Non-metal (excluding fuel) mining—									
Clays(d)	3,041	2,760	242	638	386	133	..	..	7,200
Gypsum	298	287	..	1,345	84	..	..	..	2,014
Limestone	3,297	1,411	1,626	2,506	(b)	(b)	..	..	9,711
Salt . . . . .	..	(b)	(b)	2,051	(b)	..	1	..	2,556
Other non-metal mining(d)	1,593	(b)	(b)	3,864	(b)	(b)	..	..	7,828
<i>Total, non-metal mining</i> .	<i>8,229</i>	<i>4,800</i>	<i>2,365</i>	<i>10,405</i>	<i>2,766</i>	<i>744</i>	<i>1</i>	<i>..</i>	<i>29,309</i>
<i>Total, all mining</i> . . .	<i>238,484</i>	<i>24,477</i>	<i>96,064</i>	<i>25,440</i>	<i>43,299</i>	<i>26,523</i>	<i>7,181</i>	<i>..</i>	<i>461,469</i>
Construction material quarrying(d)	28,372	24,447	2,900	14,026	7,840	2,475	1,127	986	82,172
<i>Total, all mining and quarrying</i> . .	<i>266,857</i>	<i>48,924</i>	<i>98,964</i>	<i>39,466</i>	<i>51,139</i>	<i>28,998</i>	<i>8,308</i>	<i>986</i>	<i>543,642</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) Less than \$500. (d) Incomplete. See Scope and sources of statistics, page 1079.

MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION(a)
STATES AND TERRITORIES, 1961 TO 1965
 (\$'000)

Year	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust.
1961 .	156,342	40,054	64,440	31,824	44,992	15,918	6,732	360,302
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 .	232,708	44,892	97,286	38,938	45,366	25,048	7,972	492,208
1965 .	266,857	48,924	98,964	39,466	51,139	28,998	9,294	543,642

(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 1965 and earlier years.

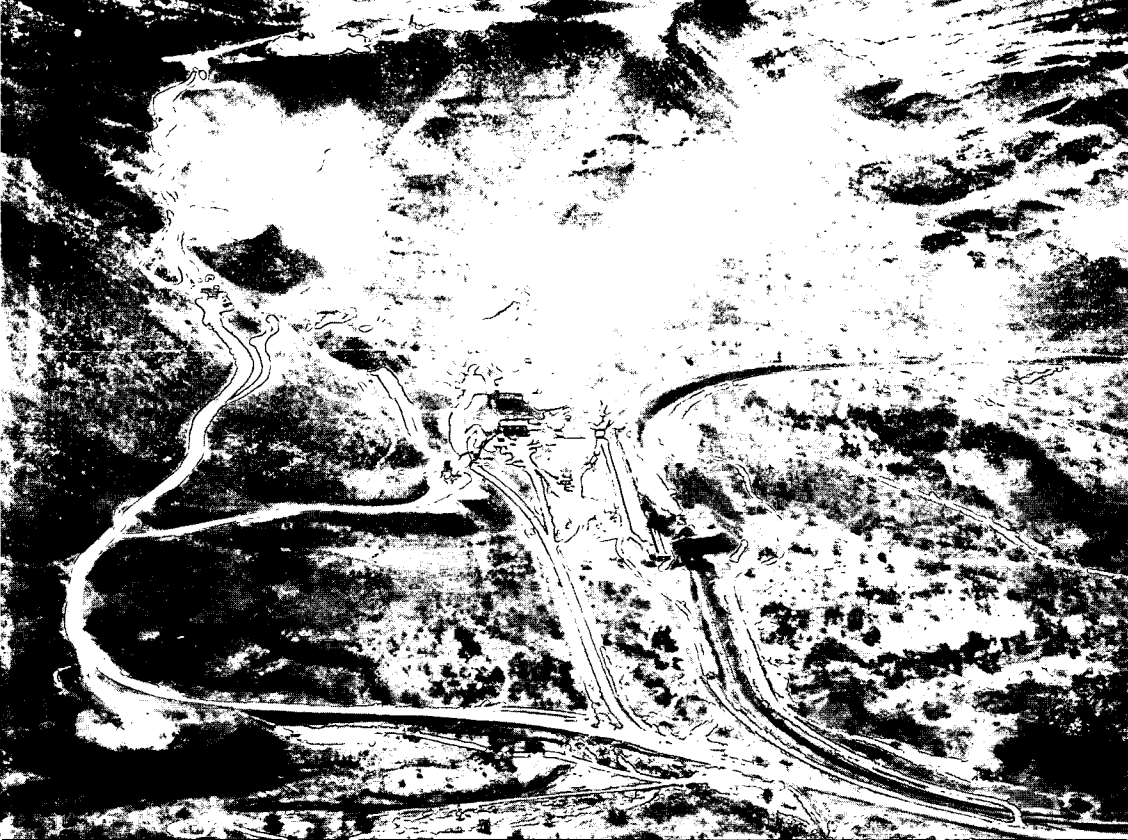
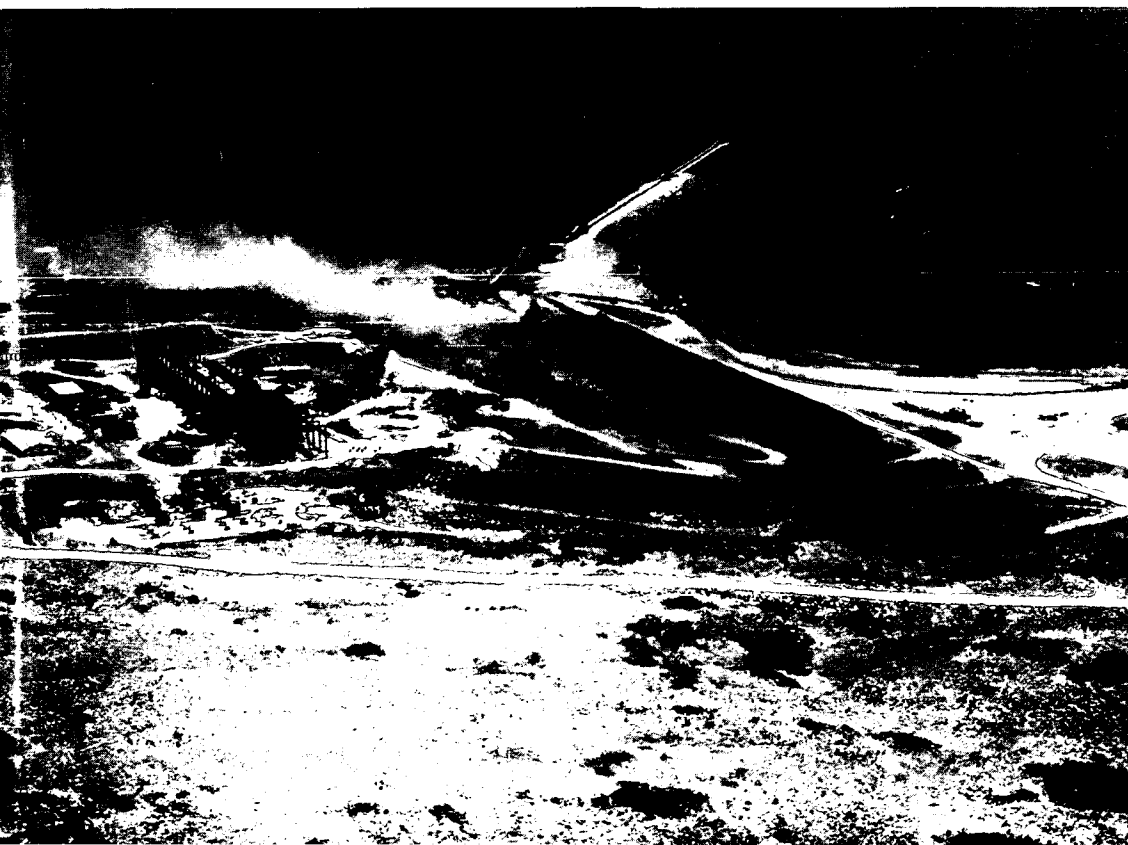


PLATE 51

Above: Iron ore mining operations at Mount Tom Price, Western Australia Below: Loading facilities and pelletising plant (under construction) for Mount Tom Price iron ore, Dampier, Western Australia



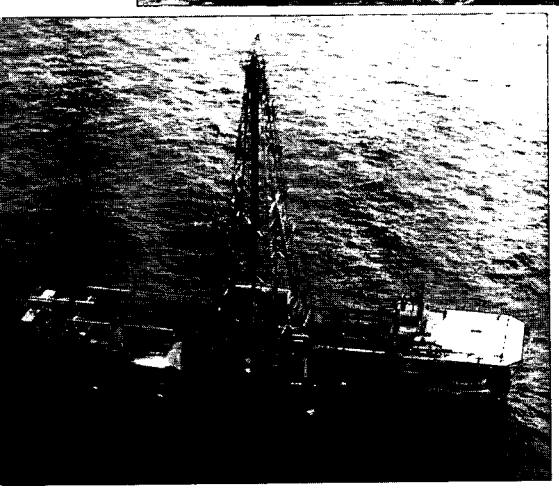
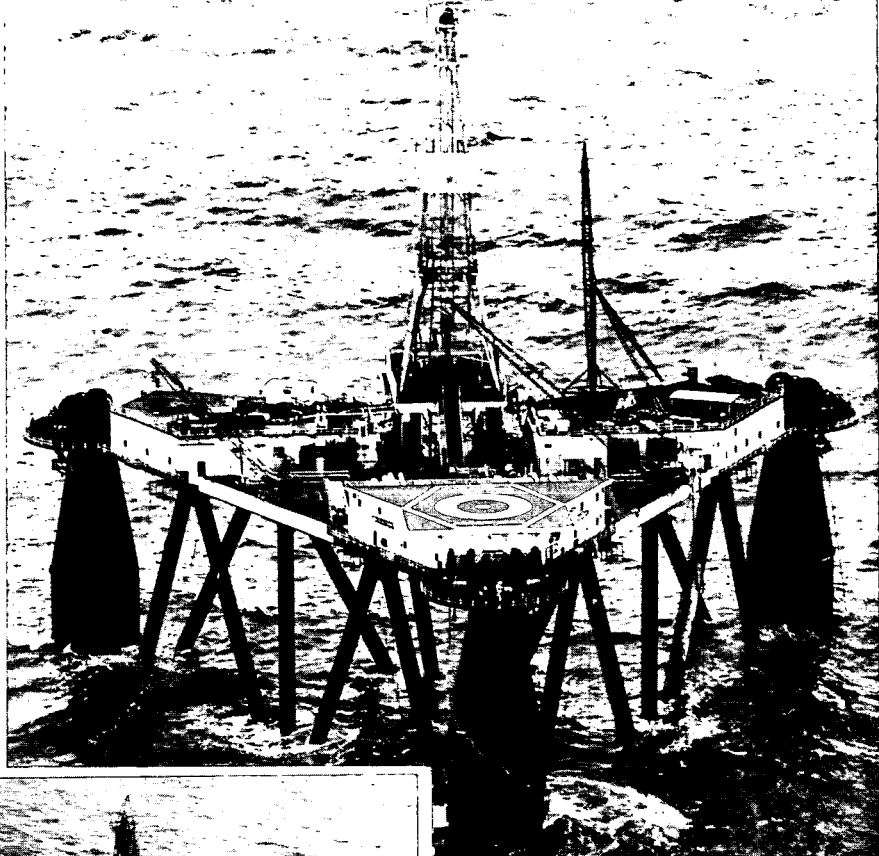
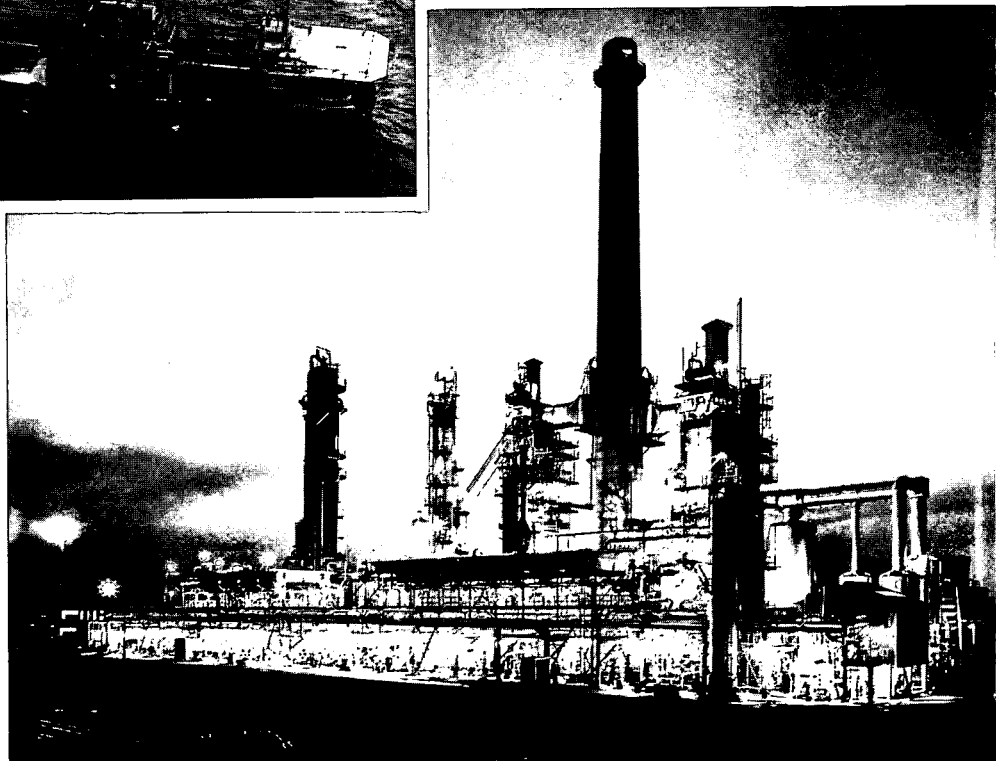


PLATE 52

*Above and left: Offshore drilling rigs
operating in Bass Strait*

Below: Oil refinery, Westernport, Victoria

Photos: Petroleum Information Bureau



**MINING AND QUARRYING: NET VALUE OF PRODUCTION(a)
STATES AND TERRITORIES, 1965**
(\$'000)

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	2	(b)	(b)	(c)	14,881	(c)	1,863	..	17,599
Lead-silver-zinc	86,997	1	41,541	(c)	346	(b)	1	..	135,416
Copper-gold	1,005	22	2,969	9	206	(b)	3,256	..	10,946
Tin	3,179	..	4,785	..	1,225	2,776	53	..	10,225
Mineral sands	11,877	(b)	(b)	9,941	3,391	..	9	..	20,053
Other metal	233	(b)	(b)	..	5,688	(b)	..	..	21,036
Total, metal mining	103,292	537	53,148	9,951	25,739	17,426	5,182	..	215,273
Fuel mining—									
Black coal	86,722	392	23,669	2,718	3,483	348	..	..	117,331
Brown coal	..	16,327	..	..	..	..	..	..	16,327
Total, fuel mining	86,722	16,719	23,669	2,718	3,483	348	..	..	133,658
Non-metal (excluding fuel) mining—									
Clays(e)	2,623	2,667	218	583	254	123	..	..	6,468
Gypsum	236	230	..	1,187	69	..	..	..	1,743
Limestone	2,324	681	1,050	2,197	(b)	(b)	..	..	6,919
Salt	..	(b)	(b)	1,801	(b)	..	(c)	..	(f)2,245
Other non-metal mining(e)	1,386	(b)	(b)	3,670	(b)	(b)	..	..	6,214
Total, non-metal mining	6,569	3,910	1,719	9,439	1,408	543	(c)	..	23,589
Total, all mining	196,583	21,166	78,535	22,107	30,629	18,317	5,182	..	372,520
Construction material quarrying(e)	28,372	18,791	2,231	11,872	6,210	1,992	554	630	70,652
Total, all mining and quarrying	224,956	39,957	80,766	33,979	36,840	20,309	5,736	630	443,173

(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) Less than \$500. (d) Includes other fuel mining. (e) Incomplete. See Scope and sources of statistics, page 1079. (f) No allowance has been made for cost of power, fuel, light, and materials and stores used by the salt industry in Victoria, as particulars are not available.

**MINING AND QUARRYING: NET VALUE OF PRODUCTION(a)
STATES AND TERRITORIES, 1961 TO 1965**

Year	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust.
NET VALUE OF PRODUCTION (\$'000)								
1961	121,368	32,958	46,868	26,206	31,106	10,406	5,578	274,490
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	5,508	325,596
1964	195,390	37,056	74,996	34,068	32,162	18,174	5,974	397,822
1965	224,956	39,957	80,766	33,979	36,840	20,309	6,366	443,173

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

Year	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust.
1961	30.76	11.16	30.63	26.69	41.67	29.17	62.44	25.89
1962	31.25	10.78	37.16	26.30	42.06	33.77	42.54	26.94
1963	36.76	10.99	38.96	28.77	39.06	39.48	51.68	29.57
1964	47.23	11.85	46.31	32.25	40.06	49.33	51.52	35.43
1965	53.51	12.52	49.02	31.53	44.66	54.98	49.43	38.72

(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 1082. Particulars relating to uranium-bearing minerals are excluded.

The following tables show particulars of the quantity of the principal minerals produced during 1965 and earlier years.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1965

Mineral	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Aust.
METALLIC MINERALS								
Antimony concentrate . . . tons	55							55
Bauxite . . . "	10,843	2,555	655,203		499,070			1,167,671
Beryllium ore . . . "	26				12			38
Chromite . . . "			23					23
Copper ore(a) . . . "	62		31,797	114	1,079	8,262	11	41,325
Copper concentrate . . . "	8,324	13	290,830		2,052	48,740	39,439	389,398
Copper precipitate . . . "	135		84			13	67	299
Gold(b) . . . oz	170	19,841	41,682	3	986,431	108	70,268	1,118,503
Ilmenite concentrate . . . tons	8,158		2,421		430,455			441,034
Iron ore(c) . . . '000 tons				4,382	2,313			6,695
Lead ore(d) . . . tons	8,258		13,003	10	3,624		11	24,906
Lead concentrate . . . "	384,973		103,564		1,254	13,565		503,356
Lead-copper concentrate . . . "						10,424		10,424
Leucoxene concentrate . . . "					380			380
Manganese ore . . . "	294		1,750		97,901		424	100,369
Pyrite concentrate . . . "	458		4,135	93,326	59,180	46,912		204,011
Rutile concentrate . . . "	161,828		55,277		225			217,330
Tantalite-columbite concentrate . lb					25,290		291	25,581
Tin concentrate . . . tons	2,325	11	1,680		679	1,493	49	6,237
Tungsten concentrates—								
Scheelite concentrate . . . "						1,150		1,150
Wolfram concentrate . . . "						487		487
Zinc concentrate . . . "	482,438		44,058			77,715		604,211
Zircon concentrate . . . "	156,763		46,690		23,410			226,863

FUEL MINERALS

Coal, black—								
Semi-anthracite . . . '000 tons			68			2		70
Bituminous . . . "	24,130	42	3,955			100		28,228
Sub-bituminous . . . "			131	2,016	994			3,140
<i>Total coal, black</i> . . . "	24,130	42	4,154	2,016	994	102		31,439
Coal, brown (lignite) . . . "		20,659						20,659
Natural gas . . . '000 cu ft			143,402					143,402
Natural gas condensate . . . gal			4,273					4,273
Crude oil . . . '000 gal			91,676					91,676

For footnotes see next page.

**QUANTITIES OF PRINCIPAL MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1965—continued**

Mineral	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Aust.
NON-METALLIC (EXCLUDING FUEL) MINERALS								
Asbestos short tons	722	..	..	..	10,844	..	..	11,566
Barite tons	876	..	..	10,349	751	..	..	11,976
Clays—								
Brick clay and shale . . '000 tons	2,145	1,517	385	386	429	194	..	5,056
Other(e) " "	499	191	72	106	112	27	..	1,008
Diatomite " tons	1,639	692	4,627	..	..	..	..	6,958
Dolomite(f) " "	4,345	..	7,987	245,184	..	1,145	..	258,661
Felspar " "	5,822	..	..	1,520	1,384	..	..	8,726
Gypsum " "	58,371	168,589	..	559,954	46,607	..	..	833,521
Limestone(f) '000 tons	2,805	1,459	(g)	1,562	(g)	(g)	..	7,516
Magnesite tons	24,500	..	1,000	663	199	..	..	26,362
Phosphate rock . . . . . " "	..	..	..	4,504	15	..	..	4,519
Salt, crude " "	..	(g)	..	512,852	(g)	..	50	654,533
Silica (glass, chemical, etc.)(e) . . " "	215,707	..	49,767	35,799	9,272	10,392	..	320,937
Talc " "	2,018	..	..	10,613	7,088	..	..	19,719

CONSTRUCTION MATERIALS(e)

Sand '000 tons	4,965	3,926	n.a.	1,795	n.a.	276	} h 595	{ 11,444
River gravel " "	2,256	3,604	n.a.	546	n.a.	1,240		
Dimension stone " "	222	14	4	32	186	1	} h 686	{ 467
Crushed and broken stone " "	6,694	15,535	2,773	10,775	2,470	1,340		
Other (decomposed rock, etc.) " "	18,628	1,909	11	..	..	284		20,931

(a) Includes cupreous ore for fertiliser. (b) Bullion, alluvial, retorted gold, etc. (c) Iron oxide for metal extraction only. (d) Includes lead-silver-zinc ore. (e) Incomplete, see Scope and sources of statistics, page 1079. (f) Excludes quantities used directly as building or road material. (g) Not available for publication. (h) Includes Australian Capital Territory which is not available for publication by individual items.

**QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA
1961 TO 1965**

Mineral	1961	1962	1963	1964	1965
METALLIC MINERALS					
Antimony ore and concentrate . . tons	190	100	115	414	55
Bauxite " "	15,976	29,547	354,206	783,900	1,167,671
Beryllium ore " "	306	223	110	111	38
Chromite " "	..	369	160	72	23
Copper ore(a) " "	75,215	101,492	82,035	59,686	41,325
Copper concentrate " "	373,770	395,427	434,368	427,258	389,398
Copper precipitate " "	825	216	504	264	299
Gold(b) '000 oz	(c)	(c)	1,231	1,150	1,119
Ilmenite concentrate tons	165,865	178,867	200,983	303,628	441,034
Iron ore(d) '000 tons	5,342	4,843	5,515	5,669	6,695
Lead ore(e) tons	7,743	13,197	16,249	25,174	24,906
Lead concentrate " "	382,292	522,276	584,462	536,213	503,356
Lead-copper concentrate " "	8,057	11,192	9,309	10,214	10,424
Leucoxene concentrate " "	535	627	547	656	380
Manganese ore " "	87,411	71,646	36,061	61,109	100,369
Pyrite concentrate " "	213,423	148,566	194,059	220,078	204,011
Rutile concentrate " "	101,431	119,195	183,260	182,371	217,330
Tantalite-columbite concentrate . . lb	31,808	43,097	30,889	33,600	25,581
Tin concentrate tons	3,870	3,842	4,132	5,314	6,237
Tungsten concentrates—					
Scheelite concentrate " "	1,017	995	958	1,020	1,150
Wolfram concentrate " "	1,142	492	394	380	487
Zinc concentrate " "	542,640	572,900	594,861	588,840	604,211
Zircon concentrate " "	136,462	133,844	184,830	184,082	226,863

For footnotes see next page.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA
1961 TO 1965—*continued*

Mineral	1961	1962	1963	1964	1965
FUEL MINERALS					
Coal, black—					
Semi-anthracite . . . '000 tons	59	70	61	79	70
Bituminous "	21,991	22,006	22,268	24,477	28,228
Sub-bituminous "	1,956	2,394	2,527	2,845	3,140
<i>Total coal, black</i> "	<i>24,006</i>	<i>24,470</i>	<i>24,856</i>	<i>27,401</i>	<i>31,439</i>
Coal, brown (lignite) "	16,279	17,137	18,456	19,035	20,659
Natural gas '000 cu ft	12,187	56,361	95,725	106,490	143,402
Natural gas condensate gal	559	2,199	4,312	8,568	4,273
Crude oil '000 gal	..	..	..	52,157	91,676

NON-METALLIC (EXCLUDING FUEL) MINERALS

Asbestos short tons	16,746	18,416	13,374	13,654	11,566
Barite tons	19,217	12,534	8,220	12,302	11,976
Clays—					
Brick clay and shale . . . '000 tons	4,344	4,383	4,549	5,163	5,056
Other(f) "	912	913	984	1,039	1,008
Diatomite tons	5,417	7,312	5,133	8,732	6,958
Dolomite(g) "	191,624	180,697	214,339	236,068	258,661
Felspar "	8,209	8,513	8,842	9,021	8,726
Gypsum "	609,907	630,910	725,444	795,003	833,521
Limestone(g) '000 tons	6,146	6,415	6,721	7,223	7,516
Magnesite tons	98,795	62,191	56,946	31,250	26,362
Phosphate rock "	4,874	4,385	4,925	5,689	4,519
Salt, crude "	508,657	536,019	581,537	545,491	654,533
Silica (glass, chemical, etc.)(f) "	212,575	218,544	247,928	322,269	320,937
Talc "	13,545	14,060	13,106	15,695	19,719

CONSTRUCTION MATERIALS(f)

Sand '000 tons	7,427	7,535	9,050	10,757	11,444
River gravel "	6,018	5,912	7,624	8,117	7,760
Dimension stone "	533	379	629	590	467
Crushed and broken stone "	27,303	27,944	29,768	34,175	40,165
Other (decomposed rock, etc.) "	16,482	17,310	20,830	23,460	20,931

(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 Scope and sources of statistics, page 1079. (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 1965 and earlier years.

**CONTENTS OF METALLIC MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1965**

Content of metallic minerals produced	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Aust.
Alumina (Al_2O_3) . . . tons	4,131	1,331	383,294	..	224,581	..	..	613,337
Antimony . . . " "	944	..	..	..	..	..	..	944
Beryllium oxide (BeO) . . . units(a)	330	..	..	..	127	..	..	457
Cadmium . . . tons	995	..	90	..	..	70	..	1,155
Chromic oxide (Cr_2O_3) . . . " "	..	..	10	..	..	..	..	10
Cobalt . . . " "	90	..	..	..	..	..	..	90
Copper . . . " "	5,211	3	60,406	23	626	15,168	8,951	90,388
Gold . . . fine oz	9,640	19,246	76,964	2	656,355	32,897	82,539	877,643
Iron(b) . . . '000 tons	..	..	..	2,812	1,486	..	..	4,297
Lead . . . tons	296,662	..	49,673	4	1,379	14,415	4	362,137
Manganese(c) . . . " "	6,200	..	..	..	48,847	233	..	55,280
Manganese dioxide (MnO_2)(d) . . . " "	181	..	1,166	..	20	..	285	1,652
Molybdenum disulphide (MoS_2) . . . lb	35,940	..	5,971	..	..	..	..	41,911
Monazite . . . tons	546	..	244	..	1,375	..	..	2,165
Silver . . . '000 fine oz	10,636	..	4,636	..	245	1,678	86	17,281
Sulphur(e) . . . tons	211,678	..	16,120	38,917	24,865	53,974	..	345,554
Tantalite-columbite ($Ta_2O_5 + Nb_2O_5$) . . . lb	..	..	..	..	10,147	..	134	10,281
Tin . . . tons	1,124	8	1,176	..	468	1,045	28	3,849
Titanium dioxide (TiO_2) . . . " "	158,963	..	54,708	..	234,647	..	..	448,318
Tungstic oxide (WO_3) . . . " "	..	..	..	..	..	1,176	..	1,176
Zinc . . . " "	270,936	..	30,975	..	1,010	46,310	..	349,231
Zircon . . . " "	155,255	..	46,223	..	23,176	..	..	224,654

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

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

CONTENTS OF METALLIC MINERALS PRODUCED: AUSTRALIA, 1961 TO 1965

Content of metallic minerals produced	1961	1962	1963	1964	1965
Alumina (Al_2O_3) . . . tons	7,464	13,250	154,499	396,329	613,337
Antimony . . . " "	680	874	1,007	1,116	944
Beryllium oxide (BeO) . . . units(a)	3,585	2,586	1,278	1,279	457
Bismuth . . . lb	602	97	..	..	..
Cadmium . . . tons	907	992	1,109	1,050	1,155
Chromic oxide (Cr_2O_3) . . . " "	..	185	72	32	10
Cobalt . . . " "	65	78	86	73	90
Copper . . . " "	95,626	106,972	112,967	104,050	90,388
Gold . . . fine oz	1,076,292	1,068,837	1,023,970	963,834	877,643
Iron(b) . . . '000 tons	3,434	3,119	3,558	3,655	4,297
Lead . . . tons	269,656	370,110	410,291	374,856	362,137
Manganese(c) . . . " "	45,087	39,413	23,951	36,564	55,280
Manganese dioxide (MnO_2)(d) . . . tons	1,429	1,512	1,228	1,033	1,652
Molybdenum disulphide (MoS_2) . . . lb	2,630	2,332	21,645	..	41,911
Monazite . . . tons	1,463	772	1,875	1,848	2,165
Platinum . . . oz	2	2	4	..	..
Silver . . . '000 fine oz	13,059	17,554	19,642	18,427	17,281
Sulphur(e) . . . tons	324,866	312,803	345,636	346,502	345,554
Tantalite-columbite ($Ta_2O_5 + Nb_2O_5$) . . . lb	13,814	18,879	12,935	12,499	10,281
Tin . . . tons	2,745	2,715	2,860	3,642	3,849
Titanium dioxide (TiO_2) . . . " "	191,965	215,494	288,050	342,646	448,318
Tungstic oxide (WO_3) . . . " "	1,536	1,042	960	996	1,176
Zinc . . . " "	311,157	337,532	351,470	344,600	349,231
Zircon . . . " "	134,483	132,109	182,112	182,174	224,654

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

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

MINE PRODUCTION OF PRINCIPAL METALS

(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1936 TO 1966

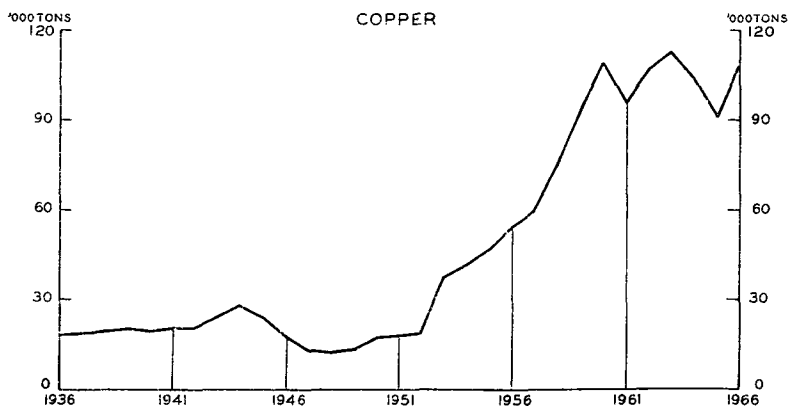
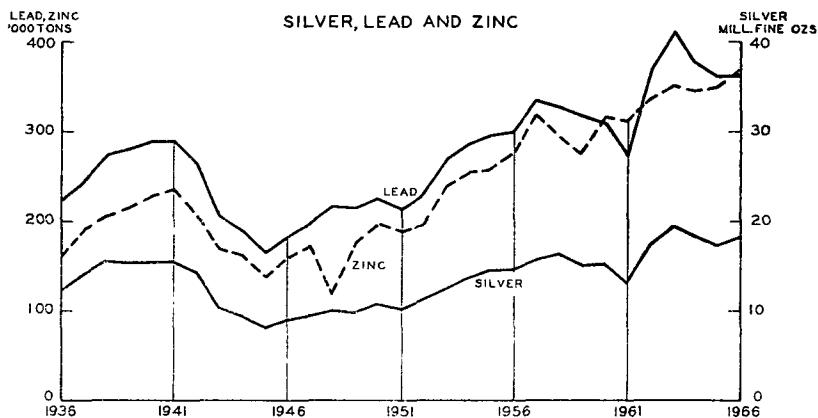
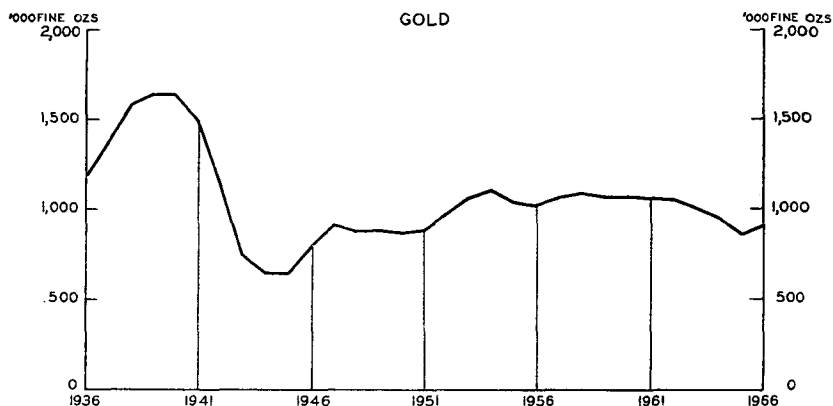


PLATE 53

MINE PRODUCTION OF PRINCIPAL METALS AND PRODUCTION OF COAL

(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1936 TO 1966

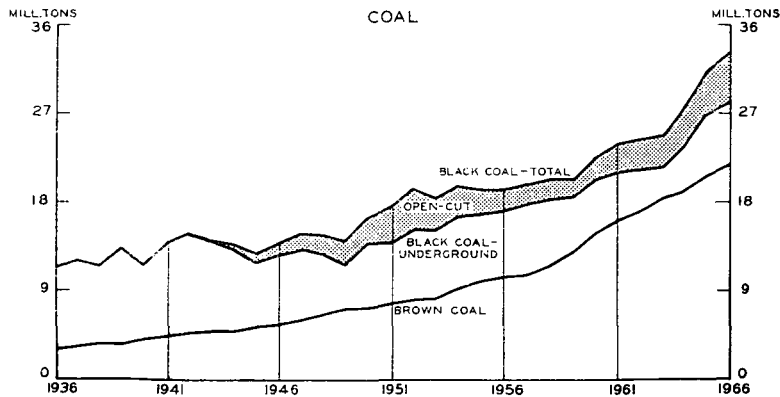
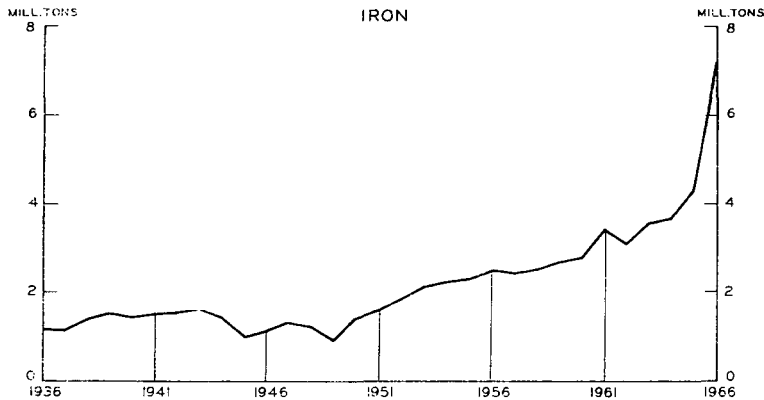
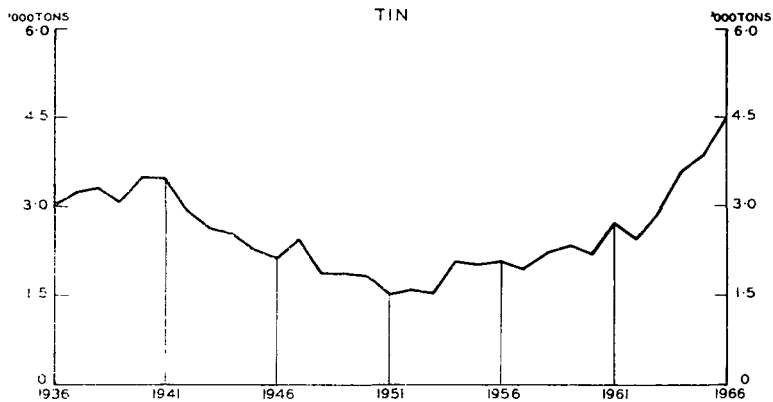


PLATE 54

Graphs showing details of the mine production of principal metals (metallic content) and coal from 1935 to 1965 are included on plates 53 and 54, pages 1094-1095.

Local value of minerals produced, 1961 to 1965

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, 1961 TO 1965 (\$'000)

Mineral	1961	1962	1963	1964	1965
Metallic minerals—					
Copper ore, concentrate, etc.	42,498	48,604	52,036	51,380	50,790
Gold ore, concentrate, other forms, etc.	31,718	31,254	29,556	26,666	25,619
Iron ore	11,798	10,650	12,200	12,550	14,640
Lead and lead-silver ore and concentrate, lead-copper concentrate, etc.	33,866	39,096	56,320	80,806	87,947
Manganese ore	854	960	492	750	808
Pyrite concentrate	2,504	2,230	2,354	3,054	3,040
Rutile concentrate	6,628	7,038	12,114	12,080	15,038
Tin concentrate	5,572	5,668	5,784	10,224	12,237
Tungsten concentrates	2,066	1,118	1,640	1,420	2,692
Zinc ore and concentrate	10,590	9,110	16,468	35,456	36,818
Zircon concentrate	2,534	2,582	3,550	3,462	6,136
Other metallic minerals	1,536	1,894	2,994	5,794	8,903
<i>Total, metallic minerals</i>	<i>152,164</i>	<i>160,204</i>	<i>195,508</i>	<i>243,642</i>	<i>264,668</i>
Fuel minerals—					
Coal, black	114,162	119,078	118,202	128,038	143,703
Coal, brown	15,444	15,682	16,156	17,304	18,436
Other fuel minerals	n.a.	n.a.	58	2,164	5,344
<i>Total, fuel minerals</i>	<i>129,606</i>	<i>134,760</i>	<i>134,416</i>	<i>147,506</i>	<i>167,483</i>
<i>Total, non-metallic minerals(a)</i>	<i>22,990</i>	<i>24,320</i>	<i>26,038</i>	<i>27,814</i>	<i>29,241</i>
<i>Total, construction materials(a)</i>	<i>55,542</i>	<i>55,854</i>	<i>60,720</i>	<i>73,244</i>	<i>82,251</i>
<i>Total, all minerals and construction materials</i>	<i>360,302</i>	<i>375,138</i>	<i>416,682</i>	<i>492,208</i>	<i>543,642</i>

(a) Incomplete owing to difficulties of coverage. See Scope and sources of statistics, page 1079.

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 1088 for mining industry groups differ slightly in some cases from totals of the corresponding groups of mine products shown in the table above.

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 1110-36 and 1144-5.

Principal products

The following table shows particulars of the production of certain important manufactured products of mineral origin during the years 1961-62 to 1965-66. 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, 1961-62 TO 1965-66**

Commodity	1961-62	1962-63	1963-64	1964-65	1965-66
METALS					
Non-ferrous—					
Refined aluminium . . . tons	14,408	26,870	58,937	85,497	87,222
Blister copper(a) . . . "	66,818	88,901	92,809	57,880	98,529
Refined copper . . . "	63,769	85,652	89,222	53,441	91,001
Lead bullion (for export)(a) "	56,063	78,299	82,440	63,827	82,084
Refined lead . . . "	174,497	208,946	217,292	199,032	188,101
Refined zinc . . . "	153,742	175,850	186,389	189,395	196,534
Refined tin . . . "	2,442	2,714	2,959	2,931	3,537
Ferrous—					
Pig iron . . . '000 tons	3,380	3,400	3,772	3,936	4,380
Steel ingots . . . "	4,076	4,260	4,764	5,027	5,561
Precious—					
Refined gold(b) . . . '000 f. oz	1,036	1,006	911	871	774
Refined silver . . . "	6,751	8,514	9,392	8,939	8,683

FUELS

Coal products—					
Metallurgical coke . . '000 tons	2,717	2,759	2,915	3,118	3,142
Brown coal briquettes . . "	1,820	1,805	1,883	1,893	1,877
Petroleum products—					
Motor spirit . . . mill. gal	1,213	1,263	1,358	1,482	1,524
Furnace fuel . . . '000 tons	3,873	4,629	4,686	4,869	5,340
Automotive distillate . . "	1,605	1,654	1,616	1,603	1,829
Industrial diesel fuel . . "	874	981	917	862	859

BUILDING MATERIALS

Clay bricks . . . millions	992	1,059	1,238	1,353	1,357
Portland cement . . . '000 tons	2,783	2,942	3,320	3,746	3,667
Plaster of paris . . . "	228	241	260	277	268
Plaster sheets (fibrous) '000 sq yd	15,332	15,932	15,922	14,760	29,613

CHEMICALS

Sulphuric acid . . . '000 tons	1,136	1,256	1,447	1,610	1,779
Caustic soda . . . tons	47,539	56,481	64,230	69,879	74,430
Superphosphate . . . '000 tons	2,591	2,862	3,347	3,703	4,185

(a) Metallic content. (b) Newly-won gold of Australian origin.

Overseas trade

A significant proportion of Australia's mineral production is exported to overseas markets, and these exports make a valuable contribution to total exports. The major exports at present are lead, zinc, coal, mineral sands, gold, silver, copper, basic iron and steel products, and opals.

Mineral imports are dominated by crude petroleum, imports of which have expanded rapidly since the mid-1950's, concomitant with the growth of the domestic petroleum refining industry. Of the other mineral imports, the most important are phosphate rock, sulphur, ferro-alloys, asbestos, tin, and alumina.

Exports and imports

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 1963 to 1965 are shown in the following table.

EXPORTS AND IMPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS AUSTRALIA, 1963 TO 1965

Item	Quantity			Value (\$'000 f.o.b.)		
	1963	1964	1965	1963	1964	1965
EXPORTS(a)						
Coal tons	3,174,773	4,805,953	7,155,564	26,674	41,047	60,661
Copper—						
Ore and concentrate "	30,937	47,255	46,111	4,102	6,484	7,337
Ingots, pigs (refined) "	24,485	13,817	11,703	14,018	8,315	12,220
Rolled, drawn and extruded shapes "	5,049	5,077	11,721	3,814	4,265	11,444
Gold, refined fine oz	472,132	427,318	745,125	14,778	13,382	23,265
Iron and steel—						
Pig iron tons	132,798	55,940	45,154	5,290	2,622	2,174
Ingots, blooms and slabs "	31,909	8,507	10,519	2,058	529	605
Tinplate "	68,200	65,435	71,363	9,534	9,028	9,282
Scrap "	334,351	392,408	308,648	7,930	10,114	9,773
Lead—						
Ore and concentrate "	121,983	112,194	108,256	13,428	17,614	20,829
Lead-silver bullion "	76,482	76,061	69,286	13,386	20,094	21,252
Pig "	174,988	156,305	156,545	26,488	35,267	43,502
Opals . . . . . "	..	..	..	5,394	5,398	5,324
Petroleum oils—						
Gasolines and solvents '000 gal	51,742	51,656	16,477	5,734	5,448	2,106
Kerosenes "	25,718	12,690	15,149	3,160	1,578	1,797
Automotive distillate "	126,665	74,183	41,339	12,878	7,442	3,825
Residuals and heavy distillates "	384,877	233,953	165,704	22,946	13,064	7,774
Rutile concentrate tons	154,508	193,893	239,454	10,632	14,080	17,134
Zinc—						
Ore and concentrate "	261,856	224,117	212,946	8,998	15,684	14,328
Refinery type shapes "	96,775	80,184	87,051	17,114	21,226	24,205
Zircon concentrate "	179,697	198,664	216,661	4,354	5,124	6,816
IMPORTS						
Alumina tons	54,486	71,437	55,647	3,650	4,818	3,900
Aluminium, refined ingots "	12,115	565	357	5,528	372	312
Asbestos short tons	36,628	42,896	51,719	4,211	4,873	5,859
Gold, unrefined bullion(b) fine oz	161,847	143,144	137,143	5,056	4,466	4,252
Ferro-alloys tons	28,778	19,271	32,587	4,976	4,171	6,909
Petroleum oils—						
Crude '000 gal	3,287,455	3,253,681	3,399,992	149,000	147,356	155,851
Enriched crude "	575,951	692,727	878,206	27,446	32,974	39,307
Kerosenes "	88,993	59,312	79,836	9,648	6,268	8,505
Lubricating oil "	53,536	47,031	20,646	14,770	12,616	5,601
Gasolines and solvents "	254,956	290,258	269,702	28,398	32,242	30,699
Phosphate rock '000 tons	1,762	2,355	2,527	10,708	16,236	17,505
Sulphur tons	222,527	376,639	387,869	4,304	6,508	7,496
Tin, refined "	1,751	1,283	1,582	3,724	3,798	5,259
Titanium oxide (pigments) "	5,086	2,875	2,167	2,012	1,231	870

(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 1965 and their principal metallic content as estimated by assay.

**PRINCIPAL METALLIC CONTENTS OF SELECTED ORES AND CONCENTRATES
ETC. EXPORTED FROM AUSTRALIA DURING 1965**

Ores and concentrates, etc.	Quantity exported	Metallic contents—estimated from assay							
		Anti- mony	Copper	Gold	Lead	Silver	Tin	Tungstic oxide	Zinc
	tons	tons	tons	fine oz	tons	'000 fine oz	tons	tons	tons
Copper—									
Ore, concentrate and precipitate	46,230	..	9,725	21,446	..	102	1	..	..
Copper-lead dross and speiss	2,833	..	600	..	1,742	154	..	..	..
Other slags and residues	381	..	212	..	5	..	2	..	..
Blister	2,115	..	2,102	32,145	..	13	..	..	..
Matte	5,855	12	2,052	196	2,562	192	..	..	..
Lead—									
Ore and concentrate(a)	108,256	162	1,237	28,398	73,885	2,568	..	..	8,080
Slags and residues	5,135	85	93	1,294	3,079	22	46	..	27
Lead-silver bullion	69,286	..	..	48	68,879	4,258	..	..	..
Tin concentrate	1,642	..	8	..	1	..	633	..	..
Tungsten—									
Scheelite ore and concentrate	1,495	..	..	..	..	..	..	1,023	..
Wolfram ore and concentrate	417	..	..	..	..	..	..	304	..
Zinc—									
Ore and concentrate	212,946	..	1	..	3,197	60	..	..	103,493
Slags and residues	7,308	..	..	..	..	..	..	..	5,103
Total metallic contents	..	259	16,030	83,532	153,345	7,371	682	1,327	116,703

(a) Includes lead-copper concentrate.

Direction of trade

Australia's minerals are exported to many countries throughout the world, but the principal markets are Japan, United Kingdom, United States, and Europe. Since 1960 Japan has been the principal buyer of Australian minerals. The distribution of exports according to principal destinations, and imports according to principal sources, for the years 1963 to 1965, are shown in the following table.

**VALUE OF OVERSEAS MINERAL TRADE, BY COUNTRY OR REGION
AUSTRALIA(a), 1963 TO 1965**

Country or region	Value (\$ m f.o.b.)			Percentage		
	1963	1964	1965	1963	1964	1965
EXPORTS(b)						
Japan	53.8	72.6	92.4	32.0	32.1	32.5
Other Asian and Pacific	13.8	25.8	30.0	8.2	11.4	10.5
United Kingdom	49.0	68.4	68.2	29.2	30.2	24.0
European Economic Community	18.4	27.8	43.8	11.0	12.3	15.4
United States	22.2	27.0	42.5	13.2	11.9	14.9
Other	10.8	4.8	7.7	6.4	2.1	2.7
Total	168.0	226.4	284.6	100.0	100.0	100.0
IMPORTS						
Middle East	118.0	126.8	132.4	51.2	51.5	44.0
Indonesia	47.0	44.6	53.0	20.4	18.1	17.6
Other Asian	4.2	14.8	24.0	1.8	6.0	8.0
Pacific	11.4	15.6	14.3	4.9	6.3	4.8
United States	7.4	17.2	23.6	3.2	7.0	7.9
Canada	8.2	8.0	9.7	3.6	3.3	3.2
Europe (including United Kingdom and European Economic Community)	5.2	9.8	31.0	2.3	4.0	10.3
Other	29.0	9.4	12.6	12.6	3.8	4.2
Total	230.4	246.2	300.6	100.0	100.0	100.0

(a) Excludes gold movements.
available for publication.

(b) Excludes uranium oxide and alumina, details of which are not

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, 1966

Expansion of the Australian mineral industry was maintained during 1966 with the preliminary value of mineral production increasing by 15 per cent from \$544 million in 1965 to \$624 million in 1966. The major reasons for this increase in the value of mineral production were the commencement of production on a large scale from three large iron ore developments in Western Australia, improved prices for copper minerals, and increased production of copper and bauxite. The value of exports of minerals and mineral products also increased, in particular because of the commencement of exports of iron ore under long-term contracts, mainly 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 1966 and early 1967 were periods 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 2.5 million tons per annum following completion of a further stage in the development of the mine and associated township, and of ore treatment and loading facilities. It is expected that production will rise to nearly 5 million tons by the early 1970's. Approximately half the output from Weipa will be used by the Gladstone, Queensland, alumina refinery, a further 110 thousand tons will be shipped to Bell Bay, Tasmania, and the remaining production will be exported.

Bauxite deposits at Gove, Northern Territory, covering reserves of the order of 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. The ultimate capacity of the plant is to be 2 million metric tons per annum; the plant is to consist of four independent production units, each with an annual capacity of 500,000 metric tons.

Alumina

An alumina refinery with a capacity of 600,000 tons per annum at Gladstone, Queensland, which was completed at a cost of \$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 40,000 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

Copper production (copper in mine products) increased to 109,260 tons in 1966, mainly because of resumption of production after the long strike at Mount Isa in late 1964 and early 1965. 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 is being extracted, the Mount Isa output will be supplemented by ore from the Young Australia mine, fifty miles south of Cloncurry, Queensland, where known reserves were reported to be sufficient for twelve months operations.

In early 1967 a pilot plant to test the new Worra copper smelting process for the continuous production of metallic copper directly from copper concentrates was completed at Port Kembla, New South Wales.

The basis of the Australian Producers' price for copper was changed in August 1966 from \$870 to \$1,250 per ton to relate to copper prices on the London Metal Exchange, which were significantly higher than the Australian Producers' price. Since August 1966 the Australian Producers' price has been adjusted regularly to reflect movements in London Metal Exchange prices, the price in May 1967 being \$950 per ton.

Gold

A new gold-copper mine will be 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.

Iron ore

The year 1966 was one of significant developments in the iron ore mining industry. Production commenced during 1966 from deposits at Mount Tom Price, Mount Goldsworthy and Koolanooka in Western Australia. Development of deposits at Savage River, Tasmania (including the construction of a pelletisation plant at Brickmakers Bay) and at Frances Creek and Mount Bunday, Northern Territory was undertaken during 1966, for production in late 1967 or early 1968.

Development of deposits at Mount Tom Price involved the construction of a railway from the mine to the deepwater port at Dampier, a distance of 182 miles. The development of the Mount Goldsworthy deposits required the construction of seventy miles of railway to the port at Port Hedland. Both projects included the development of port facilities with ore loading equipment, and the dredging of channels to the loading wharves. A two-million tons per annum pelletisation plant is under construction at Dampier and is to commence production in 1968. Details of major export contracts for the sale of iron ore were shown in the previous issue of the Year Book (No. 52, page 1048).

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 260-mile railway from Mount Newman to Port Hedland together with associated loading and port facilities.

Production commenced during 1967 from deposits at Koolyanobbing, Western Australia. Ore will be shipped on a recently converted standard gauge railway 304 miles to Kwinana, where a blast furnace is to be completed early in 1968. Initially the ore will be shipped to Port Kembla and Newcastle, New South Wales.

Investigation and negotiations for export contracts continued with respect to deposits at Robe River and Niningarra in Western Australia.

Steel

In September 1965 it was announced that blast furnace, plate and strip capacity at Port Kembla would be expanded at a cost of \$80 million. The complete expansion programme will include coke ovens, new steel making and primary rolling equipment, and additions to the tin-plate plant. The coke ovens and additions to the tin-plate plant were commissioned during 1966.

Lead and zinc

The Australian lead-zinc industry experienced one of the most prosperous periods of its history between 1963 and 1965 as a result of higher prices for its products. Prices fell slightly in 1966, however, which resulted in lower values for mine production of lead and zinc.

A new shaft is to be sunk at one of the four mines at Broken Hill, New South Wales, at an estimated cost of \$7 million.

Further exploration has proceeded at the large zinc-lead deposit at McArthur River in the Northern Territory. Metallurgical testing of the zinc-lead ores of this deposit continued, but satisfactory mineral separation has not yet been achieved.

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 1966 exports were 8.3 million tons valued at \$65.6 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 are under development in Queensland and New South Wales, and many established mines are being expanded. Exploration for coal has been stimulated, and in early 1967 there were indications that a further rich deposit of coking coal had been located in Queensland.

Details of agreements for exports of coal were shown in the last issue of the Year Book (No. 52, page 1049). During 1966 a further major contract for the export of coal from the Moura, Queensland, field of 15 million tons to Japan over ten years from 1968 was announced.

Petroleum

Petroleum exploration in Australia continued to expand in 1966 and early 1967, and encouraging discoveries during this period, although still small by world standards, have been a stimulus to further exploration. Developments in the last few years were reviewed in previous issues of the Year Book (No. 48 pages 1094-8, No. 51, page 1179 and No. 52, page 1050). A summary of developments in 1966 and early 1967 follows.

Australia now has four commercial oilfields, Moonie, Alton and Conloi in Queensland (connected by pipeline to Brisbane, Queensland), and at Barrow Island, Western Australia, capable of supplying about 6 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.

Commercial production of natural gas, currently restricted to the Roma field in Queensland, is planned for deposits at Gidgealpa and Moomba in South Australia, and off-shore Victoria. Further expansion of production from the Roma field is envisaged. It is expected that a pipeline from the Roma field to Brisbane, at a cost of \$11 million, is to be completed by the end of 1968. A pipeline is planned from Gidgealpa and Moomba field 500 miles to Adelaide. A pipeline from off-shore deposits on the Gippsland shelf of Victoria will serve Melbourne and areas of Victoria. An absorption plant is under construction at Sale, Victoria, and off-shore platforms for drilling production wells are also under construction.

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.

Proposals have been made for uniform Australian legislation to control and administer the off-shore search for oil. These proposals are outlined on pages 1068-9

Early in 1965 the Tariff Board conducted a public enquiry 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.

Mineral exploration

Increased interest in the potentialities of the mining industry in Australia since 1960 have seen a considerable expansion in mineral exploration, and several major discoveries have resulted. Some discoveries have been mentioned in earlier Year Books or other parts of this section. Details of other major discoveries follow.

Nickel

Significant discoveries of nickel have been made near Kambalda, Western Australia. Mining operations at Kambalda commenced in mid-1967, and the company concerned has obtained a contract to sell 40,000 tons of contained nickel over ten years to Japan.

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 in progress.

Silver-lead-zinc

A discovery of a silver-lead-zinc deposit was made by the Bureau of Mineral Resources at Rum Jungle in the Northern Territory towards the end of 1966. Further drilling is continuing.

