

CHAPTER 26

MINERAL INDUSTRY

Further detailed statistics and information on the subjects dealt with in this chapter are contained in the annual printed bulletin *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 bulletin *Mining and Quarrying* of this Bureau contains 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 overlie large areas of the continent and reach their greatest development in central Queensland. Cainozoic rocks occur mainly in the southern parts of Victoria and South Australia and as residual basalt cappings over an extensive area of the Palaeozoic rocks of eastern Australia.

Economic geology

Minerals of economic significance occur widely throughout the Precambrian and Palaeozoic rocks of the continent. Palaeozoic mineralization 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 mineralized 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 will begin 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). A map of Australia showing the main sedimentary basins and locations of oil and gas discoveries appears on plate 60.

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 important 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 . . . Northern Territory	Mount Isa Tennant Creek
	Gold . . .	Western Australia .	Kalgoorlie and other localities
	Iron . . .	South Australia . . Western Australia .	Middleback Ranges Yampi Sound and Pilbara
	Lead-silver-zinc	New South Wales . Queensland . . .	Broken Hill Mount Isa
Palaeozoic (between 200 and 520 million years old)	Black coal . . .	New South Wales . Queensland . . . Western Australia .	Hunter Valley, Lithgow, South Coast Kianga-Moura, Baralaba, Bowen, etc. Collie
	Copper-gold . .	Queensland . . . Tasmania . . .	Mount Morgan Mount Lyell
	Lead-silver-zinc	Tasmania . . .	Mount Read and Rosebery
	Tin (lode) . . .	Queensland . . . Tasmania . . .	Herberton North-east of State
	Tungsten . . .	Tasmania . . .	King Island and north-east of State
	Black coal . . .	Queensland . . . South Australia . .	Ipswich Leigh Creek
	Manganese . . .	Northern Territory	Groote Eylandt
Cainozoic (less than 75 million years old)	Bauxite . . .	Queensland . . . Western Australia .	Weipa Darling Range
	Brown coal . . .	Victoria . . .	Gippsland
	Mineral sands ^(a)	New South Wales . Queensland . . . Western Australia .	North coast South coast South-west coast
	Tin (alluvial) . .	New South Wales . Queensland . . . Tasmania . . .	Tingha Herberton 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 summarizes, 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. A map showing the location of principal mining centres, mineral discoveries, and mineral processing centres appears on plate 57.

RESERVES OF MINERALS: AUSTRALIA

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

Productive capacity	Reserves adequate	Reserves uncertain	Reserves negligible
Production sufficient for domestic demand and exports	Cadmium Copper Gold Lead Silver Zinc Barite Bauxite Coal (black) Crocidolite asbestos Gypsum Iron ore Mineral sands(b) Opal Salt	Beryl Manganese ore (metallurgical)(a) Talc Tantalite Uranium oxide	
Production sufficient for domestic demand	Coal (brown) Clays (except light grade china clay) Dolomite Felspar Limestone	Glass sands Sillimanite	
Production not sufficient for domestic demand	Lithium minerals Sulphides (as source of sulphur)(c)	Antimony Cobalt Platinum Tin(d) Abrasives Bentonite China clay Chromite Diatomite Fluorite Magnesite Manganese ore (chemical) Mineral pigments Petroleum	Bismuth Molybdenum Asbestos (chrysotile) Phosphate rock
Production nil	Magnesium Potassium salts (from alunite muds)	Arsenic Nickel Diamonds Graphite Vermiculite	Mercury Vanadium Borates Nitrates Sulphur

(a) Exports permitted as an exploration incentive. (b) Ilmenite, monazite, rutile, zircon. (c) At a price disadvantage as compared with imported brimstone for the manufacture of sulphuric acid. (d) Increased production for self-sufficiency or even export probable in near future.

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 estimated to exceed 70 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 34 million tons in 1964. 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 recent 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 for export. A smaller deposit in the Savage River region of north-west Tasmania is also under development at present. 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 far 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.

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.

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	..
Tasmania	Bituminous	Very small(b)	137(c)
Victoria	Bituminous	20	11
Victoria	Brown	54,700	43,000
South Australia	Lignite	630	..

(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 commercial oil fields. Other possible commercial fields have been discovered, 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.

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 revitalized 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 mining and quarrying output has doubled, both in money and real terms, 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.);

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 revitalization 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).

See page 79 of the chapter Land Tenure and Settlement for areas occupied under mining acts and ordinances.

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 authorization for exploration: (a) Permit for surface survey; (b) licence for exploratory drilling.

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. 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 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 \$2 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, and 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 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. More than three years ago Federal and State Ministers and Attorneys-General began a series of conferences to determine the extent of their respective jurisdictions over rights to prospect for petroleum in Australian off-shore areas. In November 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 off-shore territory not exceeding 200 metres in depth.

Following the November 1965 announcement representations were made by the off-shore exploration companies seeking modifications of some aspects of the scheme. These representations were considered by Federal and State Ministers, and on 30 June 1966 it was announced that the Ministers had agreed that some modifications would be made to the original scheme as a result of the representations made by exploration companies. Under the modified 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 as the authority responsible for external affairs, defence, health, customs, and navigation. Royalties are divided on a 50-50 basis between the Federal Government and 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. Rent is payable at the rate of 20c a square mile per annum, but not exceeding \$2,000 for any permit area.

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. Royalty is ten per cent of value of production at the well-head 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 ten per cent will continue to apply for the period of the licence.

The draft legislation provides 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, from which the permit holder may be granted a licence over five blocks (an area of approximately 125 square miles) with four blocks reverting to the Crown. 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 held by 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. The original permit holder will have the first option to purchase any such graticular blocks at the top price offered. Existing tenements which have been previously issued by States or Territories will be honoured where possible, and the holder may have the option of deciding whether they wish to be covered by the new legislation.

See page 80 of the chapter Land Tenure and Settlement for particulars of areas held under authorities to prospect or explore for petroleum.

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 AND NORTHERN TERRITORY, 1961-62 TO 1964-65

(\$)

State or Territory	1961-62	1962-63	1963-64	1964-65
New South Wales	2,901,734	1,633,640	5,090,622	19,946,772
Victoria	(a) 76,732	(a) 85,004	(a) 94,072	(b) 39,996
Queensland	727,688	486,938	642,560	1,201,264
South Australia	789,310	756,156	895,540	962,668
Western Australia	239,454	248,646	243,182	291,354
Tasmania	(c)	(c)	(c)	(c)
Northern Territory	65,960	61,996	68,682	80,892

(a) Includes, in addition to mineral royalty receipts, mine-tailing licences and rents. (b) Mineral royalty receipts only. (c) No mineral royalties are collected in Tasmania.

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 fertilizers 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 a 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 utilization 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 cooperate with the appropriate authorities of the States in connection with these and related matters. Secondly, it is authorized 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 1023.

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. 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. In 1963, amendments aimed at providing increased incentive to petroleum exploration companies extended the range of deductible items to include expenditure on the purchase of rights to prospect, preliminary expenses incurred in the operation of exploration companies, and several other fringe items. The effect of these concessions is to exempt a company from payment of income tax on profits derived from the sale of petroleum until such time as the capital expended in developing the production has been recouped.

Petroleum search subsidy. In 1957 the Commonwealth Government introduced the *Petroleum Search Subsidy Act 1957* whereby stratigraphic drilling operations were subsidized 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 1965-66 contained an appropriation of \$11.4 million for subsidies under the Act.

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 1050.

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 subsidize 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 liberalizations have been approved, including increases in the rates of subsidy payable authorized 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 1960 to 1965 are shown in the table on page 1023.

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 jeopardized. 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 liberalization 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 present bounty assistance until 31 December 1966 unless an earlier date of cessation is proclaimed. Under the *Copper Bounty Act 1958-1965* bounty is payable, subject to specified conditions, on refined copper sold for use in Australia. The rate of bounty is \$70 per ton when the overseas price, as determined by the Minister for Customs and Excise, is \$580 (£Stg232) or less. When the overseas price rises above \$580, the bounty falls by the same extent, so that no bounty is payable when the overseas price is \$650 (£Stg260) or more. A duty 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 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 to producers of phosphate fertilizers. The *Phosphate Fertilizers Bounty Act 1963* provides for a bounty to be paid on superphosphate and ammoniated phosphate fertilizers manufactured and sold for use in Australia on and after 14 August 1963. The bounty is based on the fertilizer 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 per ton and \$15 per ton respectively. Payments under this Act are designed to assist consumers of superphosphate (primary producers) rather than the manufacturers of superphosphate.

COMMONWEALTH GOVERNMENT PAYMENTS TO THE MINERAL INDUSTRY
AUSTRALIA, 1961 TO 1965

(£)

Period	Petroleum exploration (a)	Gold mining (b)	Copper mining (c)	Pyrites mining (d)	Sulphuric acid production (e)	Phosphate fertilizer production (f)
1961 .	2,695,800	1,399,000	1,238,119	584,060	2,706,498	..
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

(a) *Petroleum Search Subsidy Act 1959-1964.* (b) *Gold-Mining Industry Assistance Act 1954-1965 and Gold Mines Development Assistance Act 1962* (expired 30 June 1965). (c) *Copper Bounty Act 1958-1965.* (d) *Pyrites Bounty Act 1960-1965.* (e) *Sulphuric Acid Bounty Act 1954-1965.* (f) *Phosphate Fertilizers Bounty Act 1963.*

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 utilization 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 and is also engaged in the assessment of sedimentary basins in Australia and its Territories. The establishment of the Bureau is 556 officers, of whom 280 are professional. The budget for the financial year 1965-66 was \$16.8 million, of which \$11.4 million was provided for payment under the Petroleum Search Subsidy Act.

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 volcanological 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 1025 under Research.

State Government assistance

In addition to free assays and determinations of rocks and minerals carried out for prospectors by the Mines Department 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.

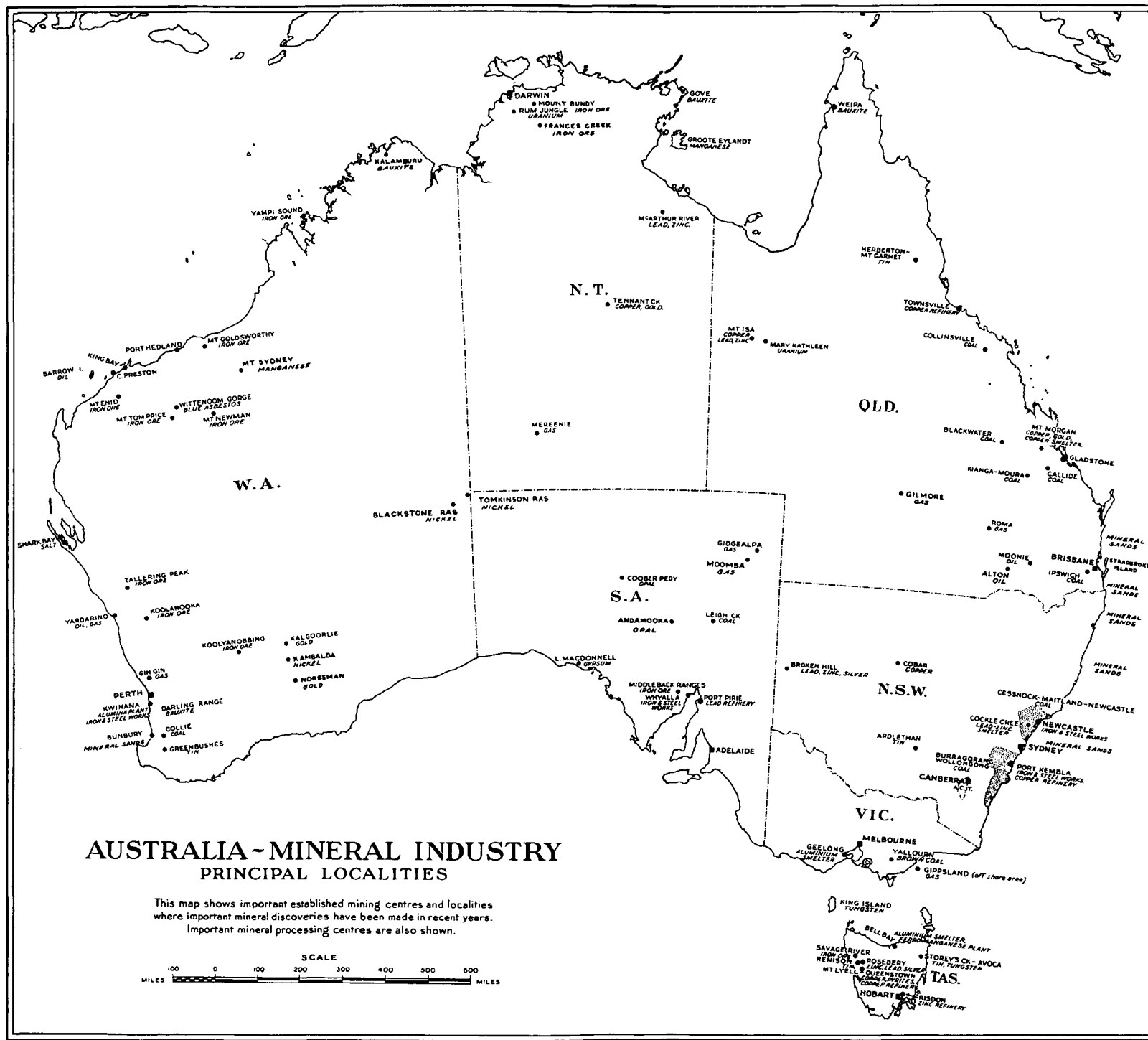
New South Wales. State aid to assist metalliferous mining may consist of grants to assist the the prospecting and/or mining for gold and minerals, and for the purchase, removal and installation of mining plant or equipment. A quantity of mechanical equipment is also available in several localities for 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 1964-65 \$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.

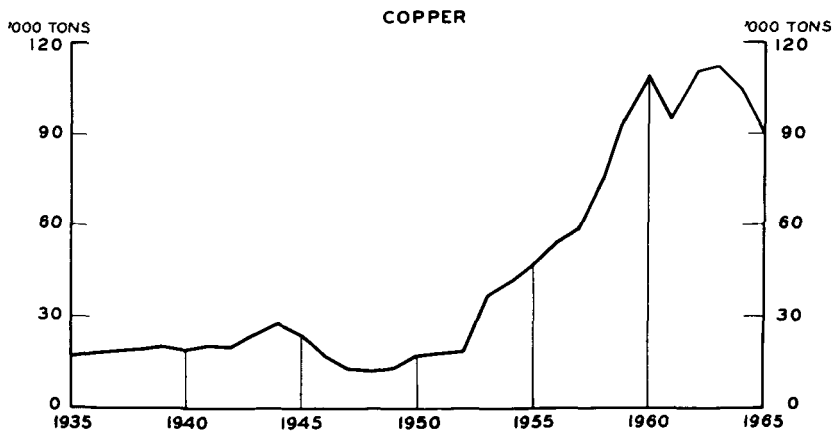
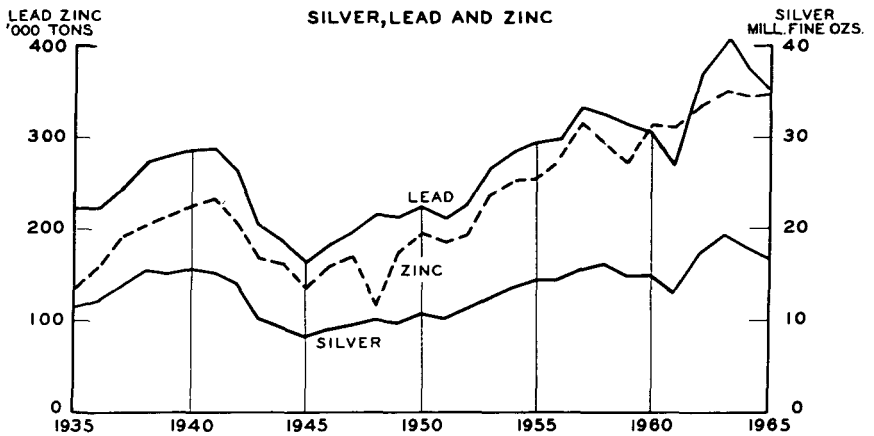
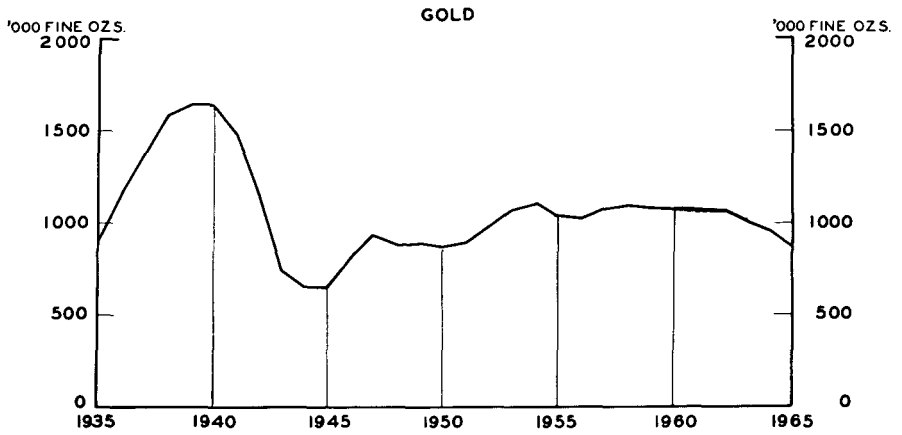
Queensland. Various forms of assistance to mining are made available by the Queensland Department of Mines. Grants are made from the Consolidated Revenue Fund for use on construction and maintenance of roads in mining areas. Advances are made from the Gold Mining Encouragement Fund for mining development 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 subsidies in approved cases for prospecting and mining development, development of sub-surface water supplies for farming, pastoral, irrigation and mining purposes, and purchase of basic metal ores from prospectors; (ii) geological examination of mineral deposits, water supply, dam foundation and drainage problems, guidance on mining legislation, and publication and issue of geological bulletins and maps. It also provides, through the Australian Mineral Development Laboratories, chemical and metallurgical 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 \$12 or \$14 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 \$14 a week. In the remainder of the State prospectors receive \$12 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.



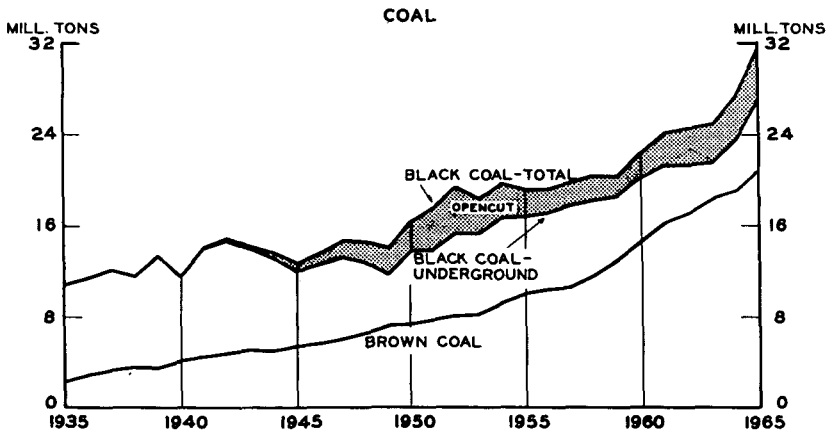
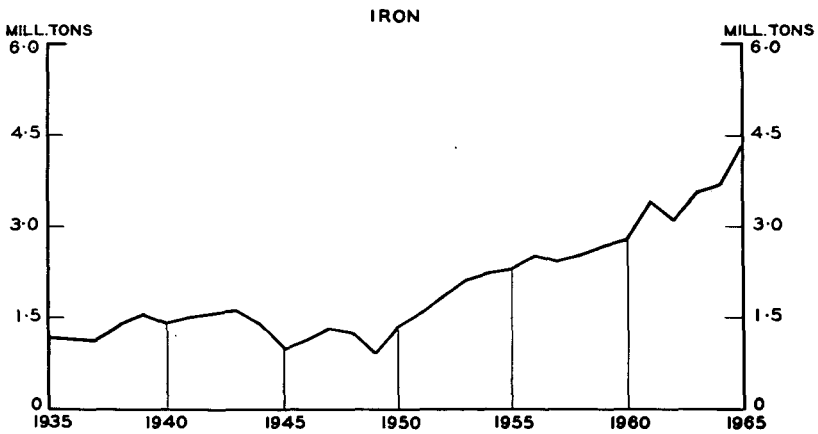
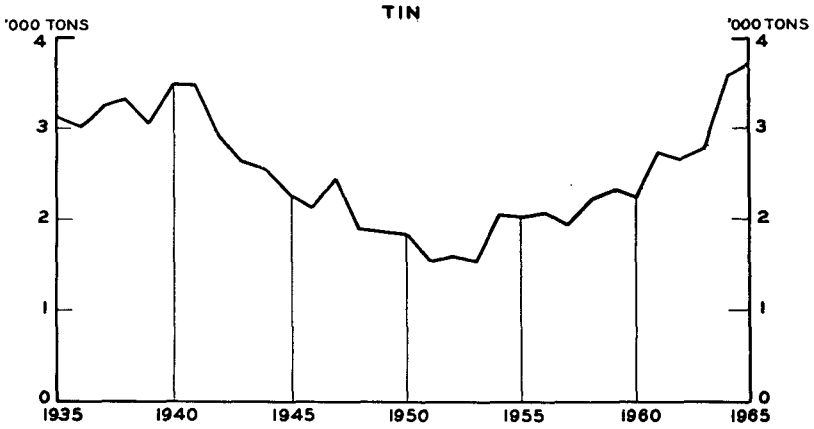
MINE PRODUCTION OF PRINCIPAL METALS
(METALLIC CONTENT OF MINERALS)
AUSTRALIA, 1935 TO 1965

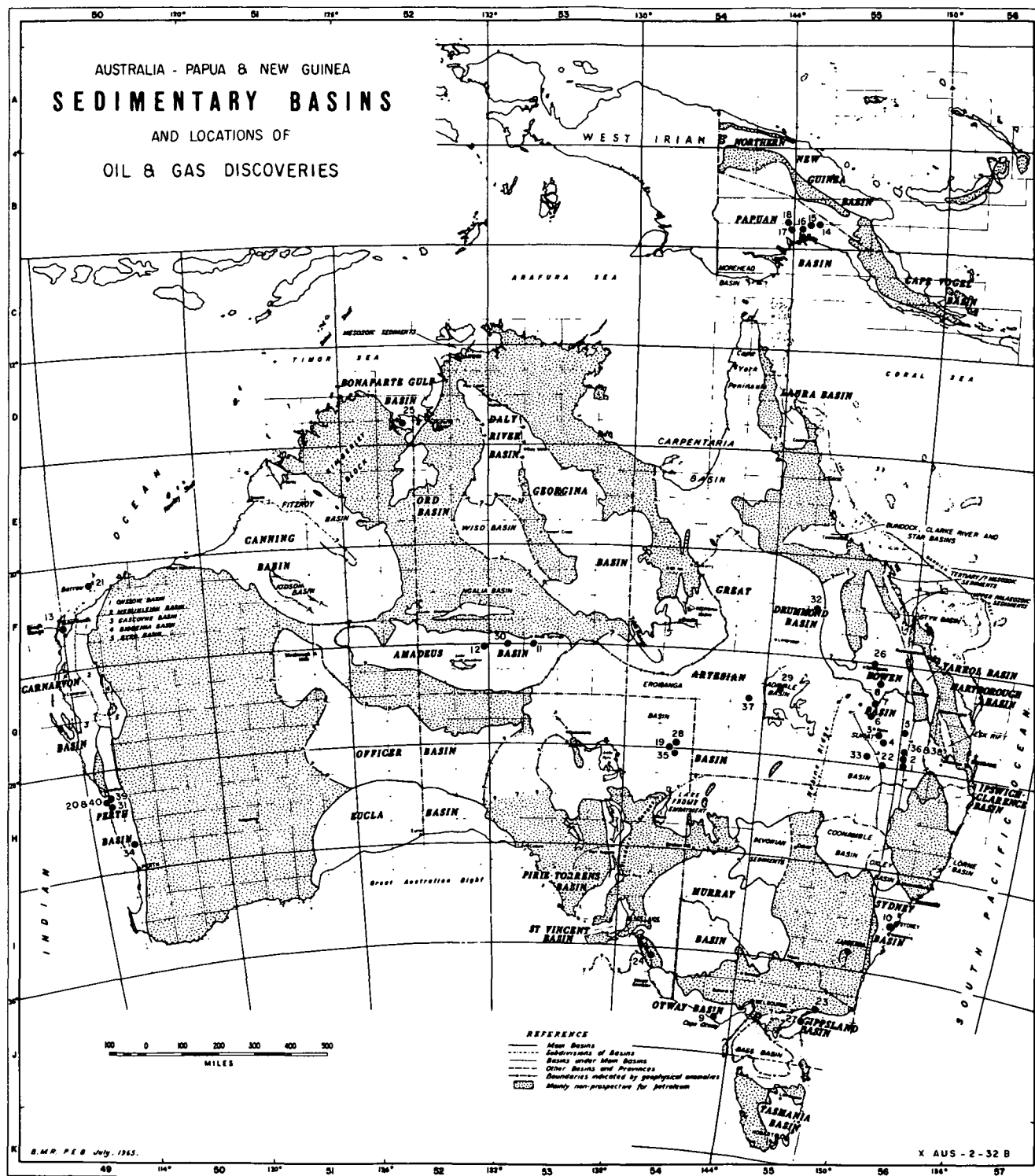


MINE PRODUCTION OF PRINCIPAL METALS AND PRODUCTION OF COAL

(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1935 TO 1965





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 constructions 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. Repayments, in respect of 1965 production, of advances under the King Island Scheelite Agreement Acts were \$302,518.

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 gold ores and tin ores. The crushing charges are subsidized by government grants. In addition, the Administration provides cartage subsidies and financial advances to encourage miners to carry out developmental work. 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

General

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 the functions of these bodies follows.

Commonwealth Scientific and Industrial Research Organization

Research for the mineral industry by the Commonwealth Scientific and Industrial Research Organization is concentrated mainly in the Divisions of Applied Mineralogy and Mineral Chemistry and in the Mineragraphic Investigations and Ore-Dressing Investigations Sections. All of these groups have their laboratories in Melbourne. In addition, the Division of Applied Mineralogy has a small laboratory in Perth.

The research programme of the Division of Applied Mineralogy is concerned mainly with the nature and the industrial application of mineral products, especially the non-metals. A major part of the Division's programme is devoted to research on production and utilization of cement. Studies of industrial refractories and engineering ceramics are also being made. The Division of Mineral Chemistry is carrying out research on the chemical basis for the better utilization and processing of Australian minerals. Particular attention is being paid to studies of minerals that are abundant in Australia and have considerable potential for increased exploitation. A major aim of the Division of Coal Research is to promote the effective use of coal through research into the processes of combustion, gasification and carbonization. This work ranges from basic studies of the kinetics of the processes involved in combustion and gasification to studies of problems that have arisen in operating boilers in large power stations. Examination and recording of the characteristics of Australian coals from all known deposits are another important activity of the Division. In the Division of Chemical Engineering projects of particular interest to the mineral industry include studies of mineral grinding, fluidized bed techniques and high-pressure reactions in carbon and coal gasification. The Mineragraphic Investigations laboratory 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 Ore Dressing Investigations laboratory, which is under the joint control of C.S.I.R.O. and the University of Melbourne, has continued to serve industry on problems arising from the processing of Australian minerals. In addition, it is collaborating with interested firms in long-term studies on the chemistry of flotation pulps and assessment of the resistance of Australian ores to grinding.

All C.S.I.R.O. groups taking part in mineral research are in close contact with industry. Several projects are currently being developed by collaboration between C.S.I.R.O. and Australian firms, and the stage has now been reached where a significant proportion of the Organization's mineral research is carried on with funds provided by industry. A committee set up by the Advisory Council of C.S.I.R.O. is at present examining research needs in the mining and mineral processing industries in consultation with the other government agencies concerned.

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 organization is sponsored by the Commonwealth Government, the South Australian Government and the Australian Mineral Industries Research Association (an association of companies engaged in the mineral industry formed to foster and develop mineral research). 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.

National Coal Research Advisory Committee

In December 1964 the appointments to the National Coal Research Advisory Committee were completed, and the inaugural meeting of the Committee was held in January 1965. The Committee will report on all coal utilization 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 year of operation, 1965-66, additional funds of \$520,000 have been made available for increased coal utilization research, bringing total expenditure on coal utilization 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 utilization research. The constitution of the Advisory Committee and the establishment of the new laboratories unit have brought into effect the recommendations of the Coal Utilization Research Advisory Committee which tabled its Report to Parliament in December 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. The Association has conducted a survey among its members to obtain details of their research expenditure. The companies surveyed reported their expenditure on research and development, excluding exploration, as \$4,729,444 in 1962 and \$5,100,226 in 1963. Five of the companies reported their expenditure on research in excess of \$200,000 per annum, four between \$100,000 and \$200,000, five between \$20,000 and \$100,000, and twenty-nine reported a research budget less than \$20,000 per annum.

International relations

Because Australia is a large supplier of certain minerals to the rest of the world and because the welfare of the domestic industry depends to a large extent on the maintenance of a high level of exports, international relations are of considerable importance to the industry, and the Commonwealth Government takes an active role in international consultations and discussions relating to minerals. The most important international commitments are discussed on pages 1027-8.

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 is to come into operation as soon as possible after 30 June 1966, 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, emphasize 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, 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 is made up to the equivalent of 20,000 tons of tin by obligatory contributions from producing countries. In addition, both producing and consuming countries may make voluntary contributions to the buffer stock. However, since October 1963 world prices have been above the ceiling price.

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: 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, 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. 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 recognized. 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, brickworks, 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 and Value of Production*, No. 1, 1962-63. 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 standardized 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 \$A 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. as 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 other time in the twentieth century.

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 1964 more than \$287 million was spent on petroleum exploration in Australia and Papua and New Guinea out of a total expenditure to the end of 1964 of almost \$300 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 1964 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 1050, and particulars of areas occupied under authorities to prospect or explore for petroleum are given on page 80 of the chapter Land Tenure and Settlement.

EXPENDITURE ON PETROLEUM EXPLORATION BY PRIVATE ENTERPRISE AND BY GOVERNMENTS: AUSTRALIA, 1964

Origin of expenditure	Expenditure	Percentage contribution
	\$'000	
Private enterprise—		
Funds of Australian origin	17,874	35.7
Funds of overseas origin	18,232	36.4
<i>Total, private enterprise</i>	<i>36,106</i>	<i>72.1</i>
State Government Departments	809	1.6
Commonwealth Government Departments (excluding subsidy payments)	4,035	8.1
Commonwealth Government subsidy payments	9,122	18.2
<i>Total expenditure</i>	<i>50,072</i>	<i>100.0</i>

**TOTAL EXPENDITURE ON PETROLEUM EXPLORATION BY PRIVATE ENTERPRISE
AND BY COMMONWEALTH, STATE AND BRITISH GOVERNMENTS
TO 31 DECEMBER 1964**

Origin of expenditure	Expenditure	Percentage contribution
	\$'000	
Private enterprise—		
To end of 1964—		
Funds of Australian origin	92,695	31.0
Funds of oversea origin	145,229	48.6
<i>Total, private enterprise</i>	<i>237,924</i>	<i>79.6</i>
Government—		
Prior to 1946—		
State Government	3,084	1.0
British Government	50	..
Commonwealth Government—Grants	324	0.1
Other	1,051	0.4
1946 to 1964—		
State and Territory Departments of Mines	5,593	1.9
Commonwealth Government—subsidy payments	31,612	10.6
Department of National Development (excluding subsidy payments)	19,245	6.4
Department of Interior—topographic surveys, oil search	200	..
<i>Total, Government</i>	<i>61,159</i>	<i>20.4</i>
Total expenditure	299,083	100.0

SUMMARY OF WELLS AND FOOTAGE DRILLED: STATES AND TERRITORIES, 1964

—	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	T.P. N.G.	Total
Wells drilled(a)	14	7	156	14	16	..	6	1	214
Average total depth of wells drilled feet	4,912	6,464	4,842	5,555	7,039	..	3,873	4,249	5,081
Wells completed as potential oil producers . . . . .	..	..	8	..	3	..	..	..	11
Wells completed as potential gas producers . . . . .	..	..	33	4	2	..	2	..	41
Wells drilled or drilling over 10,000 feet . . . . .	..	1	2	3	3	..	..	..	9
Footage drilled—									
Completed wells feet	53,280	40,828	729,907	65,608	85,546	..	20,860	4,249	1,000,278
Uncompleted holes(b) feet	7,605	767	14,528	18,351	14,426	..	9,406	..	65,083
Total footage drilled	60,885	41,595	744,435	83,959	99,972	..	30,266	4,249	1,065,361

(a) Number of holes which reached total depth during the year. (b) Uncompleted holes means wells suspended or drilling at 31 December 1964.

**WELLS AND FOOTAGE DRILLED IN PETROLEUM EXPLORATION
STATES AND TERRITORIES TO 31 DECEMBER 1964**

State or Territory	To 31 December 1962		1963		1964		To 31 December 1964	
	Wells	Footage	Wells	Footage	Wells	Footage	Wells	Footage
New South Wales	51	143,758	18	70,798	14	60,885	83	275,441
Victoria	153	305,590	6	28,028	7	41,595	166	375,213
Queensland	150	628,553	82	434,113	156	744,435	388	1,807,101
South Australia	95	142,357	11	65,956	14	83,959	120	292,272
Western Australia	100	362,770	5	41,423	16	99,972	121	504,165
Tasmania	21	14,000	..	..	..	..	21	14,000
Northern Territory	5	14,202	5	18,967	6	30,266	16	63,435
Papua and New Guinea	42	208,328	1	4,657	1	4,249	44	217,234
<i>Total</i> . . . . .	..	..	128	663,942	214	1,065,361	..	..
Cumulative total	617	1,819,558	745	2,483,500	959	3,548,861	959	3,548,861

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 in future.

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 table shows the number of mines and quarries which operated in each State and Territory in 1964.

NUMBER OF MINES AND QUARRIES: STATES AND TERRITORIES, 1964

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	33	22	29	..	148	3	11	..	246
Lead-silver-zinc	13	..	1	1	2	2	1	..	20
Copper-gold	12	2	40	1	24	1	6	..	86
Tin	51	5	247	..	14	27	27	..	371
Mineral sands	11	..	4	..	5	..	..	..	20
Other metal	16	3	7	3	21	3	3	..	56
Total, metal mining	136	32	328	5	214	36	48	..	799
Fuel mining—									
Black coal—									
Underground	91	2	66	..	3	(a) 7	..	..	169
Open-cut	3	..	5	1	1	..	..	..	10
Total, black coal	94	2	71	1	4	7	..	..	179
Brown coal . . . . .	..	7	..	..	..	..	..	..	7
Other fuel . . . . .	..	..	3	..	..	..	..	..	3
Total, fuel mining	94	9	74	1	4	7	..	..	189
Non-metal (excluding fuel) mining	390	65	92	115	68	23	3	..	756
Total, all mining	620	106	494	121	286	66	51	..	1,744
Construction material quarrying(b)	316	363	50	215	53	108	33	10	1,148
Total, all mining and quarrying	936	469	544	336	339	174	84	10	2,892

(a) Includes one mine operating both underground and open-cut workings. (b) Incomplete, owing to difficulties of coverage. See Scope and sources of statistics, page 1028.

In the next table, the numbers of mines and quarries which operated in Australia in each of the years 1960 to 1964 are shown.

NUMBER OF MINES AND QUARRIES: AUSTRALIA 1960 TO 1964

Industry	1960	1961	1962	1963	1964
Metal mining—					
Gold	296	295	286	257	246
Lead-silver-zinc	28	27	22	13	20
Copper-gold	90	111	107	98	86
Tin	216	266	344	300	371
Mineral sands	22	21	20	18	20
Other metal	94	85	87	62	56
Total, metal mining	746	805	866	748	799
Fuel mining—					
Black coal	218	202	198	185	179
Brown coal	7	6	6	6	7
Other fuel . . . . .	..	..	..	2	3
Total, fuel mining	225	208	204	193	189
Non-metal (excluding fuel) mining(a)	698	755	731	792	756
Total, all mining	1,669	1,768	1,801	1,733	1,744
Construction material quarrying(a)	892	(b) 1,056	(b) 1,107	(b) 1,044	(b) 1,148
Total, all mining and quarrying	2,561	(b) 2,824	(b) 2,908	(b) 2,777	(b) 2,892

(a) Incomplete. See Scope and sources of statistics, page 1028. (b) Not comparable with years prior to 1961, owing to extension of coverage in Victoria.

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 1964.

**MINING AND QUARRYING: EMPLOYMENT(a)
STATES AND TERRITORIES, 1964**

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	9	148	107	..	4,357	1	131	..	4,753
Lead-silver-zinc	4,288	..	(b)	1	(b)	(b)	..	..	7,811
Copper-gold	211	5	(b)	2	129	(b)	328	..	2,341
Tin	197	8	412	..	107	435	32	..	1,191
Mineral sands	1,116	..	323	..	295	..	..	..	1,734
Other metal	36	5	107	393	(b)	(b)	45	..	1,348
<i>Total, metal mining</i>	<i>5,857</i>	<i>166</i>	<i>4,684</i>	<i>396</i>	<i>5,457</i>	<i>2,082</i>	<i>536</i>	..	<i>19,178</i>
Fuel mining—									
Black coal—									
Underground	11,233	236	(b)	..	(b)	118	..	..	c14631
Open-cut	134	..	(b)	271	(b)	..	..	..	733
<i>Total, black coal</i>	<i>11,367</i>	<i>236</i>	<i>c 2,612</i>	<i>271</i>	<i>760</i>	<i>118</i>	..	..	<i>c15,364</i>
Brown coal . . . . .	..	1,673	..	..	..	..	..	..	1,673
<i>Total, fuel mining</i>	<i>11,367</i>	<i>1,909</i>	<i>2,612</i>	<i>271</i>	<i>760</i>	<i>118</i>	..	..	<i>17,037</i>
Non-metal (excluding fuel) mining	1,114	255	299	502	518	95	..	..	2,783
<i>Total, all mining</i>	<i>18,338</i>	<i>2,330</i>	<i>7,595</i>	<i>1,169</i>	<i>6,735</i>	<i>2,295</i>	<i>536</i>	..	<i>38,998</i>
Construction material quarrying(d)	1,919	1,920	421	880	302	253	49	70	5,814
<i>Total, all mining and quarrying</i>	<i>20,257</i>	<i>4,250</i>	<i>8,016</i>	<i>2,049</i>	<i>7,037</i>	<i>2,548</i>	<i>585</i>	<i>70</i>	<i>44,812</i>

(a) Average employment during whole year, including working proprietors. (b) Not available for publication. (c) Includes other fuel mining. (d) Incomplete owing to difficulties of coverage. See Scope and sources of statistics, page 1028.

The following table shows particulars of mining employment in Australia for the years 1960 to 1964. The figures show the average number of persons employed during the whole year, including working proprietors.

MINING AND QUARRYING: EMPLOYMENT, AUSTRALIA, 1960 TO 1964

Industry	1960	1961	1962	1963	1964
Metal mining—					
Gold	5,544	5,438	5,290	5,287	4,753
Lead-silver-zinc	8,731	8,158	7,958	7,946	7,811
Copper-gold	2,364	2,322	2,242	2,288	2,341
Tin	946	1,131	1,157	1,116	1,191
Mineral sands	1,127	1,141	1,408	1,565	1,734
Other metal	1,177	1,097	968	1,168	1,348
<i>Total, metal mining</i>	<i>19,889</i>	<i>19,287</i>	<i>19,023</i>	<i>19,370</i>	<i>19,178</i>
Fuel mining—					
Black coal	18,529	16,957	16,312	<i>a</i> 15,636	<i>a</i> 15,364
Brown coal	1,399	1,441	1,453	1,613	1,673
<i>Total, fuel mining</i>	<i>19,928</i>	<i>18,398</i>	<i>17,765</i>	<i>17,249</i>	<i>17,037</i>
Non-metal (excluding fuel) mining	2,925	2,942	2,838	2,823	2,783
<i>Total, all mining</i>	<i>42,742</i>	<i>40,627</i>	<i>39,626</i>	<i>39,442</i>	<i>38,998</i>
Construction material quarrying(b)	5,016	<i>c</i> 5,498	<i>c</i> 5,599	<i>c</i> 5,406	5,814
Total, all mining and quarrying	47,758	<i>c</i> 46,125	<i>c</i> 45,225	<i>c</i> 44,848	<i>c</i> 44,812

(a) Includes other fuel mining. (b) Incomplete, see Scope and sources of statistics, page 1028. (c) Not comparable with years prior to 1961, owing to extension of coverage in Victoria.

Size classification of mines and quarries. Most of the mines and quarries worked during 1964 employed less than four persons, including working proprietors. However, more than half of the persons engaged in mining and quarrying were in the 45 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 1964.

NUMBER OF MINES AND QUARRIES AND PERSONS EMPLOYED, BY AVERAGE NUMBER EMPLOYED: STATES AND TERRITORIES, 1964

Mines and quarries employing on the average(a)—	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust.
Less than 4 persons—								
Establishments	651	269	380	222	237	132	76	1,967
Persons	953	474	568	411	624	264	156	3,450
From 4 to 20 persons—								
Establishments	170	172	89	99	73	28	11	642
Persons	1,349	1,337	848	786	560	227	109	5,216
From 21 to 200 persons—								
Establishments	90	26	73	13	19	11	6	238
Persons	6,988	1,042	3,349	675	1,243	578	269	14,144
More than 200 persons—								
Establishments	25	2	2	2	10	3	1	45
Persons	11,314	1,775	3,666	570	4,844	1,697	282	24,148
Total—								
Establishments	936	469	544	336	339	174	94	2,892
Persons	20,604	4,628	8,431	2,442	7,271	2,766	816	46,958

(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 1964, 27 persons were recorded as killed and 1,120 as injured in mining (excluding quarrying) accidents. Recorded deaths and injuries in that year were highest in black coal mines (9 and 242, respectively), silver-lead-zinc mines (7 and 265), gold mines (6 and 293), and copper-gold mines (3 and 69). Persons killed and injured in the construction material quarrying industry numbered 3 and 71 respectively in 1964.

Salaries and wages paid

Salaries and wages paid in the mining and quarrying industries in Australia during each year 1960 to 1964 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 349) and also in the *Labour Report*.

MINING AND QUARRYING: SALARIES AND WAGES PAID(a), AUSTRALIA 1960 TO 1964 (\$'000)

Industry	1960	1961	1962	1963	1964
Metal mining—					
Gold	13,310	13,182	13,068	13,072	11,812
Lead-silver-zinc	27,110	26,522	24,454	25,678	29,948
Copper-gold	5,876	5,830	5,702	6,200	6,834
Tin	1,810	1,892	2,100	2,502	2,648
Mineral sands	2,672	2,948	3,478	4,156	4,706
Other metal	2,676	2,554	2,376	3,184	4,038
<i>Total, metal mining</i>	<i>53,454</i>	<i>52,928</i>	<i>51,178</i>	<i>54,792</i>	<i>59,986</i>
Fuel mining—					
Black coal	51,836	50,920	49,698	(b)49,230	(b)52,204
Brown coal	3,570	3,846	3,942	4,634	5,144
<i>Total, fuel mining</i>	<i>55,406</i>	<i>54,766</i>	<i>53,640</i>	<i>53,864</i>	<i>57,348</i>
Non-metal (excluding fuel) mining(c)	5,328	5,750	5,796	5,764	6,248
<i>Total, all mining</i>	<i>114,188</i>	<i>113,444</i>	<i>110,614</i>	<i>114,420</i>	<i>123,582</i>
Construction material quarrying(c)	7,256	(d) 8,036	(d) 8,762	(d) 8,684	(d) 9,364
<i>Total, all mining and quarrying</i>	<i>121,444</i>	<i>d 121,480</i>	<i>d 119,376</i>	<i>d 123,104</i>	<i>d 132,946</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 1028. (d) Not comparable with years prior to 1961, owing to extension of coverage in Victoria.

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

The following table contains details of the value of power, fuel, materials, and stores used by the mining and quarrying industry during each year 1960 to 1964.

**MINING AND QUARRYING: VALUE OF POWER, FUEL, LIGHT, AND
MATERIALS, ETC., USED, AUSTRALIA, 1960 TO 1964**
(\$'000)

Industry	1960	1961	1962	1963	1964
Metal mining—					
Gold	9,818	9,958	9,894	9,758	8,334
Lead-silver-zinc	24,212	20,606	17,342	21,590	22,688
Copper-gold	6,576	7,006	6,768	7,232	7,698
Tin	1,060	1,202	1,274	1,508	1,854
Mineral sands	3,124	3,594	3,676	5,052	4,906
Other metal	2,218	2,516	2,484	2,850	3,162
<i>Total, metal mining</i>	<i>47,008</i>	<i>44,882</i>	<i>41,438</i>	<i>47,990</i>	<i>48,644</i>
Fuel mining—					
Black coal	22,638	24,818	26,692	(a)27,002	(a)29,114
Brown coal	1,246	1,244	1,344	1,478	1,532
<i>Total, fuel mining</i>	<i>23,884</i>	<i>26,062</i>	<i>28,036</i>	<i>28,480</i>	<i>30,648</i>
Non-metal (excluding fuel) mining(b)	4,680	5,016	5,636	5,534	5,342
<i>Total, all mining</i>	<i>75,572</i>	<i>75,960</i>	<i>75,110</i>	<i>82,004</i>	<i>84,636</i>
Construction material quarrying(b)	8,854	(c) 9,852	(c) 9,000	(c) 9,082	(c) 9,752
Total, all mining and quarrying	84,426	(c)85,812	(c)84,110	(c)91,086	(c)94,388

(a) Includes other fuel mining. (b) Incomplete. See Scope and sources of statistics, page 1028.
(c) Not comparable with years prior to 1961, owing to extension of coverage in Victoria.

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

The following table shows details for Australia of the value of additions and replacements to fixed assets during the years 1960 to 1964.

**MINING AND QUARRYING: VALUE OF ADDITIONS AND REPLACEMENTS TO
FIXED ASSETS(a), AUSTRALIA, 1960 TO 1964**
(\$'000)

Industry	1960	1961	1962	1963	1964
Metal mining—					
Gold	1,578	1,556	3,216	2,024	1,365
Lead-silver-zinc	7,096	6,850	7,046	14,154	20,071
Copper-gold	902	1,690	2,730	5,066	7,419
Tin	370	522	540	1,548	4,459
Mineral sands	962	1,456	3,752	2,436	3,592
Other metal	2,738	2,276	5,154	4,476	5,556
<i>Total, metal mining</i>	<i>13,646</i>	<i>14,350</i>	<i>22,438</i>	<i>29,702</i>	<i>42,462</i>
Fuel mining—					
Black coal	21,894	23,070	26,096	b 20,668	b 19,952
Brown coal	3,828	5,446	6,122	6,610	5,416
<i>Total, fuel mining</i>	<i>25,722</i>	<i>28,516</i>	<i>32,218</i>	<i>27,278</i>	<i>25,368</i>
Non-metal (excluding fuel) mining(c)	1,176	2,548	1,408	1,742	3,498
<i>Total, all mining</i>	<i>40,544</i>	<i>45,414</i>	<i>56,064</i>	<i>58,722</i>	<i>71,328</i>
Construction material quarrying(c)	3,248	4,562	3,902	3,898	5,868
Total, all mining and quarrying	43,792	49,976	59,966	62,620	77,194

(a) Excludes mines and quarries employing less than four persons. (b) Includes other fuel mining.
(c) Incomplete. See Scope and sources of statistics, page 1028.

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 1964 and earlier years.

**MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION(a)
STATES AND TERRITORIES, 1964
(\$'000)**

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	22	738	534	1	23,768	1	2,344	..	27,406
Lead-silver-zinc	87,990	..	57,048	12	(b)	(b)	2	..	149,328
Copper-gold	178	4	..	6	796	(b)	4,238	..	18,290
Tin	1,946	44	3,952	..	1,232	2,830	74	..	10,078
Mineral sands	10,816	..	4,436	..	2,694	..	..	..	17,948
Other metal	260	14	2,562	11,532	(b)	(b)	4	..	20,614
<i>Total, metal mining</i>	<i>101,212</i>	<i>800</i>	<i>68,536</i>	<i>11,552</i>	<i>33,302</i>	<i>21,600</i>	<i>6,660</i>	<i>..</i>	<i>243,664</i>
Fuel mining—									
Black coal	97,252	544	21,618	3,296	4,678	650	..	..	128,040
Brown coal	..	17,304	..	..	..	..	..	..	17,304
Other fuel	..	..	2,164	..	..	..	..	..	2,164
<i>Total, fuel mining</i>	<i>97,252</i>	<i>17,848</i>	<i>23,782</i>	<i>3,296</i>	<i>4,678</i>	<i>650</i>	<i>..</i>	<i>..</i>	<i>147,508</i>
Non-metal (excluding fuel) mining—									
Clays(c)	2,808	2,880	224	766	394	126	..	..	7,196
Gypsum	254	234	..	1,438	88	..	..	..	2,014
Limestone	3,048	1,300	1,482	2,380	298	730	..	..	9,236
Salt	..	(b)	(b)	1,716	(b)	..	2	..	2,124
Other non-metal mining(c)	1,462	(b)	(b)	3,422	(b)	8	(d)	..	7,234
<i>Total, non-metal mining</i>	<i>7,570</i>	<i>4,710</i>	<i>2,014</i>	<i>9,720</i>	<i>2,922</i>	<i>864</i>	<i>2</i>	<i>..</i>	<i>27,802</i>
<i>Total, all mining</i>	<i>206,034</i>	<i>23,358</i>	<i>94,332</i>	<i>24,570</i>	<i>40,904</i>	<i>23,112</i>	<i>6,662</i>	<i>..</i>	<i>418,972</i>
Construction material quarrying(c)	26,674	21,534	2,956	14,368	4,462	1,936	570	738	73,236
<i>Total, all mining and quarrying</i>	<i>232,708</i>	<i>44,892</i>	<i>97,286</i>	<i>38,938</i>	<i>45,366</i>	<i>25,048</i>	<i>7,234</i>	<i>738</i>	<i>492,208</i>

(a) Value of output or selling value of products at the mine or quarry. (b) Not available for publication, included in total for Australia. (c) Incomplete. See Scope and sources of statistics, page 1028. (d) Less than \$500.

**MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION(a)
STATES AND TERRITORIES, 1960 TO 1964
(\$'000)**

Year	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust.
1960	159,282	32,534	75,216	27,904	44,332	16,134	7,078	362,480
1961	156,342	(b)40,054	64,440	31,824	44,992	15,918	6,732	(b)360,302
1962	159,928	(b)40,016	74,198	30,774	46,490	17,806	5,926	(b)375,138
1963	185,352	(b)40,840	84,084	34,208	44,768	20,304	7,126	(b)416,682
1964	232,708	(b)44,892	97,286	38,938	45,366	25,048	7,972	(b)492,208

(a) Value of output or selling value of products at the mine or quarry. (b) Not comparable with years prior to 1961, owing to extension of coverage of quarrying activities.

Net value of mining and quarrying production

The following tables show particulars of the net value of production of mining and quarrying for 1964 and earlier years.

MINING AND QUARRYING: NET VALUE OF PRODUCTION^(a)
STATES AND TERRITORIES, 1964
 (\$'000)

Industry	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	A.C.T.	Aust.
Metal mining—									
Gold	18	(b)	(b)	1	16,068	1	2,038	..	19,074
Lead-silver-zinc	78,118	..	(b)	12	(b)	(b)	2	..	126,640
Copper-gold	130	2	(b)	6	482	(b)	3,084	..	10,592
Tin	1,628	40	3,202	..	946	2,764	54	..	8,632
Mineral sands	8,184	..	3,027	..	1,830	..	..	..	13,041
Other metal	234	(b)	2,434	10,038	(b)	(b)	4	..	17,040
Total, metal mining	88,314	596	52,344	10,056	23,144	15,382	5,182	..	195,018
Fuel mining—									
Black coal	74,398	422	c 19,140	2,750	3,842	536	..	..	c 101,688
Brown coal . . . . .	..	15,772	..	..	..	..	..	..	15,772
Total, fuel mining	74,398	16,192	19,140	2,750	3,842	536	..	..	116,860
Non-metal (excluding fuel) mining—									
Clays ^(d)	2,314	2,722	184	678	272	116	..	..	6,288
Gypsum	182	200	..	1,272	72	..	..	..	1,725
Limestone	2,220	744	924	2,044	272	588	..	..	6,792
Salt	(b)	(b)	(b)	1,464	(b)	..	2	..	(e) 1,847
Other non-metal mining ^(d)	1,288	(b)	(b)	3,210	(b)	6	(f)	..	5,806
Total, non-metal mining	6,006	3,960	1,388	8,666	1,726	712	2	..	22,460
Total, all mining	168,718	20,748	72,872	21,472	28,712	16,630	5,184	..	334,338
Construction material quarrying^(d)	26,674	16,308	2,124	12,594	3,450	1,544	322	468	63,484
Total, all mining and quarrying	195,390	37,056	74,996	34,068	32,162	18,174	5,506	468	397,822

(a) Local value (i.e. value of output at mine or quarry) less cost of power, fuel, light and other materials and stores used; depreciation and maintenance costs have not been deducted. (b) Not available for publication, included in total for Australia. (c) Includes other fuel mining. (d) Incomplete. See Scope and sources of statistics, page 1028. (e) 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. (f) Less than \$500.

MINING AND QUARRYING: NET VALUE OF PRODUCTION^(a)
STATES AND TERRITORIES, 1960 TO 1964

Year	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T. and A.C.T.	Aust.
NET VALUE OF PRODUCTION								
(\$'000)								
1960	126,428	26,316	54,920	22,808	30,888	10,952	5,742	278,054
1961	121,368	(b) 32,958	46,868	26,206	31,106	10,406	5,578	(b) 274,490
1962	125,218	(b) 32,394	58,006	26,414	32,244	12,234	4,518	(b) 291,028
1963	149,710	(b) 33,652	61,948	29,614	30,698	14,466	5,508	(b) 325,596
1964	195,390	(b) 37,056	74,996	34,068	32,162	18,174	5,974	(b) 397,822

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

1960	32.6	9.0	36.6	23.8	42.4	31.2	71.0	26.8
1961	30.8	(b) 11.2	30.8	26.8	41.8	29.2	62.8	(b) 26.0
1962	31.2	(b) 10.8	37.4	26.4	42.2	33.8	46.6	(b) 27.0
1963	36.6	(b) 10.8	39.4	29.0	39.2	39.6	51.4	(b) 29.6
1964	47.0	(b) 11.7	47.0	32.7	40.3	49.4	51.1	(b) 35.4

(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 comparable with years prior to 1961, owing to extension of coverage of quarrying activities.

Quantity 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 1031. Particulars relating to uranium-bearing minerals are excluded.

The following tables show particulars of the quantity of the principal minerals produced during 1964 and earlier years.

**QUANTITIES OF PRINCIPAL MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1964**

Mineral	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Aust.
METALLIC MINERALS								
Antimony ore and concentrate tons	414	..	..	..	..	..	..	414
Bauxite "	10,907	1,766	447,580	..	323,647	..	..	783,900
Beryllium ore "	31	..	..	..	80	..	..	111
Copper ore(a) "	3	17	47,200	54	2,197	10,215	..	59,686
Copper concentrate "	1,028	38	332,712	..	4,619	49,463	39,398	427,258
Copper precipitate "	119	..	93	..	..	51	1	264
Gold(b) oz.	838	24,057	34,938	19	1,023,555	106	66,566	1,150,079
Ilmenite concentrate tons	6,198	..	108	..	297,322	..	..	303,628
Iron ore(c) '000 tons	..	..	..	4,311	1,358	..	..	5,669
Lead ore(d) tons	10,009	..	15,165	..	..	..	..	25,174
Lead concentrate "	384,995	..	133,000	..	3,354	14,853	11	536,213
Lead-copper concentrate . . . . . "	..	..	..	..	..	10,214	..	10,214
Leucoxene concentrate . . . . . "	..	..	..	..	656	..	..	656
Manganese ore "	336	15	199	11	60,182	..	366	61,109
Pyrite concentrate "	3,280	..	26,385	85,851	58,396	46,166	..	220,078
Rutile concentrate "	131,549	..	50,153	..	669	..	..	182,371
Tantalite-columbite concentrate lb.	..	..	..	..	33,600	..	..	33,600
Tin concentrate tons	1,036	20	2,133	..	637	1,438	50	5,314
Tungsten concentrates—	..	..	..	..	..	..	..	..
Scheelite concentrate . . . . . "	..	..	..	..	4	1,016	..	1,020
Wolfram concentrate . . . . . "	..	..	..	..	..	380	..	380
Zinc concentrate "	453,232	..	50,817	..	..	84,791	..	588,840
Zircon concentrate "	118,294	..	44,277	..	21,511	..	..	184,082

FUEL MINERALS

Coal, black—								
Semi-anthracite '000 tons	..	..	77	..	..	2	..	79
Bituminous "	20,699	47	3,582	..	..	149	..	24,477
Sub-bituminous . . . . . "	..	..	121	1,736	987	..	..	2,845
Total coal, black "	20,699	47	3,780	1,736	987	151	..	27,401
Coal, brown (lignite) "	..	19,035	..	..	..	..	..	19,035
Natural gas '000 c. ft.	..	..	106,490	..	..	..	..	106,490
Natural gas condensate gals.	..	..	8,568	..	..	..	..	8,568
Crude oil '000 gals.	..	..	52,157	..	..	..	..	52,157

For footnotes see next page.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1964—*continued*

Mineral	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Aust.
NON-METALLIC (EXCLUDING FUEL) MINERALS								
Asbestos short tons	1,165	..	..	..	12,489	..	..	13,654
Barite tons	1,299	..	..	10,831	172	..	..	12,302
Clays—								
Brick clay and shale . '000 tons	2,059	1,549	368	517	496	174	..	5,163
Other(e) " "	575	197	71	79	87	30	..	1,039
Diatomite tons	3,261	671	4,800	..	..	..	..	8,732
Dolomite(f) " "	5,545	..	7,585	222,015	..	923	..	236,068
Felspar " "	6,136	..	9	1,490	1,386	..	..	9,021
Gypsum " "	64,584	104,212	..	581,209	44,998	..	..	795,003
Limestone(f) '000 tons	2,705	1,371	(g)	1,542	(g)	352	..	7,223
Magnesite tons	29,281	..	..	395	1,574	..	..	31,250
Phosphate rock . . . . . " "	..	..	..	5,689	..	..	..	5,689
Salt, crude " "	..	(g)	(g)	440,332	(g)	..	60	545,491
Silica (glass, chemical, etc.) " "	223,883	..	49,603	25,026	10,151	13,606	..	322,269
Talc " "	1,697	..	..	8,566	5,432	..	..	15,695

CONSTRUCTION MATERIALS(e)

Mineral	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Aust.
Sand '000 tons	5,127	3,299	n.a.	1,854	n.a.	160	(h) 317	10,757
River gravel " "	2,013	4,041	n.a.	873	n.a.	1,075	(h) 115	8,117
Dimension stone " "	381	10	3	32	149	6	(h) 9	590
Crushed and broken stone " "	3,970	12,989	2,457	11,454	2,027	1,010	(h) 267	34,175
Other (decomposed rock, etc.) " "	20,240	2,919	114	n.a.	n.a.	110	(h) 76	23,460

(a) Includes cupreous ore for fertilizer. (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 1028. (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 separate publication.

**QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA
1960 TO 1964**

Mineral	1960	1961	1962	1963	1964
METALLIC MINERALS					
Antimony ore and concentrate tons	256	190	100	115	414
Bauxite " "	69,435	15,976	29,547	354,206	783,900
Beryllium ore " "	190	306	223	110	111
Chromite " "	529	..	369	160	72
Copper ore(a) " "	68,321	75,215	101,492	82,035	59,686
Copper concentrate " "	432,758	373,770	395,427	434,368	427,258
Copper precipitate " "	1,301	825	216	504	264
Gold—other forms(b) '000 oz.	(c)	(c)	(c)	1,231	1,150
Ilmenite concentrate tons	106,497	165,865	178,867	200,983	303,628
Iron ore(d) '000 tons	4,355	5,342	4,843	5,515	5,669
Lead ore(e) tons	13,716	7,743	13,197	16,249	25,174
Lead concentrate " "	449,590	382,292	522,276	584,462	536,213
Lead-copper concentrate " "	6,797	8,057	11,192	9,309	10,214
Leucoxene concentrate " "	89	535	627	547	656
Manganese ore " "	60,646	87,411	71,646	36,061	61,109
Pyrite concentrate " "	238,630	213,423	148,566	194,059	220,078
Rutile concentrate " "	88,637	101,431	119,195	183,260	182,371
Tantalite-columbite concentrate lb.	23,677	31,808	43,097	30,889	33,600
Tin concentrate tons	3,099	3,870	3,842	4,132	5,314
Tungsten concentrates—					
Scheelite concentrate " "	420	1,017	995	958	1,020
Wolfram concentrate " "	1,131	1,142	492	394	380
Zinc concentrate " "	549,000	542,640	572,900	594,861	588,840
Zircon concentrate " "	102,362	136,462	133,844	184,830	184,082

For footnotes see next page.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA
1960 TO 1964—*continued*

Mineral	1960	1961	1962	1963	1964
FUEL MINERALS					
Coal, black—					
Semi-anthracite . . . '000 tons	50	59	70	61	79
Bituminous "	20,641	21,991	22,006	22,268	24,477
Sub-bituminous "	1,878	1,956	2,394	2,527	2,845
<i>Total, coal, black</i> "	<i>22,569</i>	<i>24,006</i>	<i>24,470</i>	<i>24,856</i>	<i>27,401</i>
Coal, brown (lignite) "	14,967	16,279	17,137	18,456	19,035
Natural gas '000 c. ft.	..	12,187	56,361	95,725	106,490
Natural gas condensate gals.	..	559	2,199	4,312	8,568
Crude oil '000 gals.	..	..	..	..	52,157

NON-METALLIC (EXCLUDING FUEL) MINERALS

Asbestos short tons	15,613	16,746	18,416	13,374	13,654
Barite tons	11,417	19,217	12,534	8,220	12,302
Clays—					
Brick clay and shale . . . '000 tons	4,636	4,344	4,383	4,549	5,163
Other "	880	912	913	984	1,039
Diatomite tons	4,659	5,417	7,312	5,133	8,732
Dolomite(f) "	190,868	191,624	180,697	214,339	236,068
Felspar "	8,414	8,209	8,513	8,842	9,021
Gypsum "	580,878	609,907	630,910	725,444	795,003
Limestone(f) '000 tons	5,669	6,146	6,415	6,721	7,223
Magnesite tons	62,166	98,795	62,191	56,946	31,250
Phosphate rock "	2,321	4,874	4,385	4,925	5,689
Salt, crude "	463,296	508,657	536,019	581,537	545,491
Silica (glass, chemical, etc.) "	210,100	212,575	218,544	247,928	322,269
Talc "	15,670	13,545	14,060	13,106	15,695

CONSTRUCTION MATERIALS(g)

Sand '000 tons	5,934	7,427	7,535	9,050	10,757
River gravel "	2,932	6,018	5,912	7,624	8,117
Dimension stone "	318	533	379	629	590
Crushed and broken stone "	22,530	27,303	27,944	29,768	34,175
Other (decomposed rock, etc.) "	15,586	16,482	17,310	20,830	23,460

(a) Includes cupreous ore for fertilizer. (b) Bullion, alluvial, retorted gold, etc. (c) Gross weight not available. (d) Iron oxide for metal extraction. (e) Includes lead-silver-zinc ore. (f) Excludes quantities used directly as building or road material. (g) Incomplete owing to difficulties of coverage. See Scope and sources of statistics, page 1028. 1961 and later figures are not comparable with previous years owing to extension of coverage in Victoria.

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 1964 and earlier years.

**CONTENTS OF METALLIC MINERALS PRODUCED
STATES AND NORTHERN TERRITORY, 1964**

Content of metallic minerals produced	N.S.W.	Vic.	Qld	S.A.	W.A.	Tas.	N.T.	Aust.
Alumina (Al ₂ O ₃) . . . tons	4,156	880	261,834	..	129,459	..	..	396,329
Antimony "	1,116	..	..	..	..	..	..	1,116
Beryllium oxide (BeO) . . . units(a)	390	..	..	..	889	..	..	1,279
Cadmium "	973	..	..	..	..	77	..	1,050
Chromic oxide (Cr ₂ O ₃) . . . "	..	..	32	..	..	..	..	32
Cobalt "	73	..	..	..	..	..	..	73
Copper "	3,630	7	74,732	11	1,513	14,879	9,278	104,050
Gold fine oz.	10,569	21,284	100,937	17	715,481	34,381	81,165	963,834
Iron(b) '000 tons	..	..	..	2,802	853	..	..	3,655
Lead tons	296,954	..	61,927	..	620	15,348	7	374,856
Manganese(c) "	6,156	..	..	..	30,408	..	..	36,564
Manganese dioxide (MnO ₂)(d) . . . "	225	6	150	6	423	..	223	1,033
Monazite "	599	..	180	..	1,069	..	..	1,848
Silver '000 fine oz.	10,735	1	5,572	..	242	1,780	98	18,427
Sulphur(e) tons	202,881	..	29,604	33,911	24,002	56,104	..	346,502
Tantalite-columbite (Ta ₂ O ₅ + Nb ₂ O ₅) . . lb.	..	..	..	..	12,499	..	..	12,499
Tin tons	671	14	1,493	..	446	990	28	3,642
Titanium dioxide (TiO ₂) . . . "	129,108	..	48,820	..	164,718	..	..	342,646
Tungstic oxide (WO ₃) . . . "	..	..	..	..	3	993	..	996
Zinc "	256,001	..	37,577	42	825	50,155	..	344,600
Zircon "	117,044	..	43,834	..	21,296	..	..	182,174

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

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

CONTENTS OF METALLIC MINERALS PRODUCED: AUSTRALIA, 1960 TO 1964

Content of metallic minerals produced	1960	1961	1962	1963	1964
Alumina (Al ₂ O ₃) . . . tons	31,393	7,464	13,250	154,499	396,329
Antimony "	786	680	874	1,007	1,116
Beryllium oxide (BeO) . . . units(a)	2,221	3,585	2,586	1,278	1,279
Bismuth lb.	..	602	97	..	..
Cadmium tons	949	907	992	1,109	1,050
Chromic oxide (Cr ₂ O ₃) . . . "	265	..	185	72	32
Cobalt "	65	65	78	86	73
Copper "	109,435	95,626	106,972	112,967	104,050
Gold fine oz.	1,086,709	1,076,292	1,068,837	1,023,970	963,834
Iron(b) '000 tons	2,814	3,434	3,119	3,558	3,655
Lead tons	308,163	269,656	370,110	410,291	374,856
Manganese(c) "	33,964	45,087	39,413	23,951	36,564
Manganese dioxide (MnO ₂)(d) tons	2,058	1,429	1,512	1,228	1,033
Molybdenum disulphide (MoS ₂) lb.	..	2,630	2,332	21,645	..
Monazite tons	344	1,463	772	1,875	1,848
Platinum oz.	4	2	2	4	..
Silver '000 fine oz.	15,216	13,059	17,554	19,642	18,427
Sulphur(e) tons	340,000	324,866	312,803	345,636	346,502
Tantalite-columbite (Ta ₂ O ₅ + Nb ₂ O ₅) . . lb.	11,500	13,814	18,879	12,935	12,499
Tin tons	2,202	2,745	2,715	2,860	3,642
Titanium dioxide (TiO ₂) . . . "	144,742	191,965	215,494	288,050	342,646
Tungstic oxide (WO ₃) . . . "	1,111	1,536	1,042	960	996
Zinc "	317,489	311,157	337,532	351,470	344,600
Zircon "	101,494	134,483	132,109	182,112	182,174

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

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

Graphs showing details of the mine production of principal metals (metallic content) and coal from 1935 to 1965 are included on plates 58 and 59.

Local value of minerals produced, 1960 to 1964

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, 1960 TO 1964 (\$'000)

Mineral	1960	1961	1962	1963	1964
Metallic minerals—					
Copper ore, concentrate, etc.	50,878	42,498	48,604	52,036	51,380
Gold ore, concentrate, other forms, etc.	31,740	31,718	31,254	29,556	26,666
Iron ore	9,688	11,798	10,650	12,200	12,550
Lead and lead-silver ore and concentrate, lead-copper concentrate, etc.	40,792	33,866	39,096	56,320	80,806
Manganese ore	658	854	960	492	750
Pyrite concentrate	2,272	2,504	2,230	2,354	3,054
Rutile concentrate	7,278	6,628	7,038	12,114	12,080
Tin concentrate	3,880	5,572	5,668	5,784	10,224
Tungsten concentrates	1,880	2,066	1,118	1,640	1,420
Zinc ore and concentrate	15,460	10,590	9,110	16,468	35,456
Zircon concentrate	1,944	2,534	2,582	3,550	3,462
Other metallic minerals	1,150	1,536	1,894	2,994	5,794
<i>Total, metallic minerals</i>	<i>167,620</i>	<i>152,164</i>	<i>160,204</i>	<i>195,508</i>	<i>243,642</i>
Fuel minerals—					
Coal, black	110,402	114,162	119,078	118,202	128,038
Coal, brown	13,690	15,444	15,682	16,156	17,304
Other fuel minerals		n.a.	n.a.	58	2,164
<i>Total, fuel minerals</i>	<i>124,092</i>	<i>129,606</i>	<i>134,760</i>	<i>134,416</i>	<i>147,506</i>
<i>Total, non-metallic minerals</i>	<i>21,686</i>	<i>22,990</i>	<i>24,320</i>	<i>26,038</i>	<i>27,814</i>
<i>Total, construction materials(a)</i>	<i>49,082</i>	<i>(b) 55,542</i>	<i>(b) 55,854</i>	<i>(b) 60,720</i>	<i>(b) 73,244</i>
Total, all minerals and construction materials	362,480	(b) 360,302	(b) 375,138	(b) 416,682	(b) 492,208

(a) Incomplete owing to difficulties of coverage. See Scope and sources of statistics, page 1028. (b) Not comparable with years prior to 1961, owing to extension of coverage in Victoria.

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 1037 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 realized. 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 fertilizers, 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 95–119 and 126–8.

Principal products

The following table shows particulars of the production of certain important manufactured products of mineral origin. 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, 1960-61 TO 1964-65**

Commodity	1960-61	1961-62	1962-63	1963-64	1964-65
METALS					
Non-ferrous—					
Refined aluminium . . . tons	12,101	14,408	26,870	58,937	85,702
Blister copper(a) . . . "	70,678	66,818	88,901	92,809	57,880
Refined copper . . . "	68,986	63,769	85,652	89,222	55,773
Lead bullion (for export)(a) "	52,927	56,063	78,851	82,440	63,827
Refined lead . . . "	174,816	174,497	208,946	217,296	199,030
Refined zinc . . . "	125,936	153,742	175,850	186,388	189,396
Refined tin . . . "	2,422	2,442	2,714	2,959	2,931
Ferrous—					
Pig iron . . . '000 tons	3,002	3,380	3,400	3,772	4,033
Steel ingots . . . "	3,748	4,076	4,260	4,764	5,121
Precious—					
Refined gold(b) . . . '000 f. oz.	1,031	1,036	1,006	911	871
Refined silver . . . "	8,008	6,751	8,514	9,392	8,939
FUELS					
Coal products—					
Metallurgical coke . . . '000 tons	2,739	2,717	2,759	2,915	3,175
Brown coal briquettes . . . "	1,807	1,800	1,805	1,883	1,892
Petroleum products—					
Motor spirit . . . mill. gals	1,150	1,213	1,263	1,358	1,482
Furnace fuel . . . '000 tons	3,519	3,873	4,629	4,686	4,869
Automotive distillate . . . "	1,514	1,605	1,654	1,616	1,603
Industrial diesel fuel . . . "	1,055	874	981	917	862
BUILDING MATERIALS					
Clay bricks . . . millions	1,061	992	1,059	1,238	1,344
Portland cement . . . '000 tons	2,860	2,783	2,942	3,320	3,741
Plaster of paris . . . "	245	228	241	259	276
Plaster sheets (fibrous) '000 sq. yds	17,176	15,332	15,932	15,922	14,298
CHEMICALS					
Sulphuric acid . . . '000 tons	1,122	1,136	1,256	1,447	1,613
Caustic soda . . . tons	47,758	47,539	56,481	64,230	69,879
Superphosphate . . . '000 tons	2,531	2,591	2,862	3,347	3,703

(a) Metallic content.

(b) Newly-won gold of Australian origin.

Oversea 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, asbestos, alumina, tin, nickel, industrial diamonds, and potassium fertilizers.

Exports and imports

Particulars of the quantities and values (\$A f.o.b. port of shipment) of the principal minerals and mineral products exported from and imported into Australia during the years 1962 to 1964 are shown in the following table.

IMPORTS AND EXPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS AUSTRALIA, 1962 TO 1964

Item	Quantity			Value (\$A'000 f.o.b.)		
	1962	1963	1964	1962	1963	1964
IMPORTS						
Alumina tons	10,821	54,486	71,437	780	3,650	4,818
Aluminium, refined ingots "	31,389	12,115	565	14,886	5,528	372
Asbestos short tons	39,105	36,628	42,896	4,874	4,212	4,872
Gold, unrefined bullion(a) fine oz.	132,957	161,847	143,144	4,148	5,050	4,466
Ferro-alloys tons	16,218	28,778	19,271	2,592	4,976	4,172
Petroleum oils—						
Crude '000 gals.	2,976,789	3,287,455	3,253,882	133,350	149,000	147,356
Enriched crude "	411,683	575,951	671,635	23,384	27,446	31,916
Kerosenes "	103,176	88,993	59,309	10,806	9,648	6,268
Lubricating oil "	52,296	53,536	46,778	14,432	14,770	12,532
Gasolines and solvents "	234,186	254,956	289,359	26,186	28,398	32,316
Phosphate rock '000 tons	1,721	1,762	2,355	8,968	10,708	16,236
Sulphur tons	229,195	222,527	376,639	4,778	4,304	6,548
Tin, refined "	1,778	1,751	1,283	3,986	3,724	3,798
Titanium oxide (pigments) "	5,947	5,086	2,875	2,288	2,012	1,230
EXPORTS(b)						
Coal tons	2,909,169	3,174,773	4,805,953	23,388	26,674	41,046
Copper—						
Ore and concentrate "	78,983	30,937	47,255	9,968	4,102	6,484
Ingots, pigs (refined) "	16,497	24,485	13,817	9,654	14,018	8,316
Rolled, drawn and extruded shapes "	3,270	5,049	5,077	2,376	3,814	4,264
Gold, refined fine oz.	314,996	472,132	427,203	9,864	14,778	13,382
Iron and steel—						
Pig iron tons	157,502	132,798	55,940	7,028	5,290	2,622
Ingots, blooms and slabs "	97,950	31,909	8,507	6,420	2,058	528
Tinplate "	25,238	68,200	65,435	4,268	9,534	9,028
Scrap "	138,977	334,351	392,408	3,934	7,930	10,114
Lead—						
Ore and concentrate(c) "	109,058	121,983	112,194	11,192	13,428	17,614
Lead-silver bullion "	76,014	76,482	76,061	12,424	13,386	20,094
Pig "	197,049	174,988	155,305	26,398	26,488	35,094
Opals "				4,212	5,394	5,398
Petroleum oils—						
Gasolines and solvents '000 gals.	32,073	51,742	51,975	4,262	5,734	5,470
Kerosenes "	20,710	25,718	12,685	2,508	3,160	1,588
Automotive distillate "	165,262	126,665	76,630	16,576	12,878	7,600
Residuals and heavy distillates "	350,661	384,877	234,203	20,752	22,946	12,912
Rutile concentrate tons	117,291	154,508	193,893	7,258	10,632	14,080
Zinc—						
Ore and concentrate "	255,209	261,856	224,117	8,144	8,998	15,684
Refinery type shapes "	91,215	96,775	80,184	14,918	17,114	21,226
Zircon concentrate "	131,843	179,697	198,664	3,290	4,354	5,124

(a) Includes gold contained in matte. (b) Includes re-exports. (c) Includes lead-copper concentrate.

Considerable quantities of metallic ores, concentrates, slags, and residues are exported from Australia for refining overseas. The following table shows the quantities of such items exported during 1964 and their principal metallic content as estimated by assay.

**PRINCIPAL METALLIC CONTENTS OF SPECIFIED ORES AND CONCENTRATES
ETC. EXPORTED FROM AUSTRALIA DURING 1964**

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	47,634	..	11,437	22,815	..	211	..	..	..
Copper-lead dross and speiss	6,904	..	1,169	..	4,488	268	..	..	83
Other slags and residues	440	2	258	..	4	..	15	..	..
Blister	40	..	37	..	..	..	..	..	..
Matte	8,284	..	3,194	83	3,414	234	2	..	..
Lead—									
Ore and concentrate(a)	112,194	180	2,667	24,546	72,623	2,616	..	..	7,460
Slags and residues	12,343	53	252	2,404	5,600	32	52	..	175
Lead-silver bullion	76,061	..	..	..	75,258	4,878	..	..	..
Tin concentrate	457	..	5	..	1	..	252	2	..
Tungsten—									
Scheelite ore and concentrate	1,471	..	..	..	..	..	..	1,021	..
Wolfram ore and concentrate	423	..	..	..	..	..	..	310	..
Zinc—									
Ore and concentrate	224,117	..	..	..	2,029	68	..	..	116,385
Slags and residues	6,793	..	..	..	..	..	..	..	5,097
Total metallic contents	..	235	19,019	49,848	163,417	8,306	321	1,333	129,200

(a) Includes lead-copper concentrate.

The following table shows indexes at constant prices of exports of minerals and basic mineral products for the years 1953 to 1965.

**EXPORTS OF MINERAL PRIMARY PRODUCTS
INDEX AT CONSTANT PRICES(a), 1953 TO 1964**

(Base of each index : year 1959 = 100)

Year	Metals	Other mineral products	All mineral products
1953	111	56	88
1954	96	57	79
1955	87	62	76
1956	104	77	93
1957	102	101	102
1958	102	81	93
1959	100	100	100
1960	90	136	110
1961	132	153	142
1962	156	155	156
1963	157	156	156
1964	136	216	171

(a) These series are composed of two indexes linked at 1959.

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 1962 to 1964, are shown in the following table.

**VALUE OF OVERSEA MINERAL TRADE, BY COUNTRY OR REGION
AUSTRALIA(a), 1962 TO 1964**

Country or region	Value (\$A m f.o.b.)			Percentage		
	1962	1963	1964	1962	1963	1964
EXPORTS(b)						
Japan	56.0	53.8	72.6	35.8	32.0	32.1
Other Asian and Pacific	13.4	13.8	25.8	8.6	8.2	11.4
United Kingdom	35.2	49.0	68.4	22.5	29.2	30.2
European Economic Community	21.6	18.4	27.8	13.8	11.0	12.3
United States	21.0	22.2	27.0	13.4	13.2	11.9
Other	9.2	10.8	4.8	5.9	6.4	2.1
Total	156.4	168.0	226.4	100.0	100.0	100.0
IMPORTS						
Middle east	93.4	118.0	126.8	43.8	51.2	51.5
Indonesia	40.6	47.0	44.6	19.0	20.4	18.1
Other Asian	5.0	4.2	14.8	2.4	1.8	6.0
Pacific	8.4	11.4	15.6	3.9	4.9	6.3
United States	12.4	7.4	17.2	5.8	3.2	7.0
Canada	13.8	8.2	8.0	6.5	3.6	3.3
Europe (including United Kingdom and European Economic Com- munity)	3.2	5.2	9.8	1.5	2.3	4.0
Other	36.4	29.0	9.4	17.1	12.6	3.8
Total	213.2	230.4	246.2	100.0	100.0	100.0

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

Review of recent developments in the Australian mineral industry

In previous issues of the Year Book it has been customary to include a series of detailed reviews of the principal commodities produced by the Australian mineral industry. However, with the increasing diversification and development of the industry in recent years, 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. This Annual Review contains comprehensive reviews of the 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 are reviewed in subsequent parts of this section.

General review, 1965

Expansion of the mineral industry continued during 1965 despite the effects of the Mount Isa mine closure during late 1964 and early 1965. The value of output of mining and quarrying in 1965, on an ex-mine basis, is estimated at \$538 million, compared with \$492 million in 1964. Processing and treatment of mine and quarry products added substantially to this value and the industry's total contribution to the economy increased significantly. Despite the loss of export income from copper, and returns from lead and zinc which were lower than might have been expected, export earnings from minerals and mineral products were at a record level in 1965. Expenditure on exploration continued to increase and expenditure on petroleum exploration during 1965 was more than \$50 million.

Iron ore

Considerable interest is now being focussed on the development of the extensive resources of iron ore which have been revealed in Australia in the last few years. Developments up to early 1965 were reviewed in the previous issue of the Year Book (No. 51, page 1164). Over the last year additional contracts have been negotiated, and the pattern of development has become clearer. Recent developments are summarized below.

In August 1965 a contract was signed with the Japanese steel industry to supply 71.4 million tons of pellets (64 per cent iron content) over twenty-one years from April 1968 from the Robe River iron ore deposits. The contract provided for the construction of a pelletizing plant with a capacity of 5 million tons at Cape Preston by 1968. The Commonwealth Government subsequently granted a licence for these exports in March 1966.

Approval was granted by the Commonwealth Government in August 1965 to a contract which had been negotiated for the export of 16 million tons of pellets from the Mount Tom Price iron ore deposits to the Japanese steel industry over a period of sixteen years. In January 1966, however, the Commonwealth Government refused to grant an export licence for the export of a further 8.6 million tons of pellets to Japan from the Mount Tom Price deposit on the basis that the price was too low. Further negotiations took place, and in late March 1966 it was announced that agreement had been reached with the Japanese purchasers whereby the original 16 million tons of pellets would be shipped to Japan over a period of ten years, with no change in the approved price. The new agreement also incorporated variations in the pellet specifications in the previous contract. The Commonwealth Government subsequently granted a licence for the revised export contract, and plans are being developed for the establishment of a pelletizing plant at King Bay with an annual capacity of 2 million tons.

On 4 April 1966 the Commonwealth Government announced that permission had been granted for the export of 1.4 million tons of iron ore from the Mount Bundy deposits in the Northern Territory. Shipments, at an annual rate of 200,000 tons, will commence during 1967 and extend for a period of seven years. Total capital expenditure is estimated to be \$3.2 million.

In addition to these contracts with Japan, a contract has been concluded with a Welsh steel company for the export of 875,000 tons of iron ore from the Mount Tom Price iron ore deposits. Shipments under this contract are to commence in 1967 and to extend for a period of three years.

The projects under development as a result of these export contracts will require a capital investment in excess of \$500 million and involve the construction of about 625 miles of standard gauge railway and the development of four new ports for vessels of 60,000 tons and larger. Deliveries under the existing contracts will be spread over the period 1966-1991.

The following table summarizes iron ore contracts signed up to early 1966.

IRON ORE CONTRACTS: AUSTRALIA, UP TO EARLY 1966

State	Material	Quantity	Approximate value	Estimated cost of projects
		mil. tons	\$m	\$m
Western Australia	Ore	192.95	1,558	286
	Pellets	87.4	932	148
Tasmania	Pellets	45.0	494	80
Northern Territory	Ore	4.4	32.6	9.8
Total		329.75	3,016.6	523.8

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 ultimately include new coke ovens, new steelmaking and primary rolling equipment, and additions to the tin-plate plant. The completion of these projects will make Port Kembla one of the world's major producing centres for flat products and will involve a total capital expenditure in excess of \$180 million.

Aluminium

The history of the aluminium industry in Australia and recent significant developments in the industry were reviewed in the previous issue of the Year Book (No. 51, page 1168). The aluminium industry continued its growth during 1965 and 1966, and plans for the establishment

of new smelting plants and the expansion of existing plants were announced. On 21 July plans were announced for the establishment of an aluminium smelter at Kurri Kurri near Newcastle by 1969. The new smelter will have a capacity of 35,700 tons per annum. The cost of this plant is expected to be approximately \$35 million. In December 1965 a \$9 million expansion programme was announced for the Bell Bay (Tasmania) smelting plant to bring capacity to 71,500 tons of aluminium per year. These increases in capacity will raise total domestic capacity to almost 150,000 tons per annum. In 1965 an aluminium extrusion plant was established at Belmont, Perth (Western Australia).

On 15 September 1965 the Commonwealth Government announced that the lease covering the central portion of the bauxite deposits in the Gove area had been allotted to a consortium made up of one oversea and several Australian companies. In addition to bauxite mining, the consortium envisages the construction at Gove by 1971 of a 500,000 tons per annum alumina plant, with associated facilities, at a cost of about \$100 million.

Deposits of bauxite were discovered in the Kimberly district of Western Australia during 1965, and testing of these deposits is proceeding to ascertain their commercial significance.

The Tariff Board opened an inquiry into the domestic aluminium industry on 28 September 1965. Until the report of the Tariff Board is received, protection in the form of tariffs and quantitative import restrictions, which had been temporarily extended after the date of expiry in January 1965, have been further extended.

Copper

Copper production during the second half of 1964 and the first half of 1965 was seriously disrupted by an industrial dispute at Mount Isa. Production at Mount Isa was resumed in March 1965, and subsequently record production levels were achieved. The \$130 million expansion programme at Mount Isa is due for completion in 1967-68.

An important recent development was the revival of copper mining at Cobar. Following an extensive investigation and development programme in the last few years, ore production at Cobar re-commenced in July 1965. Mine output in terms of contained copper is expected to rise to about 15,000-20,000 tons per year by late 1966, although the drought resulted in diminished water supplies and caused a reduction in output in early 1966.

Lead-zinc

The Australian lead-zinc industry has been experiencing one of the most prosperous periods of its history as a result of higher prices for lead and zinc since 1963. Mine and smelter output has not increased significantly, but higher prices have meant considerably increased returns for the producing companies.

As from October 1958 imports of lead and zinc into the United States were controlled by a quota system. Australia received a quota for lead but not for zinc, and Australian exports of lead and zinc were restricted by this policy. In October 1965 the quota system was revoked, and in future all producing countries will have equal access to the large United States market.

A large lead-zinc deposit has been delineated at McArthur River in the Northern Territory, and further exploration and investigation is proceeding. In May 1966 it was announced by the company concerned that expenditure on this project to the end of 1966 would exceed \$3 million. It was anticipated that feasibility studies would continue for about five years before a decision on possible development could be made.

Black coal

There has been a significant revival of the Australian black coal industry in recent years as a result of increased exports and increased domestic consumption of black coal in iron and steel production and electricity generation. These increases have more than balanced losses in consumption in some uses 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 1965 exports were 7.2 million tons valued at \$60.7 million. These increased exports have been almost wholly to Japan. As a result of this increased demand, *new mines have been opened or are under development in Queensland and New South Wales, and established mines are being expanded.*

In late 1965 further agreements for the export of coal to Japan were made public. These agreements and contracts which were negotiated earlier provide for exports of black coal to Japan to rise from about 7.5 million tons in 1966 to over 12 million tons in 1970. In 1970 the value of exports of black coal to Japan under existing contracts amounts to about \$100 million. The existing contracts in total involve the sale of almost 70 million tons of coal valued at about \$540 million. The largest single contract involves the export from Moura in central Queensland of 29.6 million tons of coal over thirteen years.

Petroleum

Petroleum exploration in Australia continued to expand during 1964 and 1965. Encouraging discoveries in the last few years, although small by world standards, have given new stimulus to further expenditure on exploration in potential areas. Developments in the last few years were reviewed in previous issues of the Year Book (No. 48, page 1094-8, No. 51, page 1179). A summary of developments in 1965 and early 1966 is given below.

Australia now has two commercial oil fields, Moonie and Alton, in Queensland, which together are producing more than 10,000 barrels of oil daily. Commercial production from an oil field on Barrow Island, Western Australia, will commence in 1967. A number of potentially important gas strikes were made during 1965 and the first half of 1966. Gas flows from two deep wells at Gingin, fifty-five miles north of Perth, might have potential for utilization in industrial enterprises at Kwinana. Promise of a major field of gas and possibly oil is indicated at Mereenie, 140 miles south-west of Alice Springs, Northern Territory. Other structures in adjacent areas, particularly one well at Palm Valley, have given very promising results. Potentially important gas discoveries have also been made at Gidgealpa and Moomba in South Australia.

Following the discovery of a number of natural gas flows in Queensland in the years 1962-1964, exploration activity has been concerned largely with further drilling in the vicinity of these discoveries. Drilling has continued at Rolleston and near Roma and Bony Creek, Richmond and Pickanjinie. The possibility of a very extensive natural gas deposit at Gilmore is being further investigated. Small but interesting oil flows from several wells in the Roma area, such as Sunny Bank and Richmond, suggest possible commercial fields, but further drilling is required.

Substantial gas flows from three off-shore wells on the Gippsland Shelf, off the south-east Victorian coast, preceded the oil and gas discovery in the area announced on 15 March 1966. These discoveries, because of their close proximity to potential industrial consumers in Melbourne, could be of great significance, and prospects for this area are rated as very promising. These discoveries on the East Gippsland Shelf are characteristic of a new phase which petroleum exploration in Australia is now entering—off-shore exploration. Considerable attention is now being devoted to off-shore areas, and plans have been announced to bring additional off-shore drilling rigs to Australia to take part in this activity. As a result of this increase in interest in off-shore drilling, it is planned to construct off-shore drilling rigs at the shipbuilding and engineering works at Whyalla. Proposals have been made for uniform Australian legislation to control and administer this part of the search for oil. These proposals are outlined on page 1018.

Early in 1965 the Tariff Board conducted a public inquiry to determine an appropriate price for Australian crude oil, having regard to the Commonwealth Government's desire to encourage the search for oil and the consequent need to offer sufficient incentive to exploration companies. At the same time the Government indicated that it was anxious to prevent or minimize 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 method 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.