

## CHAPTER 27

# MINERAL INDUSTRY

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

### GENERAL

#### Geology

##### General geology

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

##### Economic geology

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

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

The mineralised Palaeozoic rocks contain major deposits of gold, now mostly worked out, and a few large copper and lead-zinc-silver occurrences. Smaller amounts of tin, tungsten, molybdenum, bismuth, antimony, 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 rocks of various ages. Extensive deposits of bauxite occur at Weipa on Cape York peninsula in north Queensland, at Gove on the north-eastern tip of the Northern Territory, in the Darling Range in Western Australia, and near Kalumburu in the north-west of Western Australia. These deposits are the result of a long period of weathering.

Mineral sands, another important exception, contain rutile, zircon, ilmenite, monazite, and other minerals, and are particularly well developed on the central and northern New South Wales coast, southern Queensland and south-western Western Australia. The deposits of the eastern States are considered to be derivatives of Mesozoic rocks. The Western Australian deposits are thought to be derivatives of the Precambrian granites of the Australian shield.

Occurrences of fuel minerals (coal, oil and natural gas) are characteristically located in former sedimentary basins. Large areas of Australia are covered by these basins, and more than twenty

major sedimentary basins have been identified on the Australian mainland. In addition, sedimentary basins are known to exist in off-shore areas adjacent to the Australian coast. The individual basins range in area from 4,000 to 680,000 square miles and contain marine and continental sedimentary rocks ranging in maximum thickness from 1,000 to about 30,000 feet and including rocks of all ages from Proterozoic to Tertiary.

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

Crude oil and natural gas have been found in a number of sedimentary basins. In the Bowen-Surat Basin, Queensland, commercial deposits of oil exist at the Moonie and Alton fields, and commercial deposits of natural gas exist in numerous prospects in the Roma and Rolleston areas. Gas reserves are present in the Adavale Basin at Gilmore, and in the Cooper Basin at Roseneath. In general the oil reservoir rocks in Queensland are of Lower Jurassic age, and the gas reservoir rocks are of Mesozoic and Permian age. In the Gippsland Basin, off-shore Victoria in the Bass Strait, oil in considerable quantities was discovered in the Kingfish and Halibut fields, and oil and natural gas in the Marlin and Barracouta fields. In the same basin, significant deposits of hydrocarbons, were encountered in the Flounder, Tuna, Snapper, Bream, and Emperor prospects. In the Gippsland Basin, the Cretaceous and Tertiary strata are the reservoir rocks. In the Cooper Basin, South Australia, commercial deposits of natural gas were discovered at Gidgealpa and Moomba, and also at Daralingie, Toolachee and Tirrawarra. The reservoir rocks are of Permian age. In the Carnarvon Basin, Western Australia, commercial crude oil mainly in the Cretaceous formations, and also to a lesser degree in the Jurassic, was discovered at Barrow Island. Off-shore, significant hydrocarbon shows have been discovered in Lower Cretaceous rocks at Legendre. Further south, in the Perth Basin, natural gas in commercially significant quantities was discovered in the Yardarino, Gingin, Dongara, Mondarra and Whicher Range prospects, the reservoir rock being of Lower Permian age. In the off-shore Bonaparte Gulf Basin high pressure natural gas was encountered at the Petrel prospect. In the Amadeus Basin, Northern Territory, natural gas was discovered in commercial quantities in formations of Ordovician age at Mereenie and Palm Valley.

Of the non-metallic minerals, many occur in, or were formed from, rocks of various ages. The most important are asbestos, clays, sand and gravel, limestone, gypsum, and silica. Salt won by evaporation of sea water is another important product.

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

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

### Mineral resources

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

#### RESERVES OF MINERALS: AUSTRALIA

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

| <i>Production</i>                                     | <i>Reserves adequate</i>   | <i>Reserves uncertain</i>  | <i>Reserves negligible</i> |
|---|--|----------------------------|----------------------------|
| Production sufficient for domestic demand and exports | Barite<br>Bauxite<br>Cadmium<br>Coal (black)<br>Copper<br>Gold<br>Gypsum<br>Iron ore<br>Lead | Beryl<br>Talc<br>Tantalite |                            |



RESERVES OF MINERALS: AUSTRALIA—*continued*

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

(a) Ilmenite, monazite, rutile, zircon.

**Individual minerals**

**Aluminium.** As a result of recent discoveries at Weipa, Gove, in the Darling Range, and in the Kimberley area, Australia's reserves of bauxite are known to be very large, perhaps the largest in the world. Total reserves at Weipa are believed to be in excess of 3,000 million tons, while the deposits at Gove are reported to contain up to 250 million tons of bauxite. In the Darling Range, reserves of economic grade bauxite are estimated to exceed 500 million tons spread over several locations. Another significant deposit of over 200 million tons has so far been proved in the Mitchell Plateau area in the Kimberley district of Western Australia.

**Coal.** Australia has coal resources adequate to provide for future domestic requirements and a substantial export surplus. These resources include coal of all types, except pure anthracite. Australia's coal reserves are concentrated mainly in the mainland eastern States. The bituminous coal is located mainly in New South Wales and Queensland; Victoria has very substantial brown coal reserves in the Latrobe Valley. A table showing Australian coal reserves is published in Year Book No. 53, page 1065.

**Copper.** The principal deposit of this metal is at Mount Isa, where ore reserves were estimated at 75 million tons in 1969. Other important deposits are situated at Cobar, New South Wales, Mount Morgan, Queensland, Mount Lyell, Tasmania and Tennant Creek, Northern Territory. A small deposit at Ravensthorpe, Western Australia has also been developed.

**Crude oil.** Recent exploration and development activity indicates that Australia has substantial reserves of crude oil and that additional reserves will be discovered in the near future as exploration activity finds further drilling prospects, particularly in the off-shore areas. The Moonie and Alton

fields in Queensland, and the Barrow Island field in Western Australia have been producing since 1964, 1966 and 1967 respectively. The Barracouta, Marlin and Halibut fields in the off-shore Gippsland Shelf area in Victoria commenced production in 1969. Production from the nearby Kingfish field is expected to start in mid to late 1970. At the end of 1969, recoverable reserves in Australia were estimated to be 1,860 million barrels and the recent discoveries indicate the possibility of an upward revision of this figure in the near future.

**Gold.** Australia's gold resources are heavily concentrated in Western Australia, mainly in the Kalgoorlie-Coolgardie area, but small deposits of gold-bearing ore occur in all States. In addition, gold is commonly obtained as a by-product of other mining activities, particularly copper mining. Economic gold ore reserves at Kalgoorlie were estimated at more than 10.8 million tons in 1969, with a gold content of 5.20 dwt per ton.

**Iron ore.** In recent years very extensive deposits of iron ore have been discovered in Australia. These discoveries have established Australia as one of the most important iron ore provinces in the world. The largest deposits are located in the Hamersley and Ophthalmia Ranges of north-west Western Australia. Other commercially important deposits of iron ore are situated in the Savage River area of Tasmania, in the Middleback Ranges of South Australia, in the Mount Goldsworthy area, and at Yampi Sound, Koolyanobbing, and Koolanooka in Western Australia, and at Mount Bunday and Frances Creek in the Northern Territory. These deposits are adequate to supply the estimated needs of the Australian iron and steel industry far into the future, as well as providing a large export availability. Total Australian reserves with an iron content greater than 50 per cent are estimated to be more than 20,000 million tons.

**Lead-zinc.** Australia has been a major producer of lead and zinc since the discovery of ore at Broken Hill, New South Wales in 1883. Reserves of lead-zinc ore at Broken Hill are currently 17.3 million tons assaying 12 per cent lead and 11 per cent zinc. Reserves at another major producing mine, Mount Isa in Queensland, are 34.6 million tons assaying 7 per cent lead, 6 per cent zinc. Preparations are now being made to start production from a new mine near Mount Isa with reserves of 35.0 million tons of ore, assaying 8 per cent lead and 10 per cent zinc. The capacity of the mine at Rosebery in Tasmania (reserves of 9.3 million tons, 6 per cent lead and 18 per cent zinc) is being increased. Definite proposals for the development of McArthur River in Northern Territory (reserves of 200.0 million tons, 4 per cent lead and 9 per cent zinc) have not yet been announced. Reserves also exist at Cobar, New South Wales, Beltana, South Australia, and Brown's Prospect and Woodcutters, Northern Territory.

**Manganese.** Australia's known reserves of manganese, which is highly important for the iron and steel industry, are in excess of domestic requirements, and exports have increased sharply in recent years. The principal deposits currently being worked are in the Pilbara area of Western Australia and on Groote Eylandt in the Gulf of Carpentaria. Reserves on Groote Eylandt are substantial.

**Mineral sands.** Ores of titanium (rutile and ilmenite), zirconium (zircon) and thorium (monazite) occur in beach sands over extensive areas of the north and central coasts of New South Wales, the south and central coasts of Queensland, and the south-western corner of Western Australia. Resources are large and easily workable. Australia's reserves of rutile and zircon represent a large proportion of the world's reserves of these minerals. Australia is responsible for about 90 per cent of the world's supplies of rutile, 85 per cent of zircon, 30 per cent of monazite and 25 per cent of ilmenite.

**Natural gas.** Significant discoveries of natural gas have been made throughout Australia, the most notable being the Barracouta and Marlin fields with combined reserves of 5.3 U.S. trillion cubic feet, the Gidgealpa and Moomba fields with reserves of 1.23 U.S. trillion cubic feet in South Australia and numerous small fields in the Roma and Rolleston areas in Queensland with combined reserves of 200 U.S. billion cubic feet. Commercial production is being undertaken from the Barracouta, Marlin, Gidgealpa, Moomba and Roma fields. Total daily gas production at the end of 1969 was of the order of 57 million cubic feet. To these commercial fields must be added the significant discoveries at Yardarino, Gingin, Dongara and Mondarra in Western Australia where reserves are estimated at 500 U.S. billion cubic feet and the reserves of 1.1 U.S. trillion cubic feet at Mereenie and Palm Valley in the Northern Territory. The total reserves of natural gas in Australia, excluding Papua and New Guinea, are estimated at 13.2 U.S. trillion cubic feet.

**Natural gas liquids.** The production of natural gas liquids in association with natural gas is becoming an important facet of Australian petroleum production. Natural gas liquids, also known as condensate, are produced in association with gas from the Barracouta, Marlin, Gidgealpa and Moomba fields and to a lesser degree at Roma. Natural gas liquids from Barracouta and Marlin are separated from the gas at the Dutson gas and crude stabilisation plant and piped to Westernport Bay for shipment to local and export markets. As yet, the liquids extracted from the Gidgealpa and Moomba gas are not used commercially but are returned to the reservoir for future reclamation. The liquids produced at Roma, because of their small quantity, are mainly used as fuel on the producing fields.

Reserves of natural gas liquids in Australia, excluding Papua and New Guinea, are estimated to be 208 million barrels.

*Nickel.* In the Kalgoorlie region of Western Australia a number of nickel sulphide ore bodies have been discovered since 1966. Reserves contained in more than 14 separate ore bodies total more than 27 million tons averaging 3 per cent nickel. Large lateritic nickel deposits have been discovered at Wingellina in Central Australia and at Greenvale and Marlborough in Queensland; plans to develop the Greenvale deposit were announced in early 1970.

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

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

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

*Uranium.* Australia's known reserves of uranium ore were mined during the years 1953 to 1963. During this period substantial quantities of uranium concentrate were exported to the United Kingdom and the United States. In 1967, the Minister for National Development announced a partial embargo on exports of uranium from Australia, which was designed to conserve known resources while encouraging exploration for new deposits. The policy represents a liberalisation of former policies in that prospecting companies are given an assurance in advance that approval would be given to export specified quantities of uranium from existing or newly discovered deposits, depending on their size and date of discovery. Stated reserves amounted to 11,620 short tons of uranium oxide reasonably assured and a further 3,230 short tons possible but not proven; of these reserves, 10,660 short tons were said to be economically recoverable within the price range \$5 to \$10 per pound and 4,190 short tons economically recoverable within the price range \$10 to \$30 per pound. A marked increase in exploration activity following the relaxation of export restrictions has resulted in several important discoveries. At Mary Kathleen in north-west Queensland, an extensive programme of diamond drilling is reported to have significantly extended previously known reserves, while at Westmoreland also in north-west Queensland a preliminary assessment of recently discovered deposits suggests that total reserves could exceed those at Mary Kathleen. Other important areas of exploration are Mount Painter in South Australia, Rum Jungle and South Alligator River in Northern Territory and the Kimberley region of Western Australia.

## Administration

For all practical purposes all mineral rights in Australia are vested in the Crown. In the States, sovereign rights are held by the State Governments with respect to mineral resources within their boundaries. In the Territories of the Commonwealth these rights are vested in the Commonwealth Government. The Commonwealth Government is able also to influence over-all development and production activity in the mineral industry by virtue of its statutory powers with respect to international trade, customs and excise, taxation, and loan raisings. Certain specially formed bodies such as the Joint Coal Board and the Australian Atomic Energy Commission have been given administrative responsibility in defined areas.

### Control of mining

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

The following table sets out particulars of the areas occupied under mining Acts and Ordinances in the several States and Territories at 31 December 1965 to 1969. These figures exclude data relating to exploration licences, etc., covering the large areas referred to in the next section below. Also excluded are areas occupied under petroleum exploration and development titles, particulars of which are shown in the table on page 910.

**AREAS OCCUPIED UNDER MINING ACTS AND ORDINANCES<sup>(a)</sup>**  
**STATES AND NORTHERN TERRITORY, 31 DECEMBER 1965 TO 1969**  
('000 acres)

| Year       | N.S.W. <sup>(b)</sup> | Vic. | Qld <sup>(c)</sup> | S.A. <sup>(b)(c)</sup> | W.A. <sup>(d)</sup> | Tas. | N.T. <sup>(b)</sup> | Total |
|------------|-----------------------|------|--------------------|------------------------|---------------------|------|---------------------|-------|
| 1965 . . . | 1,015                 | 60   | 2,494              | 93                     | 263                 | 45   | 61                  | 4,031 |
| 1966 . . . | 1,083                 | 84   | 2,591              | 98                     | 343                 | 54   | 36                  | 4,289 |
| 1967 . . . | 1,177                 | 74   | 2,304              | 97                     | 372                 | 60   | 37                  | 4,121 |
| 1968 . . . | 1,146                 | 615  | 2,618              | 97                     | 705                 | 66   | 43                  | 5,290 |
| 1969 . . . | 1,397                 | 626  | 2,607              | 97                     | 1,566               | 54   | 93                  | 6,440 |

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

### Control of exploration

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

Following the introduction of large-scale modern prospecting methods (particularly air-borne prospecting), the small prospecting areas referred to in the previous section were found to be unsuitable in some instances, and steps have been taken in the States and Territories to ensure the availability of large areas for prospecting by interested persons. Large areas may be made available 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.

### Control of petroleum exploration

*On-shore.* In Australia, all petroleum 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, organisation or individual proposing to undertake petroleum exploration or development must first satisfy the Government concerned that the necessary financial and technological resources are available to carry out the operation.

There are three main types of petroleum titles:

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

Further details of the petroleum legislation are given in Year Book No. 55, pages 996 and 997.

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

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

The table following shows details of areas occupied under both on-shore and off-shore petroleum exploration and development titles at 31 December 1965 to 1969.

**AREAS OCCUPIED UNDER PETROLEUM EXPLORATION AND DEVELOPMENT  
TITLES: STATES AND NORTHERN TERRITORY, 31 DECEMBER 1965 TO 1969**  
(<sup>'000</sup> acres)

| Year       | N.S.W.(a) | Vic.   | Qld     | S.A.(a) | W.A.    | Tas.   | N.T.(a) | Total     |
|------------|-----------|--------|---------|---------|---------|--------|---------|-----------|
| 1965 . . . | 105,853   | 31,201 | 324,205 | 221,060 | 491,670 | 34,800 | 120,130 | 1,328,916 |
| 1966 . . . | 113,276   | 31,174 | 389,252 | 237,649 | 429,994 | 34,800 | 239,519 | 1,475,664 |
| 1967 . . . | 83,893    | 32,348 | 252,213 | 240,791 | 426,107 | 37,979 | 221,666 | 1,294,997 |
| 1968 . . . | 96,522    | 37,585 | 297,671 | 207,260 | 317,497 | 34,905 | 99,505  | 1,090,945 |
| 1969 . . . | 88,174    | 36,636 | 269,150 | 212,188 | 298,888 | 37,433 | 74,472  | 1,016,941 |

(a) At 30 June.

#### Mineral royalties

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

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

**MINERAL ROYALTY RECEIPTS: GOVERNMENTS 1964-65 TO 1968-69**  
(\$)

|                              | 1964-65    | 1965-66    | 1966-67    | 1967-68    | 1968-69    |
|------------------------------|------------|------------|------------|------------|------------|
| New South Wales . . . . .    | 19,946,772 | 24,317,168 | 16,326,973 | 11,029,697 | 9,067,603  |
| Victoria . . . . .           | 494,128    | 546,117    | 597,639    | 662,820    | 687,789    |
| Queensland . . . . .         | 1,201,264  | 1,183,046  | 2,241,575  | 1,711,503  | 1,544,417  |
| South Australia . . . . .    | 926,984    | 985,560    | 1,091,582  | 1,036,552  | 1,254,295  |
| Western Australia . . . . .  | 291,354    | 478,295    | 2,639,895  | 6,237,593  | 11,000,716 |
| Tasmania . . . . .           | 1,376      | 2,570      | 6,306      | 11,105     | 172,744    |
| Northern Territory . . . . . | 80,894     | 88,727     | 110,574    | 290,701    | 282,616    |
| Commonwealth . . . . .       | ..         | ..         | ..         | ..         | 360        |

#### Control of exports

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

*Department of National Development*—iron ores, beneficiated iron ores and iron concentrates; mineral sands (whether treated or untreated), and concentrates of mineral sands, containing zircon,



rutile or ilmenite; manganese ores; beryllium ores and concentrates; tin ores and concentrates, refined tin in the form of ingots or in any other refinery form, and any of the following materials from which tin may be obtained, being materials resulting from the refining of tin, that is to say, residues, slag, dross, dust and other wastes; copper matte, blister copper, copper scrap, copper refinery shapes; copper alloys in the form of ingots, billets, etc.; copper alloy scrap; any of the following materials from which copper may be obtained, that is to say, residues, speiss, slag, dross, scale, sweepings, ash, sludge, slime, dust and wastes; and natural gas.

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

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

After a review of the copper controls administered by the Department of National Development, the Commonwealth Government announced in March 1969 that the ban on the export of copper scrap and ingots, and copper alloy scrap and ingots would be continued. Export permits are generally issued also for copper residues, dross, ashes, slag and similar materials, and primary copper materials.

Export controls on tin and other tin-bearing materials were introduced by the Commonwealth Government in 1968 for reasons arising from Australia's membership of the International Tin Agreement. The restrictions were lifted a year later.

The Minister for National Development announced on 20 January 1970 that the export of natural gas would be subject to control in order to conserve supplies for local use. Export will be permitted only from fields remote from significant local markets.

#### Joint Coal Board

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

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

#### Australian Atomic Energy Commission

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

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

### Government assistance

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

#### Commonwealth Government Assistance

Assistance provided by the Commonwealth Government takes the form of income taxation concessions, subsidies, bounties, and technical assistance mainly through the work of the Bureau

of Mineral Resources and the Commonwealth Scientific and Industrial Research Organization. A table showing direct Commonwealth Government payments to sectors of the mineral industry is included on page 915.

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

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

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

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

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

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

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

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

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

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

*Petroleum search subsidy.* In 1957 the Commonwealth Government introduced the *Petroleum Search Subsidy Act 1957* whereby stratigraphic drilling operations were subsidised to the extent of 50 per cent of cost. An amendment in 1959 widened the scope of operations for which subsidy was offered to include all types of geophysical surveys and off-structure drilling. Subsidy payments under the Act for the years 1965 to 1969 are shown in the table on page 1004 of Year Book No. 55.

Various amendments to the Act have altered the amount of subsidy and the type of operations to which a subsidy is applicable. The most recent amendment in 1969, provides for the payment of subsidy for approved operations completed before 30 June 1974. On-shore operations, both exploration drilling and geophysical, are subsidised at the rate of 30 per cent of approved costs. All similar off-shore operations are subsidised at a rate dependant upon the Australian financial contribution to the operation, the maximum rate being 30 per cent for operations wholly financed by Australian companies. Details of earlier amendments are given on page 1001 of Year Book No. 55.

*Pricing of Australian crude oil.* Early in 1965 the Tariff Board conducted a public inquiry to determine an appropriate price for Australian crude oil, having regard to the Commonwealth Government's desire to encourage the search for oil and the consequent need to offer sufficient incentive to exploration companies. At the same time the Government indicated that it was anxious to prevent or minimise increased costs of petroleum products to consumers and to ensure that refineries using Australian crude oil were not detrimentally affected in relation to other refineries. Evidence was heard from oil exploration, marketing and refining interests, government officials, coal and power interests, and major users of refined petroleum products. The Tariff Board recommended at that time that Australian crude oil should be valued at \$US2.48 (\$A2.21) a barrel at the nearest refinery centre, plus a differential for the quality of the oil produced. The Government adopted the Tariff Board's recommendations, and raised the incentive margin to 67 Australian cents a barrel; this margin to apply to all Australian crude oil producers.

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

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

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

Subsequently, the Barrow Island field began production and is \$3.24 a barrel delivered Kwinana.

This pricing structure was to remain operative until 17 September 1970.

However, the discovery of very large crude oil reserves in the Gippsland Shelf fields, due to begin production in 1969, revealed that this pricing structure could result in the Australian consumer paying more for indigenous petroleum products, than for similar products refined from imported crude oils. Following negotiations with the Commonwealth Government the Gippsland Shelf operators agreed to forgo the \$0.67 a barrel incentive, plus a further \$0.05 per barrel. This will result in the pricing of Gippsland Shelf crude oil at \$2.47 per barrel in the early stages of production and \$2.44 per barrel in the third quarter of 1970 to 17 September 1970, i.e. the original price of \$3.19 minus 72 cents (incentive plus 5 cent discount). The further reduction to \$2.44 is a quality differential reduction of 3 cents as heavier crude oils commingle with the stream.

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

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

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

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

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

Barrow Island crude will be the basic \$1.89 per barrel plus a quality differential of 32 cents, giving the total of \$2.21 per barrel f.o.b. Kwinana.

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

*Assistance to the gold-mining industry.* Assistance to the gold-mining industry by subsidy was introduced at a time of rising costs in the industry and fixed official world price for gold. Because many producers were faced with the likelihood of closing down, the Government decided to subsidise marginal producers in Australia and the Territories of Papua and New Guinea. Under the *Gold-Mining Industry Assistance Act 1954* a producer, the value of whose gold output exceeded 50 per cent of the total value of his mine output, was eligible for assistance, subject to certain conditions, on the production of gold from 1 July 1954. The assistance scheme has been reviewed on a number of occasions since the Act was originally passed, and some liberalisations have been approved, including increases in the rates of subsidy payable authorised in amendments passed in 1957, 1959 and 1965.

Under the Act as it now stands the subsidy payable to small producers whose annual deliveries do not exceed 500 fine oz is \$6 per fine oz, irrespective of cost of production. For large producers, subject to certain provisions, the rate of subsidy payable is an amount equal to three-quarters of the excess of the average cost of production over \$27 per fine oz, with a maximum amount of subsidy of \$8 per fine oz. A producer whose deliveries during the year exceed 500 fine oz may elect to be treated as a small producer. In this case the subsidy rate payable per fine oz on total deliveries is \$6 reduced by 1c for each fine oz by which deliveries exceed 500 fine oz. The benefit under this provision terminates when deliveries in a year reach 1,100 fine oz. Where a producer receives an amount in excess of the official price of \$31.25 per fine oz as a result of sales on overseas premium markets or otherwise, the subsidy payable is, with effect from 1 July 1968, reduced by seventy-five per cent of the amount of the excess. Prior to 1 July 1968 subsidy was reduced by the full amount of the excess.

Payments under the Act will apply to production until 30 June 1973. The amounts paid to gold producers in the various States and Territories of Australia in each of the years 1965 to 1969 are shown in the table on page 915.

*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. Under the *Copper Bounty Act 1958-1966* bounty was payable, subject to specified conditions, on refined copper sold for use in Australia. The rate of bounty was \$70 per ton when the overseas price, as determined by the Minister for Customs and Excise, was \$580 or less. When the overseas price rose above \$580, the bounty fell by the same extent, so that no bounty was payable when the overseas price was \$650 or more. The Act lapsed on 31 December 1966. The import duty continues in operation, and is imposed on imports of copper when the overseas price falls below \$580 a ton, to the extent of \$1 for each \$1 that the price falls below \$580.

*Assistance to producers of sulphuric acid and iron pyrites.* Following recommendations of the Tariff Board, the *Sulphuric Acid Bounty Act 1954* was extended for a period of five years from 1 July 1960. Arising from these same recommendations, the *Pyrites Bounty Act 1960* was enacted on 15 December 1960 to be operative for a period of four and a half years from 1 January 1961. The Acts provide for bounties to be paid, subject to specified conditions, on sulphuric acid produced from prescribed materials of Australian origin and to producers of iron pyrites. Both of these Acts have now been extended by legislation to 30 June 1970. Payments under the above Acts in each of the years 1965 to 1969 are shown in the table on page 915.

*Payments to producers of phosphate fertilisers.* The *Phosphate Fertilizers Bounty Act 1963-1969* provides for a bounty to be paid on superphosphate and ammoniated phosphate fertilisers manufactured and sold for use in Australia on and after 14 August 1963. An amendment to this Act provides that approved trace elements, compounds or substances, when added to superphosphate, shall be deemed to be superphosphate for purpose of bounty eligibility. The bounty is based on the fertiliser value of superphosphate as measured by its soluble content of phosphorus pentoxide. A standard grade of superphosphate containing 20 per cent, plus or minus 0.5 per cent, soluble content of phosphorus pentoxide qualifies for the full bounty of \$12 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 \$60 for each ton of contained phosphorus pentoxide. Bounty in respect of ammonium phosphate is payable at the rate of \$60 for each ton of the phosphorus pentoxide content of the ammonium phosphate. In addition to standard grade superphosphate, 'double' and 'triple' superphosphates are produced in Australia and bounty on these products is payable in accordance with the phosphorus pentoxide content. The intention of this Act is to assist consumers of superphos-

phate (primary producers) and to this end the benefits of bounty are required to be passed on to the end user of the bountiable product. The Act is due to expire on 31 October 1971. Payments under the above Act in each of the years 1965 to 1969 are shown in the following table.

**COMMONWEALTH GOVERNMENT PAYMENTS TO THE MINERAL  
INDUSTRY: AUSTRALIA, 1965 TO 1969**

(\$)

| Year       | Petroleum<br>exploration<br>(a) | Gold<br>mining(b) | Pyrites<br>mining(c) | Sulphuric<br>acid<br>production<br>(d) | Phosphate<br>fertiliser<br>production<br>(e) |
|------------|---------------------------------|-------------------|----------------------|--|--|
| 1965 . . . | 10,412,842                      | 1,984,966         | 1,113,964            | 2,138,914                              | 22,604,562                                   |
| 1966 . . . | 10,154,169                      | 3,784,241         | 288,319              | 1,397,679                              | 25,817,516                                   |
| 1967 . . . | 10,326,587                      | 3,858,763         | 45,714               | 1,382,485                              | 25,543,785                                   |
| 1968 . . . | 13,805,484                      | 2,817,453         | ..                   | 1,279,260                              | 24,906,817                                   |
| 1969 . . . | 14,911,351                      | 1,076,521         | ..                   | 988,450                                | 31,665,208                                   |

(a) *Petroleum Search Subsidy Act 1959-69*. Includes payments in the Territory of Papua and New Guinea: see also the table on page 940. (b) *Gold-Mining Industry Assistance Act 1954-1968* and *Gold Mines Development Assistance Act 1962* (expired 30 June 1965). Includes payments in the Territory of Papua and New Guinea. (c) *Pyrites Bounty Act 1960-1969*. (d) *Sulphuric Acid Bounty Act 1954-1969*. (e) *Phosphate Fertilizers Bounty Act 1963-1969*.

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

The Bureau comprises five branches under the Director: Operations, Mineral Resources, Geological, Geophysical, and Petroleum Exploration. The Operations Branch consists of three sections, Planning and Co-ordination, Publications and Information, and Administrative. It carries out central office functions, including planning and control of programme, assessment of results, co-ordination of activities, liaison, and distribution of information. The Mineral Resources Branch comprises the sections Mineral Economics, Mining Engineering, and Petroleum Technology, and is concerned largely with those aspects of the Bureau's work which involve studies of the mineral industry as a whole, and the preparation of advice and reviews for the Government, industry and the public. The Geological and Geophysical Branches are responsible for the principal field activities of the Bureau, and the operation of observatories, while the Petroleum Exploration Branch is concerned with the administration of the *Petroleum Search Subsidy Act 1959-1969* and is also engaged in the assessment of sedimentary basins in Australia and its Territories. The establishment of the Bureau is 627 officers (at 30 June 1970), of whom 308 are professional. The budget for the financial year 1969-70 was \$21.6 million, of which \$14.3 million was provided for payment under the *Petroleum Search Subsidy Act 1959-1969*.

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

*Commonwealth Scientific and Industrial Research Organization.* The activities of this body with respect to the mineral industry are discussed on page 917 under Research.

#### State Government assistance

In addition to free assays and determinations of rocks and minerals carried out for prospectors by the Mines Departments of the States and Territories, technical officers of these departments provide advice to the mining and allied industries where required, carry out field examinations of mining prospects, advise on exploration and development, select sites for water supply, and in general give a free technical service to the mining industry.

*New South Wales.* The State Mines Department renders scientific, technical and financial assistance to the mining industry. Grants, which are repayable in the event of pay minerals being discovered, are made to cover half the cost of prospecting and drilling operations. Loans may be made to prospectors and miners for the purchase of plant and machinery. A quantity of equipment is also available for hire in several localities. The Department has itself undertaken a programme of contract drilling to investigate the existence of mineral deposits in the State (including the testing and proving of coal resources). Expenditure on financial assistance in 1968-69 amounted to \$637,000 including \$95,000 on the Department's own drilling programme.

*Victoria.* The Mines Department provides loans for prospecting, development, or the purchase of machinery; ore crushing facilities through stamp mills at various parts of the State at nominal rates; diamond, rotary and percussion type drilling; mineral surveys; the provision of small and large scale geological maps of the State; and memoirs and bulletins on specific regional and economic studies published periodically.

Detailed sedimentary basin studies are continuing in the Otway, Gippsland and Murray Basins to elucidate the stratigraphy and structure and evaluate the economic potential. The survey of the State's groundwater resources is now well advanced and the study of the provision of town supplies from groundwater sources is being investigated.

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

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

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

*Tasmania.* The Department of Mines provides financial assistance to mining lessees for the purchase of plant and machinery, for sinking, repairing or de-watering of shafts, for construction of dams and water races, for testing and proving a deposit of any mining product, for developmental work, and for diamond and other types of drilling. The Department has available for hire percussion and diamond drills for exploration, as well as a complete plant for small shaft sinking and tunnelling. Other assistance is rendered to the industry in the form of geological and engineering advice, through ore-dressing research into metallurgical recoveries, and the selection and design of treatment plant.

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

## Research

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

### Australian Atomic Energy Commission

The Australian Atomic Energy Commission conducts research at its laboratories at Lucas Heights in Sydney on the development of nuclear power, including research on nuclear materials and on metals and ceramics used for nuclear power. Research conducted by the Commission is discussed in detail in Chapter 20, Education, Cultural Activities and Research.

### Australian Mineral Development Laboratories

Contract research and technical consulting for the mineral and associated industries is undertaken by The Australian Mineral Development Laboratories (Amdel), at Adelaide. This Organisation is controlled by a council comprising representatives of the mineral industry, the South Australian Government and the Commonwealth Government. Extensive facilities are available in the fields of analytical chemistry, mineralogy and petrology, chemical and metallurgical engineering, computer services/operations research, and materials technology. Both long and short term applied research is carried out and all investigations are conducted on a strictly confidential basis.

### The Baas Becking Geobiological Research Laboratory

In 1965 the Baas Becking Geobiological Research Laboratory was established in the Bureau of Mineral Resources Building in Canberra, under the joint sponsorship of the Commonwealth Scientific and Industrial Research Organization, the Bureau of Mineral Resources, and the Australian Mineral Industries Research Association (*see* Research by private enterprise, page 918). The broad objective of the research work is to investigate the biological and chemical processes associated with the formation of mineral deposits of the stratiform type.

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

### Bureau of Mineral Resources, Geology and Geophysics

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

For details of the functions of the Bureau of Mineral Resources, Geology and Geophysics, *see* page 915.

### Commonwealth Scientific and Industrial Research Organization

Research for the mineral industry by the Commonwealth Scientific and Industrial Research Organization is undertaken mainly in the Divisions of Applied Mineralogy, Mineral Chemistry, and Chemical Engineering. All of these groups have laboratories in Melbourne. In addition, the Division of Applied Mineralogy has laboratories in Perth and Sydney, and the Division of Mineral Chemistry has a laboratory in Sydney.

The research programme of the Division of Applied Mineralogy is concerned mainly with the production and utilisation of natural and synthetic mineral products. Research is undertaken on cement and concrete, industrial refractories, engineering ceramics, clays, mineral-organic complexes, fillers, foundry materials and on the genesis of ores and the geochemistry of some economic minerals. The Division of Mineral Chemistry is undertaking research aimed at a more thorough evaluation of Australian minerals and their better utilisation through chemical, electrochemical and metallurgical processes. It includes studies on mineral exploration techniques, and the processing and utilisation of minerals as well as broad based investigations related to more general aspects of mineral science and technology. The Division is working closely with industry on sulphide minerals, mineral

sands, iron ores, coal and industrial carbons. In the Division of Chemical Engineering, projects of particular interest to the mineral industry includes studies on the dynamics and automatic control of mineral processing operations such as grinding, classifying and flotation, fluidised-bed techniques, high-temperature extraction metallurgy and metal refining.

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

#### **National Coal Research Advisory Committee**

The functions of the National Coal Research Advisory Committee are to review coal research activity in Australia, to recommend priorities for further activities in this area, and to allocate special Commonwealth funds of \$260,000 per year provided for coal research projects as recommended by the committee. This amount is additional to that expended by C.S.I.R.O. and Commonwealth Departments on coal research. The major beneficiary under this scheme is the Australian Coal Industry Research Laboratories; other beneficiaries are the State Electricity Commission of Victoria (for brown coal research) and the Universities. From 1965 to 1969 special coal research funds of \$520,000 annually were available to the committee, comprising the Commonwealth contribution of \$260,000 matching an equivalent total contribution from State Governments and coal producing and consuming industries. Beginning with the financial year 1968-69 the States and industry are independently sponsoring coal research and development according to their own individual requirements.

#### **University Research**

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

#### **Research by private enterprise**

Most large mining and smelting companies have laboratories dealing with their own individual immediate problems. Private industry has formed the Australian Mineral Industries Research Association, which is composed of fifty members representing a large proportion of the mining, metallurgical and related companies operating in Australia at present. It was set up in 1959, chiefly to represent private industry in the management of the Australian Mineral Development Laboratories, but the Association now finances other research work into geology, mining and ore-dressing at Universities, C.S.I.R.O., and the Australian Mineral Development Laboratories. Expenditure for the year 1968-69 was \$165,819.

In addition, the Association provided \$50,000 to the Australian Mineral Development Laboratories towards the cost of a new building (the first of four such payments) and an advance of \$41,000 to International Technical Services Limited. The latter is a new non-profit consulting company jointly owned by the Association and Battelle Memorial Institute, Columbus, U.S.A. and associated with the Australian Mineral Development Laboratories.

### **International relations**

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

#### **International Tin Agreement**

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



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

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

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

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

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

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

The International Tin Agreement establishes floor and ceiling prices for tin and, by the medium of a buffer stock and remedial trading on the London Metal Exchange, aims at confining the price within these limits. The buffer stock was established with contributions from producing countries, equivalent to 10,000 long tons of metal, wholly made in cash at £stg1,000 per long ton; a further £10 million remains on call from the producer members and a standby-credit facility of £10 million from a consortium of banks. The original buffer stock price range under the Third Agreement was: ceiling £1,400—must sell; £1,300 to £1,400—may sell; £1,200 to £1,300—no action; £1,100 to £1,200—may buy; floor £1,100—must buy. However, following devaluation of sterling, the buffer stock price range was adjusted to the following limits: £1,630—must sell; £1,515 to £1,630—may sell; £1,400 to £1,515—no action; £1,280 to £1,400—may buy; £1,280—must buy.

On 18 September 1968 the International Tin Council declared the period 19 September 1968 to 31 December 1968 to be a period of export control. The total permissible export amount during that period for the six producing members in the agreement, Bolivia, Congo D.R., Indonesia, Malaysia, Nigeria, and Thailand, was 42,950 long tons. The quotas established for the producer members represented a moderate cut, in effect some 4 per cent on reports in the second quarter of 1968. The Council also addressed an invitation to the Australian Government, asking that Australia limit its exports of tin to the same degree and for the same period as the producer members of the Agreement. The Australian Government introduced export controls on tin and tin concentrates as from 6 December 1968. Export restrictions on tin were lifted in early December 1969.

A United Nations Tin Conference under UNCTAD auspices negotiated a Fourth International Tin Agreement in Geneva during April and May 1970. The new Agreement is designed to follow the existing one which will expire on 30 June 1971. The objectives of the Agreement remain basically unchanged. They include maintaining a balance between world production and consumption of tin, preventing excessive fluctuations in the market price and increasing export earnings of producer countries. The basic mechanism of the Agreement remains unchanged, although greater flexibility in buffer stock operations is provided for, especially as regards buying and selling tin in the upper

and lower sections of the price range set by the International Tin Council. The price range will initially be the same as that in force at the end of the present Agreement. The current range, subject to revision by the Council, is £1,260 to £1,605 per metric ton.

#### **International Lead-Zinc Study Group**

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

### **MINERAL INDUSTRY STATISTICS**

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

#### **Mining and quarrying**

##### **Definition**

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

##### **Coverage**

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

##### **Sources of Statistics**

Mining industry data (such as employment, costs, value of output, etc.) have been obtained annually since 1952 from the Mining and Quarrying Census. This Census is carried out in collaboration with the several Mines Departments and involves the uniform collection of particulars from all establishments employing on the average four or more persons during the period worked by the mine. A representative specimen collection form is included in the bulletin *Non-Rural Primary Industries*, No. 2, 1965-66 and 1966-67. 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 and Water Resources Branch. The particulars shown have been compiled as far as practicable on the standardised basis which has been used in Australia since 1950, and this presentation has involved some re-arrangement of official statistics published by the Mines Departments in some States. These statistics have been supplemented, as necessary, by data obtained from the Statisticians of the several States, the Bureau of Mineral Resources, Geology and Geophysics, the Joint Coal Board and from several other sources.

#### Classification of mining and quarrying industry

The mining and quarrying industry is classified into four major groups, namely metal mining, fuel mining, non-metal mining (excluding fuel), and construction material quarrying. Mining and quarrying establishments are classified to these groups and to sub-divisions of these groups on the basis of the product or products of the establishments. This method of classification is straightforward for those establishments which produce only one product, but for mines and quarries which produce more than one product classification is 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 most important product by value, and as a tungsten mine if tungsten were the dominant product. There is, however, one important exemption to this rule in that the mining establishment at Mount Isa is classified to the silver-lead-zinc sector rather than to the copper-gold sector.

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

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

#### Number of mines and quarries

The following tables show the number of mines and quarries which operated in each State and Territory in 1968 and in Australia for the years 1964 to 1968.

NUMBER OF MINES AND QUARRIES: STATES AND TERRITORIES, 1968

| Industry  | N.S.W.       | Vic.       | Qld        | S.A.       | W.A.       | Tas.       | N.T.      | A.C.T.    | Aust.        |
|---|--------------|------------|------------|------------|------------|------------|-----------|-----------|--------------|
| <b>Metal mining—</b>                                  |              |            |            |            |            |            |           |           |              |
| Gold . . . . .  | 13           | 7          | 25         | 1          | 110        | ..         | 4         | ..        | 160          |
| Silver-lead-zinc . . . . .                            | 11           | ..         | 6          | 5          | 5          | 1          | 2         | ..        | 30           |
| Copper-gold . . . . .                                 | 16           | 1          | 174        | 7          | 7          | 1          | 8         | ..        | 214          |
| Tin . . . . .   | 37           | 4          | 241        | ..         | 15         | 31         | 13        | ..        | 341          |
| Mineral sands . . . . .                               | 12           | ..         | 6          | ..         | 4          | 1          | ..        | ..        | 23           |
| Iron . . . . .  | ..           | ..         | ..         | 1          | 8          | 1          | 2         | ..        | 12           |
| Other metal . . . . .                                 | 18           | 1          | 18         | 3          | 8          | 5          | 6         | ..        | 59           |
| <i>Total, metal mining</i> . . . . .                  | <i>107</i>   | <i>13</i>  | <i>470</i> | <i>17</i>  | <i>157</i> | <i>40</i>  | <i>35</i> | <i>..</i> | <i>839</i>   |
| <b>Fuel mining—</b>                                   |              |            |            |            |            |            |           |           |              |
| <b>Black coal—</b>                                    |              |            |            |            |            |            |           |           |              |
| Underground . . . . .                                 | 81           | 1          | 43         | ..         | 2          | 3          | ..        | ..        | 130          |
| Opencut . . . . .                                     | 11           | ..         | 7          | 1          | 1          | ..         | ..        | ..        | 20           |
| <i>Total, black coal</i> . . . . .                    | <i>92</i>    | <i>1</i>   | <i>50</i>  | <i>1</i>   | <i>3</i>   | <i>3</i>   | <i>..</i> | <i>..</i> | <i>150</i>   |
| Brown coal . . . . .                                  | ..           | 5          | ..         | ..         | ..         | ..         | ..        | ..        | 5            |
| Other fuel . . . . .                                  | ..           | 1          | 3          | ..         | 1          | ..         | ..        | ..        | 5            |
| <i>Total, fuel mining</i> . . . . .                   | <i>92</i>    | <i>7</i>   | <i>53</i>  | <i>1</i>   | <i>4</i>   | <i>3</i>   | <i>..</i> | <i>..</i> | <i>160</i>   |
| <b>Non-metal (excluding fuel) mining(a)</b> . . . . . | 699          | 106        | 150        | 113        | 60         | 24         | ..        | ..        | 1,152        |
| <i>Total, all mining</i> . . . . .                    | <i>898</i>   | <i>126</i> | <i>673</i> | <i>131</i> | <i>221</i> | <i>67</i>  | <i>35</i> | <i>..</i> | <i>2,151</i> |
| <b>Construction material quarrying(a)</b> . . . . .   | 483          | 412        | 70         | 233        | 59         | 101        | 23        | 14        | 1,395        |
| <i>Total, all mining and quarrying</i> . . . . .      | <i>1,381</i> | <i>538</i> | <i>743</i> | <i>364</i> | <i>280</i> | <i>168</i> | <i>58</i> | <i>14</i> | <i>3,546</i> |

(a) Incomplete, owing to difficulties of coverage. See Coverage, page 920.

## NUMBER OF MINES AND QUARRIES: AUSTRALIA, 1964 TO 1968

| Industry   | 1964         | 1965         | 1966         | 1967         | 1968         |
|--|--------------|--------------|--------------|--------------|--------------|
| <b>Metal mining—</b>                             |              |              |              |              |              |
| Gold . . . . .                                   | 246          | 193          | 179          | 171          | 160          |
| Silver-lead-zinc . . . . .                       | 20           | 32           | 30           | 32           | 30           |
| Copper-gold . . . . .                            | 86           | 75           | 124          | 174          | 214          |
| Tin . . . . .                                    | 371          | 391          | 363          | 393          | 341          |
| Mineral sands . . . . .                          | 20           | 21           | 23           | 25           | 23           |
| Iron . . . . .                                   | (a)          | (a)          | 11           | 11           | 12           |
| Other metal . . . . .                            | 56           | 53           | 52           | 69           | 59           |
| <i>Total, metal mining</i> . . . . .             | <i>799</i>   | <i>765</i>   | <i>782</i>   | <i>875</i>   | <i>839</i>   |
| <b>Fuel mining—</b>                              |              |              |              |              |              |
| Black coal . . . . .                             | 179          | 168          | 158          | 150          | 150          |
| Brown coal . . . . .                             | 7            | 6            | 5            | 5            | 5            |
| Other fuel . . . . .                             | 3            | 3            | 4            | 5            | 5            |
| <i>Total, fuel mining</i> . . . . .              | <i>189</i>   | <i>177</i>   | <i>167</i>   | <i>160</i>   | <i>160</i>   |
| Non-metal (excluding fuel) mining(b) . . . . .   | 756          | 802          | 973          | 1,098        | 1,152        |
| <i>Total, all mining</i> . . . . .               | <i>1,744</i> | <i>1,744</i> | <i>1,922</i> | <i>2,133</i> | <i>2,151</i> |
| Construction material quarrying(b) . . . . .     | 1,148        | 1,234        | 1,276        | 1,280        | 1,395        |
| <i>Total, all mining and quarrying</i> . . . . . | <i>2,892</i> | <i>2,978</i> | <i>3,198</i> | <i>3,413</i> | <i>3,546</i> |

(a) Included in Other metal. (b) Incomplete. See Coverage, page 920.

## Employment in mining and quarrying

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

The following two tables are derived from mining census data and show the average numbers engaged in the various mining industries in each State or Territory in 1968 and in Australia for the years 1964 to 1968. The figures show the average number of persons employed during the whole year, including working proprietors.

MINING AND QUARRYING: EMPLOYMENT(a)  
STATES AND TERRITORIES, 1968

| Industry   | N.S.W.        | Vic.         | Qld             | S.A.         | W.A.          | Tas.         | N.T.         | A.C.T.    | Aust.            |
|--|---------------|--------------|-----------------|--------------|---------------|--------------|--------------|-----------|------------------|
| <b>Metal mining—</b>                             |               |              |                 |              |               |              |              |           |                  |
| Gold . . . . .                                   | 6             | 101          | (b)             | ..           | 3,263         | ..           | (b)          | ..        | 3,602            |
| Silver-lead-zinc . . . . .                       | 4,287         | ..           | 5,501           | (b)          | 16            | (b)          | 76           | ..        | 9,490            |
| Copper-gold . . . . .                            | 388           | ..           | ..              | 5            | (b)           | (b)          | (b)          | ..        | 3,016            |
| Tin . . . . .                                    | 213           | 30           | 377             | ..           | 147           | 749          | 28           | ..        | 1,544            |
| Mineral sands . . . . .                          | 1,552         | ..           | 780             | ..           | (b)           | (b)          | ..           | ..        | 2,694            |
| Iron . . . . .                                   | ..            | ..           | ..              | (b)          | (b)           | (b)          | 118          | ..        | 1,999            |
| Other metal . . . . .                            | 41            | ..           | (b)             | (b)          | (b)           | (b)          | 215          | ..        | 1,670            |
| <i>Total, metal mining</i> . . . . .             | <i>6,487</i>  | <i>136</i>   | <i>7,093</i>    | <i>452</i>   | <i>5,877</i>  | <i>2,909</i> | <i>1,061</i> | ..        | <i>24,015</i>    |
| <b>Fuel mining—</b>                              |               |              |                 |              |               |              |              |           |                  |
| Black coal—                                      |               |              |                 |              |               |              |              |           |                  |
| Underground . . . . .                            | 12,452        | (c)112       | (b)             | ..           | (b)           | 60           | ..           | ..        | (c)14,946        |
| Opencut . . . . .                                | 272           | ..           | (b)             | 253          | (b)           | ..           | ..           | ..        | 1,362            |
| <i>Total, black coal</i> . . . . .               | <i>12,724</i> | <i>112</i>   | <i>(c)2,301</i> | <i>253</i>   | <i>(c)858</i> | <i>60</i>    | ..           | ..        | <i>(c)16,308</i> |
| Brown coal . . . . .                             | ..            | 1,487        | ..              | ..           | ..            | ..           | ..           | ..        | 1,487            |
| <i>Total, fuel mining</i> . . . . .              | <i>12,724</i> | <i>1,599</i> | <i>2,301</i>    | <i>253</i>   | <i>858</i>    | <i>60</i>    | ..           | ..        | <i>17,795</i>    |
| Non-metal (excluding fuel) mining(d) . . . . .   | 1,713         | 361          | 478             | 529          | 258           | 94           | ..           | ..        | 3,433            |
| <i>Total, all mining</i> . . . . .               | <i>20,924</i> | <i>2,096</i> | <i>9,872</i>    | <i>1,234</i> | <i>6,993</i>  | <i>3,063</i> | <i>1,061</i> | ..        | <i>45,243</i>    |
| Construction material quarrying(d) . . . . .     | 2,815         | 1,809        | 472             | 699          | 370           | 213          | 71           | 78        | 6,527            |
| <i>Total, all mining and quarrying</i> . . . . . | <i>23,739</i> | <i>3,905</i> | <i>10,344</i>   | <i>1,933</i> | <i>7,363</i>  | <i>3,276</i> | <i>1,132</i> | <i>78</i> | <i>51,770</i>    |

(a) Average employment during whole year, including working proprietors. (b) Not available for publication. (c) Includes Other fuel mining. (d) Incomplete, owing to difficulties of coverage. See Coverage, page 920.

## MINING AND QUARRYING: EMPLOYMENT(a), AUSTRALIA, 1964 TO 1968

| Industry   | 1964          | 1965          | 1966          | 1967          | 1968          |
|--|---------------|---------------|---------------|---------------|---------------|
| <b>Metal mining—</b>                             |               |               |               |               |               |
| Gold . . . . .                                   | 4,753         | 4,525         | 4,447         | 4,074         | 3,602         |
| Silver-lead-zinc . . . . .                       | 7,811         | 7,269         | 8,681         | 9,703         | 9,490         |
| Copper-gold . . . . .                            | 2,341         | 2,312         | 2,554         | 2,712         | 3,016         |
| Tin . . . . .                                    | 1,191         | 1,402         | 1,550         | 1,748         | 1,544         |
| Mineral sands . . . . .                          | 1,734         | 2,000         | 2,434         | 2,543         | 2,694         |
| Iron . . . . .                                   | (b)           | (b)           | 1,323         | 1,609         | 1,999         |
| Other metal . . . . .                            | 1,348         | 2,251         | 972           | 1,299         | 1,670         |
| <i>Total, metal mining</i> . . . . .             | <i>19,178</i> | <i>19,759</i> | <i>21,961</i> | <i>23,688</i> | <i>24,015</i> |
| <b>Fuel mining—</b>                              |               |               |               |               |               |
| Black coal(c) . . . . .                          | 15,364        | 15,391        | 15,169        | 15,448        | 16,308        |
| Brown coal . . . . .                             | 1,673         | 1,710         | 1,760         | 1,677         | 1,487         |
| <i>Total, fuel mining</i> . . . . .              | <i>17,037</i> | <i>17,101</i> | <i>16,929</i> | <i>17,125</i> | <i>17,795</i> |
| Non-metal (excluding fuel) mining(d) . . . . .   | 2,783         | 2,795         | 2,930         | 2,803         | 3,433         |
| <i>Total, all mining</i> . . . . .               | <i>38,998</i> | <i>39,655</i> | <i>41,820</i> | <i>43,616</i> | <i>45,243</i> |
| Construction material quarrying(d) . . . . .     | 5,814         | 6,217         | 5,957         | 5,848         | 6,527         |
| <i>Total, all mining and quarrying</i> . . . . . | <i>44,812</i> | <i>45,872</i> | <i>47,777</i> | <i>49,464</i> | <i>51,770</i> |

(a) Average employment during whole year including working proprietors. (b) Included in Other metal. (c) Includes Other fuel mining. (d) Incomplete, see Coverage, page 920.

*Size classification of mines and quarries.* The following table shows the distribution of the total number of mines into various size groups according to the average number of persons employed during the period worked by each mine in 1968.

## NUMBER OF MINES AND QUARRIES AND PERSONS EMPLOYED, BY AVERAGE NUMBER EMPLOYED: STATES AND TERRITORIES, 1968

| Mines and quarries<br>employing on the<br>average(a)— | N.S.W. | Vic.  | Qld    | S.A.  | W.A.  | Tas.  | N.T.<br>and<br>A.C.T. | Aust.  |
|---|--------|-------|--------|-------|-------|-------|-----------------------|--------|
| <b>Less than 4 persons—</b>                           |        |       |        |       |       |       |                       |        |
| Establishments . . . . .                              | 1,060  | 356   | 588    | 280   | 176   | 124   | 50                    | 2,634  |
| Persons . . . . .                                     | 1,942  | 512   | 1,008  | 473   | 437   | 208   | 72                    | 4,652  |
| <b>From 4 to 20 persons—</b>                          |        |       |        |       |       |       |                       |        |
| Establishments . . . . .                              | 206    | 152   | 104    | 71    | 66    | 30    | 12                    | 641    |
| Persons . . . . .                                     | 1,460  | 1,196 | 1,009  | 626   | 547   | 211   | 110                   | 5,159  |
| <b>From 21 to 200 persons—</b>                        |        |       |        |       |       |       |                       |        |
| Establishments . . . . .                              | 84     | 30    | 45     | 11    | 29    | 9     | 9                     | 217    |
| Persons . . . . .                                     | 6,368  | 2,504 | 2,497  | 558   | 2,463 | 677   | 609                   | 15,676 |
| <b>More than 200 persons—</b>                         |        |       |        |       |       |       |                       |        |
| Establishments . . . . .                              | 31     | ..    | 6      | 2     | 9     | 5     | 1                     | 54     |
| Persons . . . . .                                     | 14,155 | ..    | 6,546  | 587   | 4,281 | 2,413 | 442                   | 28,424 |
| <b>Total—</b>   |        |       |        |       |       |       |                       |        |
| Establishments . . . . .                              | 1,381  | 538   | 743    | 364   | 280   | 168   | 72                    | 3,546  |
| Persons . . . . .                                     | 23,925 | 4,212 | 11,060 | 2,244 | 7,728 | 3,509 | 1,233                 | 53,911 |

(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 1968, 42 persons were recorded as killed and 1,129 as injured in mining (excluding quarrying) accidents. Recorded deaths and injuries in that year in black coal mines were 13 and 292, silver-lead-zinc mines 6 and 306, gold mines 10 and 227. In mineral sands mining there was 1 death and 55 injuries reported. Persons killed and injured in the construction material quarrying industry numbered 5 and 109 respectively in 1968.

#### Salaries and wages paid

Salaries and wages paid in the mining and quarrying industries in Australia during each year 1964 to 1968 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 248) and also in the *Labour Report*.

#### MINING AND QUARRYING: SALARIES AND WAGES PAID<sup>(a)</sup>, AUSTRALIA 1964 TO 1968 (\$'000)

| <i>Industry</i>  | <i>1964</i>    | <i>1965</i>    | <i>1966</i>    | <i>1967</i>    | <i>1968</i>    |
|--|----------------|----------------|----------------|----------------|----------------|
| <b>Metal mining—</b>                                       |                |                |                |                |                |
| Gold . . . . .   | 11,812         | 11,974         | 12,409         | 12,591         | 11,465         |
| Silver-lead-zinc . . . . .                                 | 29,948         | 34,397         | 44,651         | 46,711         | 49,225         |
| Copper-gold . . . . .                                      | 6,834          | 7,415          | 8,205          | 9,235          | 10,780         |
| Tin . . . . .  | 2,648          | 3,313          | 4,156          | 5,035          | 5,056          |
| Mineral sands . . . . .                                    | 4,706          | 5,837          | 7,673          | 8,603          | 10,015         |
| Iron . . . . .   | (b)            | (b)            | 4,917          | 7,529          | 9,631          |
| Other metal . . . . .                                      | 4,038          | 7,241          | 3,683          | 5,790          | 7,372          |
| <i>Total, metal mining</i> . . . . .                       | <i>59,986</i>  | <i>70,177</i>  | <i>85,696</i>  | <i>95,495</i>  | <i>103,544</i> |
| <b>Fuel mining—</b>  |                |                |                |                |                |
| Black coal <sup>(c)</sup> . . . . .                        | 52,204         | 55,942         | 60,191         | 65,549         | 75,607         |
| Brown coal . . . . .                                       | 5,144          | 5,503          | 5,672          | 5,662          | 5,729          |
| <i>Total, fuel mining</i> . . . . .                        | <i>57,348</i>  | <i>61,445</i>  | <i>65,863</i>  | <i>71,210</i>  | <i>81,335</i>  |
| Non-metal (excluding fuel) mining <sup>(d)</sup> . . . . . | 6,248          | 6,388          | 6,821          | 5,570          | 6,753          |
| <i>Total, all mining</i> . . . . .                         | <i>123,582</i> | <i>138,010</i> | <i>158,380</i> | <i>172,275</i> | <i>191,632</i> |
| Construction material quarrying <sup>(d)</sup> . . . . .   | 9,364          | 10,751         | 11,256         | 11,136         | 11,290         |
| <b>Total, all mining and quarrying</b> . . . . .           | <b>132,946</b> | <b>148,761</b> | <b>169,636</b> | <b>183,411</b> | <b>202,922</b> |

<sup>(a)</sup> 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. <sup>(b)</sup> Included in Other metal. <sup>(c)</sup> Includes Other fuel mining. <sup>(d)</sup> Incomplete. See Coverage, page 920.

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

**MINING AND QUARRYING: VALUE OF POWER, FUEL, LIGHT, AND  
OTHER MATERIALS AND STORES USED, AUSTRALIA, 1964-1968**  
(\$'000)

| <i>Industry</i>                                  | <i>1964</i>   | <i>1965</i>    | <i>1966</i>    | <i>1967</i>    | <i>1968</i>    |
|--|---------------|----------------|----------------|----------------|----------------|
| <b>Metal mining—</b>                             |               |                |                |                |                |
| Gold . . . . .                                   | 8,334         | 8,433          | 8,207          | 8,147          | 7,397          |
| Silver-lead-zinc . . . . .                       | 22,688        | 21,009         | 22,265         | 24,923         | 26,479         |
| Copper-gold . . . . .                            | 7,698         | 8,365          | 10,537         | 12,544         | 14,501         |
| Tin . . . . .                                    | 1,854         | 2,115          | 3,095          | 3,676          | 4,336          |
| Mineral sands . . . . .                          | 5,496         | 6,138          | 7,569          | 7,820          | 9,761          |
| Iron . . . . .                                   | (a)           | (a)            | 3,923          | 11,564         | 16,047         |
| Other metal . . . . .                            | 3,162         | 4,366          | 2,285          | 3,656          | 4,914          |
| <i>Total, metal mining . . . . .</i>             | <i>49,234</i> | <i>50,427</i>  | <i>57,883</i>  | <i>72,329</i>  | <i>83,434</i>  |
| <b>Fuel mining—</b>                              |               |                |                |                |                |
| Black coal(b) . . . . .                          | 29,114        | 31,718         | 35,746         | 41,069         | 49,125         |
| Brown coal. . . . .                              | 1,532         | 2,108          | 2,082          | 1,968          | 1,987          |
| <i>Total, fuel mining . . . . .</i>              | <i>30,648</i> | <i>33,827</i>  | <i>37,828</i>  | <i>43,036</i>  | <i>51,112</i>  |
| Non-metal (excluding fuel) mining(c) . . . . .   | 5,342         | 5,720          | 5,641          | 5,209          | 6,189          |
| <i>Total, all mining . . . . .</i>               | <i>85,226</i> | <i>89,974</i>  | <i>101,351</i> | <i>120,574</i> | <i>140,735</i> |
| Construction material quarrying(c) . . . . .     | 9,728         | 11,067         | 12,072         | 13,115         | 14,106         |
| <b>Total, all mining and quarrying . . . . .</b> | <b>94,952</b> | <b>101,041</b> | <b>113,423</b> | <b>133,689</b> | <b>154,841</b> |

(a) Included in Other metal. (b) Includes Other fuel mining. (c) Incomplete. See Coverage, page 920.

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

**MINING AND QUARRYING: VALUE OF ADDITIONS AND REPLACEMENTS TO  
FIXED ASSETS(a), AUSTRALIA, 1964 TO 1968**  
(\$'000)

| <i>Industry</i>                                  | <i>1964</i>   | <i>1965</i>    | <i>1966</i>    | <i>1967</i>    | <i>1968</i>    |
|--|---------------|----------------|----------------|----------------|----------------|
| <b>Metal mining—</b>                             |               |                |                |                |                |
| Gold . . . . .                                   | 1,365         | 1,094          | 1,195          | 1,558          | 2,516          |
| Silver-lead-zinc . . . . .                       | 20,071        | 10,939         | 12,535         | 14,595         | 8,350          |
| Copper-gold . . . . .                            | 7,419         | 5,333          | 6,085          | 5,813          | 7,234          |
| Tin . . . . .                                    | 4,459         | 6,583          | 9,798          | 10,361         | 3,651          |
| Mineral sands . . . . .                          | 3,592         | 6,729          | 11,103         | 9,674          | 11,470         |
| Iron . . . . .                                   | (b)           | (b)            | 36,436         | 20,112         | 18,829         |
| Other metal . . . . .                            | 5,556         | 32,228         | 13,051         | 12,827         | 14,373         |
| <i>Total, metal mining . . . . .</i>             | <i>42,462</i> | <i>62,906</i>  | <i>90,203</i>  | <i>74,939</i>  | <i>66,423</i>  |
| <b>Fuel mining—</b>                              |               |                |                |                |                |
| Black coal(c) . . . . .                          | 19,952        | 28,695         | 45,442         | 71,506         | 109,281        |
| Brown coal. . . . .                              | 5,416         | 6,115          | 5,107          | 5,277          | 7,668          |
| <i>Total, fuel mining . . . . .</i>              | <i>25,368</i> | <i>34,810</i>  | <i>50,548</i>  | <i>76,783</i>  | <i>116,949</i> |
| Non-metal (excluding fuel) mining(d) . . . . .   | 3,497         | 2,109          | 3,638          | 8,302          | 9,927          |
| <i>Total, all mining . . . . .</i>               | <i>71,327</i> | <i>99,825</i>  | <i>144,387</i> | <i>160,024</i> | <i>193,299</i> |
| Construction material quarrying(d) . . . . .     | 5,867         | 7,303          | 5,273          | 7,640          | 6,744          |
| <b>Total, all mining and quarrying . . . . .</b> | <b>77,194</b> | <b>107,128</b> | <b>149,661</b> | <b>167,664</b> | <b>200,043</b> |

(a) Excludes mines and quarries employing less than four persons. (b) Included in Other metal. (c) Includes Other fuel mining. (d) Incomplete. See Coverage, page 920.

## 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 table shows particulars of the local value of production of mining and quarrying for 1968 and earlier years.

Due to the fact that the classification of individual mines to industry is on the basis of the principal mineral produced, the values in the following table for mining industry groups differ slightly in some cases from the totals of the corresponding groups of mine products shown in the table on page 933.

**MINING AND QUARRYING: LOCAL VALUE OF PRODUCTION(a)**  
**STATES AND TERRITORIES, 1964 TO 1968**  
(**\$'000**)

| Industry and year                              | N.S.W.         | Vic.          | Qld            | S.A.          | W.A.           | Tas.          | N.T.          | A.C.T.       | Aust.          |
|--|----------------|---------------|----------------|---------------|----------------|---------------|---------------|--------------|----------------|
| <b>1968—</b>                                   |                |               |                |               |                |               |               |              |                |
| Metal mining—                                  |                |               |                |               |                |               |               |              |                |
| Gold . . . . .                                 | 4              | 451           | (b)            | ..            | 19,852         | ..            | (b)           | ..           | 25,831         |
| Silver-lead-zinc . . . . .                     | 72,083         | ..            | 99,876         | { 41          | (b)            | (b)           | 601           | ..           | 173,337        |
| Copper-gold . . . . .                          | 8,352          | 10            | ..             | { 15          | (b)            | (b)           | 6,127         | ..           | 39,232         |
| Tin . . . . .                                  | 3,683          | 162           | 3,093          | ..            | 1,967          | 8,356         | 56            | ..           | 17,317         |
| Mineral sands . . . . .                        | 23,127         | ..            | 10,398         | ..            | 4,854          | ..            | ..            | ..           | 38,379         |
| Iron . . . . .                                 | ..             | ..            | ..             | 13,048        | 110,942        | (b)           | (b)           | ..           | 131,518        |
| Other metal . . . . .                          | 179            | 1             | (b)            | 1,230         | (b)            | (b)           | 7,668         | ..           | 43,571         |
| <i>Total, metal mining.</i>                    | <i>107,428</i> | <i>624</i>    | <i>133,011</i> | <i>14,334</i> | <i>148,845</i> | <i>41,114</i> | <i>23,828</i> | ..           | <i>469,185</i> |
| Fuel mining—                                   |                |               |                |               |                |               |               |              |                |
| Black coal . . . . .                           | 144,899        | 209           | 35,436         | 3,053         | 4,817          | 371           | ..            | ..           | 188,786        |
| Brown coal . . . . .                           | ..             | 21,555        | ..             | ..            | ..             | ..            | ..            | ..           | 21,555         |
| Other fuel . . . . .                           | ..             | ..            | 8,225          | ..            | 31,083         | ..            | ..            | ..           | 39,308         |
| <i>Total, fuel mining .</i>                    | <i>144,899</i> | <i>21,765</i> | <i>43,661</i>  | <i>3,053</i>  | <i>35,900</i>  | <i>371</i>    | ..            | ..           | <i>249,649</i> |
| Non-metal (excluding fuel) mining—             |                |               |                |               |                |               |               |              |                |
| Clays(c) . . . . .                             | 3,761          | 3,373         | 317            | 721           | 557            | 106           | ..            | ..           | 8,835          |
| Gypsum . . . . .                               | 151            | 161           | ..             | (b)           | (b)            | ..            | ..            | ..           | 2,165          |
| Limestone . . . . .                            | 3,305          | (b)           | 2,946          | 2,487         | (b)            | 556           | ..            | ..           | 12,382         |
| Salt . . . . .                                 | ..             | (b)           | (b)            | 2,443         | (b)            | ..            | ..            | ..           | 3,600          |
| Other non-metal mining(c) . . . . .            | 3,421          | (b)           | (b)            | (b)           | (b)            | 27            | ..            | ..           | 9,946          |
| <i>Total, non-metal mining .</i>               | <i>10,637</i>  | <i>6,833</i>  | <i>4,149</i>   | <i>12,465</i> | <i>2,155</i>   | <i>690</i>    | ..            | ..           | <i>36,928</i>  |
| <i>Total, all mining .</i>                     | <i>262,964</i> | <i>29,221</i> | <i>180,822</i> | <i>29,853</i> | <i>186,900</i> | <i>42,175</i> | <i>23,828</i> | ..           | <i>755,762</i> |
| Construction material quarrying(c) . . . . .   | 37,041         | 29,805        | 5,080          | 12,211        | 7,591          | 2,793         | 1,018         | 1,195        | 96,735         |
| <i>Total, all mining and quarrying, 1968 .</i> | <i>300,005</i> | <i>59,026</i> | <i>185,902</i> | <i>42,064</i> | <i>194,491</i> | <i>44,968</i> | <i>24,846</i> | <i>1,195</i> | <i>852,497</i> |
| 1967 . . . . .                                 | 275,929        | 57,339        | 135,510        | 40,449        | 134,319        | 34,688        | 19,317        | 1,087        | 698,636        |
| 1966 . . . . .                                 | 263,751        | 53,156        | 138,483        | 41,954        | 78,918         | 34,561        | 13,282        | 1,046        | 625,152        |
| 1965 . . . . .                                 | 267,673        | 48,926        | 98,964         | 39,466        | 49,072         | 28,998        | 8,286         | 986          | 542,370        |
| 1964 . . . . .                                 | 233,298        | 44,892        | 97,286         | 38,938        | 45,366         | 25,048        | 7,234         | 738          | 492,800        |

(a) Value of output or selling value of products at the mine or quarry. (b) Not available for publication, included in total for Australia. (c) Incomplete. See Coverage, page 920.



*Net value of mining and quarrying production*

The following table shows particulars of the net value of production of mining and quarrying for 1968 and earlier years.

**MINING AND QUARRYING: NET VALUE OF PRODUCTION(a)**  
**STATES AND TERRITORIES 1964 TO 1968**  
 (\$'000)

| <i>Industry and year</i>                    | <i>N.S.W.</i>  | <i>Vic.</i>   | <i>Qld</i>     | <i>S.A.</i>   | <i>W.A.</i>    | <i>Tas.</i>   | <i>N.T.</i>   | <i>A.C.T.</i> | <i>Aust.</i>   |
|---|----------------|---------------|----------------|---------------|----------------|---------------|---------------|---------------|----------------|
| 1968—                                       |                |               |                |               |                |               |               |               |                |
| Metal mining—                               |                |               |                |               |                |               |               |               |                |
| Gold  |                | 290           | (b)            |               | 13,112         |               | (b)           |               | 18,434         |
| Silver-lead-zinc                            | 58,042         |               | 84,984         | (b)           | (b)            | (b)           | 484           |               | 146,858        |
| Copper-gold                                 | 5,484          | (c) 2         |                | 14            | (b)            | (b)           | (b)           |               | 24,731         |
| Tin   | 2,970          | 139           | 2,342          |               | 1,458          | 6,044         | 29            |               | 12,982         |
| Mineral sands                               | 18,168         |               | 6,668          |               | 3,782          |               |               |               | 28,618         |
| Iron  |                |               |                | (b)           | 99,151         | (b)           | 3,657         |               | 115,471        |
| Other metal                                 | 155            |               | (b)            | (b)           | (b)            | (b)           | 7,005         |               | 38,658         |
| <i>Total, metal mining</i>                  | <i>84,819</i>  | <i>426</i>    | <i>112,709</i> | <i>12,132</i> | <i>126,004</i> | <i>29,626</i> | <i>20,034</i> |               | <i>385,751</i> |
| Fuel mining—                                |                |               |                |               |                |               |               |               |                |
| Black coal                                  | 108,496        | 147           | (d)33,017      | 2,467         | (d)34,548      | 293           |               |               | (d)178,969     |
| Brown coal                                  |                | 19,568        |                |               |                |               |               |               | 19,568         |
| <i>Total, fuel mining</i>                   | <i>108,496</i> | <i>19,715</i> | <i>33,017</i>  | <i>2,467</i>  | <i>34,548</i>  | <i>293</i>    |               |               | <i>198,537</i> |
| Non-metal (excluding fuel) mining—          |                |               |                |               |                |               |               |               |                |
| Clays(e)                                    | 3,444          | 3,069         | 276            | 2,042         | (b)            | 98            |               |               | 7,907          |
| Gypsum                                      | 107            | 131           |                |               | (b)            |               |               |               | 1,889          |
| Limestone                                   | 2,388          | (b)           | 1,557          | 2,181         | (b)            | 373           |               |               | 8,863          |
| Salt  |                | (b)           | (b)            |               | (b)            |               |               |               | 2,717          |
| Other non-metal mining(e)                   | 3,200          | (b)           | (b)            | 6,916         | (b)            | 25            |               |               | 9,358          |
| <i>Total, non-metal mining</i>              | <i>9,139</i>   | <i>5,754</i>  | <i>2,555</i>   | <i>11,139</i> | <i>1,652</i>   | <i>495</i>    |               |               | <i>30,735</i>  |
| <i>Total, all mining</i>                    | <i>202,455</i> | <i>25,895</i> | <i>148,281</i> | <i>25,739</i> | <i>162,205</i> | <i>30,414</i> | <i>20,034</i> |               | <i>615,022</i> |
| Construction material quarrying(e)          | 37,041         | 21,979        | 3,769          | 10,546        | 5,563          | 2,214         | 602           | 914           | 82,629         |
| <i>Total all mining and quarrying, 1968</i> | <i>239,496</i> | <i>47,875</i> | <i>152,050</i> | <i>36,285</i> | <i>167,768</i> | <i>32,628</i> | <i>20,635</i> | <i>914</i>    | <i>697,652</i> |
| 1967  | 222,817        | 47,382        | 107,440        | 34,595        | 110,267        | 25,197        | 16,416        | 834           | 564,947        |
| 1966  | 215,902        | 43,438        | 115,370        | 36,250        | 63,097         | 25,828        | 11,070        | 772           | 511,728        |
| 1965  | 225,771        | 39,958        | 79,742         | 33,979        | 35,192         | 20,309        | 5,715         | 663           | 441,330        |
| 1964  | 195,980        | 37,056        | 74,406         | 34,068        | 32,162         | 18,174        | 5,507         | 493           | 397,846        |

(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) Cost of materials used, etc., exceeds local value of production. (d) Includes other fuel mining. (e) Incomplete. See Coverage, page 920.

**Quantities of principal minerals produced**

In the preparation of Australian mineral commodity production statistics the quantities and values of individual minerals produced are recorded in terms of the form in which they are dispatched from the locality of each mine. For example, in the case of metalliferous mines, the output is recorded as ore if no treatment is undertaken at the mine, or as a concentrate if ore-dressing operations are carried out in associated works in the locality of the mine. In addition to the basic output data, which are set out in the following tables through to page 929, the contents of metallic minerals are shown in the tables on page 930. 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 fuel), and construction material quarrying, referred to on page 921. Particulars relating to uranium bearing minerals are excluded.

The following tables show particulars of the quantity of the principal minerals produced during 1968 and earlier years.

QUANTITIES OF PRINCIPAL MINERALS PRODUCED  
STATES AND NORTHERN TERRITORY, 1968

| Mineral                                       |              | N.S.W.  | Vic.   | Qld     | S.A.    | W.A.    | Tas.   | N.T.    | Aust          |
|---|--------------|---------|--------|---------|---------|---------|--------|---------|---------------|
| <b>METALLIC MINERALS</b>                      |              |         |        |         |         |         |        |         |               |
| Antimony ore and concentrate                  | tons         | 241     | ..     | 3       | ..      | ..      | ..     | ..      | 244           |
| Bauxite                                       | '000 tons    | 12      | ..     | 3,257   | ..      | 1,608   | ..     | ..      | 4,877         |
| Beryllium ore                                 | tons         | 2       | ..     | ..      | ..      | 13      | ..     | ..      | 15            |
| Bismuth concentrate                           | "            | ..      | ..     | ..      | ..      | ..      | ..     | 1,553   | 1,553         |
| Copper ore(a)                                 | "            | 1,737   | 162    | 29,894  | 510     | 690     | 5,056  | 1,153   | 39,202        |
| Copper concentrate(b)                         | "            | 38,253  | ..     | 324,669 | ..      | 4,276   | 54,187 | 30,715  | 452,100       |
| Gold(c)                                       | oz           | 95      | 12,417 | 40,267  | 1       | 765,417 | 115    | 89,974  | 908,286       |
| Ilmenite concentrate(d)                       | tons         | 11,737  | ..     | 4,532   | ..      | 536,839 | ..     | ..      | 553,108       |
| Iron ore and concentrate(e)                   | '000 tons    | ..      | ..     | ..      | 5,680   | 18,828  | 869    | 827     | 26,204        |
| Lead ore(f)                                   | tons         | 8,204   | ..     | 42,757  | 500     | ..      | ..     | ..      | 51,461        |
| Lead concentrate                              | "            | 321,824 | ..     | 264,174 | ..      | 418     | 13,352 | 1,941   | 601,709       |
| Lead-copper concentrate                       | "            | ..      | ..     | ..      | ..      | ..      | 12,558 | ..      | 12,558        |
| Lead-zinc concentrate                         | "            | 5,373   | ..     | ..      | ..      | ..      | ..     | ..      | 5,373         |
| Manganese ore                                 | "            | 529     | ..     | 270     | 24      | 150,338 | ..     | 581,715 | 732,077       |
| Monazite concentrate                          | "            | ..      | ..     | ..      | ..      | 1,256   | ..     | ..      | 2,055         |
| Nickel concentrate                            | "            | ..      | ..     | 2,045   | ..      | 36,880  | ..     | ..      | 36,880        |
| Pyrite concentrate                            | "            | ..      | ..     | 2,045   | 87,837  | 32,879  | 42,504 | ..      | 165,265       |
| Rutile concentrate                            | "            | 192,928 | ..     | 93,844  | ..      | 845     | ..     | ..      | 287,617       |
| Tantalite-columbite concentrate               | lb           | ..      | ..     | ..      | ..      | 238,134 | ..     | ..      | 238,134       |
| Tin concentrates(g)                           | tons         | 2,472   | 92     | 1,760   | ..      | 895     | 6,030  | 48      | 11,297        |
| Tungsten concentrates—                        |              |         |        |         |         |         |        |         |               |
| Scheelite concentrate                         | "            | ..      | ..     | ..      | ..      | ..      | 1,465  | ..      | 1,465         |
| Wolfram concentrate                           | "            | 1       | ..     | 37      | ..      | 1       | 484    | 36      | 559           |
| Xenotime                                      | "            | ..      | ..     | ..      | ..      | 18      | ..     | ..      | 18            |
| Zinc ore                                      | "            | ..      | ..     | ..      | 2,700   | ..      | ..     | ..      | 2,700         |
| Zinc concentrate                              | "            | 504,244 | ..     | 128,047 | ..      | ..      | 82,458 | 3,562   | 718,311       |
| Zircon concentrate                            | "            | 186,292 | ..     | 79,807  | ..      | 28,096  | ..     | ..      | 294,195       |
| <b>FUEL MINERALS</b>                          |              |         |        |         |         |         |        |         |               |
| Coal, black—                                  |              |         |        |         |         |         |        |         |               |
| Semi-anthracite                               | '000 tons    | ..      | ..     | 29      | ..      | ..      | 2      | ..      | 31            |
| Bituminous                                    | "            | 30,349  | 26     | 6,201   | ..      | ..      | 89     | ..      | 36,665        |
| Sub-bituminous                                | "            | ..      | ..     | 322     | 2,078   | 1,087   | ..     | ..      | 3,488         |
| Total coal, black                             | "            | 30,349  | 26     | 6,552   | 2,078   | 1,087   | 91     | ..      | 40,183        |
| Coal, brown (lignite)                         | "            | ..      | 22,971 | ..      | ..      | ..      | ..     | ..      | 22,971        |
| Natural gas                                   | '000 cu ft   | ..      | ..     | 122,883 | ..      | 92,922  | ..     | ..      | 215,805       |
| Crude oil                                     | '000 barrels | ..      | ..     | 3,100   | ..      | 10,777  | ..     | ..      | 13,877        |
| <b>NON-METALLIC (EXCLUDING FUEL) MINERALS</b> |              |         |        |         |         |         |        |         |               |
| Asbestos                                      | short tons   | 822     | ..     | ..      | ..      | 75      | ..     | ..      | 897           |
| Barite  | tons         | 5,660   | ..     | ..      | 32,839  | 656     | ..     | ..      | 39,155        |
| Clays—  |              |         |        |         |         |         |        |         |               |
| Brick clay and shale                          | '000 tons    | 3,058   | 1,580  | 492     | 473     | 664     | 156    | ..      | 6,422         |
| Other(h)                                      | "            | 477     | 447    | 150     | 116     | 145     | 62     | ..      | 1,396         |
| Diatomite                                     | tons         | 1,493   | 5,188  | ..      | ..      | 44      | ..     | ..      | 6,725         |
| Dolomite(i)                                   | "            | 7,822   | ..     | 7,743   | 298,632 | ..      | 2,534  | ..      | 316,731       |
| Felspar                                       | "            | 1,893   | ..     | ..      | 2,476   | 469     | ..     | ..      | 4,838         |
| Gypsum  | "            | 32,323  | 77,472 | ..      | 630,020 | 103,929 | ..     | ..      | 843,724       |
| Limestone(j)                                  | '000 tons    | 2,686   | 1,820  | 1,179   | 1,558   | 733     | 496    | ..      | 5,470         |
| Magnesite                                     | tons         | 22,661  | ..     | 319     | 166     | ..      | ..     | ..      | 23,146        |
| Phosphate rock                                | "            | ..      | ..     | ..      | 5,744   | ..      | ..     | ..      | 5,744         |
| Salt, crude                                   | "            | ..      | (j)    | (j)     | 610,827 | (j)     | ..     | ..      | 899,704       |
| Silica (glass, chemical, etc.)(h)             | "            | 282,221 | ..     | 159,776 | 66,024  | 20,560  | 14,099 | ..      | 542,680       |
| Talc  | "            | 2,587   | ..     | ..      | (j)     | (j)     | ..     | ..      | 38,280        |
| <b>CONSTRUCTION MATERIALS(h)</b>              |              |         |        |         |         |         |        |         |               |
| Sand  | '000 tons    | 6,612   | 4,995  | n.a.    | 2,077   | n.a.    | 276    | (k)     | 446 (l)14,406 |
| River gravel                                  | "            | 2,995   | 3,196  | n.a.    | 345     | n.a.    | 1,595  | 209     | (l)8,340      |
| Dimension stone                               | "            | 41      | 7      | 5       | 42      | (j)     | 4      | (j)     | 275           |
| Crushed and broken stone                      | "            | 9,197   | 17,297 | 3,855   | 8,874   | 3,660   | 1,187  | 308     | 44,375        |
| Other (decomposed rock, etc.)                 | "            | 23,348  | 1,970  | 564     | n.a.    | (j)     | 167    | (j)     | (l)26,581     |

(a) Includes cupreous ore for fertiliser. (b) Includes copper precipitate. (c) Bullion, alluvial, retorted gold, etc. (d) Includes leucoxene. (e) Iron oxide for metal extraction. (f) Includes lead-silver-zinc ore. (g) Includes tin-copper concentrate. (h) Incomplete, see Coverage, page 920. (i) Excludes quantities used directly as building or road material. (j) Not available for publication. (k) Includes Australian Capital Territory. (l) Incomplete, see individual States.

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

## QUANTITIES OF PRINCIPAL MINERALS PRODUCED: AUSTRALIA, 1964 TO 1968

| <i>Mineral</i>                                |              | 1964      | 1965      | 1966      | 1967    | 1968    |
|---|--------------|-----------|-----------|-----------|---------|---------|
| <b>METALLIC MINERALS</b>                      |              |           |           |           |         |         |
| Antimony ore and concentrate                  | tons         | 414       | 55        | 150       | 152     | 244     |
| Bauxite . . . . .                             | '000 tons    | 784       | 1,168     | 1,798     | 4,176   | 4,877   |
| Beryllium ore . . . . .                       | tons         | 111       | 38        | 52        | 55      | 15      |
| Bismuth concentrate . . . . .                 | "            | ..        | ..        | 1         | 106     | 1,553   |
| Copper ore(a) . . . . .                       | "            | 59,686    | 41,325    | 53,463    | 31,453  | 39,202  |
| Copper concentrate(b) . . . . .               | "            | 427,522   | 389,697   | 478,710   | 392,679 | 452,100 |
| Gold(c) . . . . .                             | oz.          | 1,150,079 | 1,118,503 | 1,078,587 | 997,793 | 908,286 |
| Ilmenite concentrate(d) . . . . .             | tons         | 304,284   | 441,414   | 513,767   | 544,912 | 553,108 |
| Iron ore and concentrate(e) . . . . .         | '000 tons    | 5,669     | 6,695     | 10,893    | 17,036  | 26,204  |
| Lead ore(f) . . . . .                         | tons         | 25,174    | 24,906    | 19,221    | 18,224  | 51,461  |
| Lead concentrate . . . . .                    | "            | 536,213   | 503,356   | 515,573   | 537,193 | 601,709 |
| Lead-copper concentrate . . . . .             | "            | 10,214    | 10,424    | 12,083    | 12,227  | 12,558  |
| Lead-zinc concentrate . . . . .               | "            | ..        | ..        | 14,254    | 14,685  | 5,373   |
| Manganese ore . . . . .                       | "            | 61,109    | 100,369   | 312,540   | 559,967 | 732,077 |
| Monazite concentrate . . . . .                | "            | 1,981     | 2,305     | 1,984     | 2,313   | 2,055   |
| Nickel concentrate . . . . .                  | "            | ..        | ..        | ..        | 15,753  | 36,880  |
| Pyrite concentrate . . . . .                  | "            | 220,078   | 204,011   | 245,998   | 252,748 | 165,265 |
| Rutile concentrate . . . . .                  | "            | 182,371   | 217,330   | 243,858   | 265,514 | 287,617 |
| Tantalite-columbite concentrate . . . . .     | lb           | 33,600    | 25,581    | 10,550    | 79,587  | 238,134 |
| Tin concentrates(g) . . . . .                 | tons         | 5,314     | 6,237     | 7,604     | 8,557   | 11,297  |
| Tungsten concentrates—                        |              |           |           |           |         |         |
| Scheelite concentrate . . . . .               | "            | 1,020     | 1,150     | 1,308     | 1,202   | 1,465   |
| Wolfram concentrate . . . . .                 | "            | 380       | 487       | 498       | 448     | 559     |
| Xenotime . . . . .                            | "            | ..        | ..        | ..        | 18      | 18      |
| Zinc ore . . . . .                            | "            | ..        | ..        | ..        | ..      | 2,700   |
| Zinc concentrate . . . . .                    | "            | 588,840   | 604,211   | 638,788   | 702,792 | 718,311 |
| Zircon concentrate . . . . .                  | "            | 184,082   | 226,863   | 235,649   | 283,682 | 294,195 |
| <b>FUEL MINERALS</b>                          |              |           |           |           |         |         |
| Coal, black—                                  |              |           |           |           |         |         |
| Semi-anthracite . . . . .                     | '000 tons    | 79        | 70        | 45        | 38      | 31      |
| Bituminous . . . . .                          | "            | 24,477    | 28,228    | 30,045    | 31,299  | 36,665  |
| Sub-bituminous . . . . .                      | "            | 2,845     | 3,140     | 3,243     | 3,370   | 3,488   |
| <i>Total coal, black</i> . . . . .            | "            | 27,401    | 31,439    | 33,334    | 34,707  | 40,183  |
| Coal, brown (lignite) . . . . .               | "            | 19,035    | 20,659    | 21,783    | 23,384  | 22,971  |
| Natural gas . . . . .                         | '000 cu ft   | 106,490   | 143,402   | 143,478   | 152,360 | 215,805 |
| Natural gas condensate . . . . .              | barrels      | 245       | 122       | 121       | ..      | ..      |
| Crude oil . . . . .                           | '000 barrels | 1,244     | 2,622     | 3,390     | 7,600   | 13,877  |
| <b>NON-METALLIC (EXCLUDING FUEL) MINERALS</b> |              |           |           |           |         |         |
| Asbestos . . . . .                            | short tons   | 13,654    | 11,566    | 13,468    | 600     | 897     |
| Barite . . . . .                              | tons         | 12,302    | 11,976    | 13,724    | 15,666  | 39,155  |
| Clays—  |              |           |           |           |         |         |
| Brick clay and shale . . . . .                | '000 tons    | 5,163     | 5,056     | 5,187     | 5,696   | 6,422   |
| Other(h) . . . . .                            | "            | 1,039     | 1,007     | 1,052     | 961     | 1,396   |
| Diatomite . . . . .                           | tons         | 8,732     | 7,063     | 7,592     | 11,103  | 6,725   |
| Dolomite(i) . . . . .                         | "            | 236,068   | 258,661   | 256,008   | 290,659 | 316,731 |
| Felspar . . . . .                             | "            | 9,021     | 8,726     | 7,259     | 4,450   | 4,838   |
| Gypsum . . . . .                              | "            | 795,003   | 833,521   | 801,552   | 914,084 | 843,724 |
| Limestone(i) . . . . .                        | '000 tons    | 7,223     | 7,516     | 7,730     | 8,355   | 8,470   |
| Magnesite . . . . .                           | tons         | 31,250    | 26,362    | 19,556    | 23,653  | 23,146  |
| Phosphate rock . . . . .                      | "            | 5,689     | 4,519     | 5,715     | 11,770  | 5,744   |
| Salt, crude . . . . .                         | "            | 545,491   | 654,533   | 644,817   | 703,157 | 899,704 |
| Silica (glass, chemical, etc.)(h) . . . . .   | "            | 322,269   | 320,937   | 347,123   | 443,555 | 542,680 |
| Talc . . . . .                                | "            | 15,695    | 19,719    | 17,327    | 17,779  | 38,280  |
| <b>CONSTRUCTION MATERIALS(h)</b>              |              |           |           |           |         |         |
| Sand . . . . .                                | '000 tons    | 10,757    | 11,444    | 10,666    | 11,149  | 14,406  |
| River gravel . . . . .                        | "            | 8,117     | 7,760     | 8,549     | 9,048   | 8,340   |
| Dimension stone . . . . .                     | "            | 590       | 467       | 241       | 286     | 275     |
| Crushed and broken stone . . . . .            | "            | 34,175    | 39,733    | 46,796    | 46,268  | 44,375  |
| Other (decomposed rock, etc.) . . . . .       | "            | 23,460    | 21,363    | 22,216    | 25,202  | 26,581  |

(a) Includes cupreous ore for fertiliser. (b) Includes copper precipitate. (c) Bullion, alluvial, retorted gold, etc. (d) Includes leucoxene. (e) Iron oxide for metal extraction. (f) Includes lead-silver-zinc ore. (g) Includes tin-copper concentrate. (h) Incomplete, owing to difficulties of coverage. See Coverage, page 920. (i) Excludes quantities used directly as building or road material.

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

## Contents of metallic minerals produced

The following tables show the contents of metallic minerals produced in 1968 and earlier years.

**CONTENTS OF METALLIC MINERALS PRODUCED  
STATES AND NORTHERN TERRITORY, 1968**

| <i>Content of metallic minerals produced</i>   | <i>N.S.W.</i> | <i>Vic.</i> | <i>Qld</i>    | <i>S.A.</i> | <i>W.A.</i> | <i>Tas.</i> | <i>N.T.</i> | <i>Aust.</i> |
|--|---------------|-------------|---------------|-------------|-------------|-------------|-------------|--------------|
| Alumina (Al <sub>2</sub> O <sub>3</sub> ) . . . . .  | '000 tons     | 5           | 1,905         | ..          | 724         | ..          | ..          | 2,633        |
| Antimony . . . . .   | tons          | 842         | ..            | ..          | ..          | ..          | ..          | 842          |
| Beryllium oxide (BeO) . . . . .  | units(a)      | 25          | ..            | ..          | 153         | ..          | ..          | 178          |
| Bismuth . . . . .  | lb            | ..          | ..            | ..          | ..          | ..          | 403,200     | 403,200      |
| Cadmium . . . . .  | tons          | 1,007       | 261           | ..          | ..          | 74          | 17          | 1,359        |
| Chromic oxide (Cr <sub>2</sub> O <sub>3</sub> ) . . . . .  | ..            | ..          | ..            | ..          | ..          | ..          | ..          | 27           |
| Cobalt . . . . .   | ..            | 113         | ..            | ..          | 121         | ..          | 1           | 235          |
| Copper . . . . .   | ..            | 12,279      | 5 69,447      | 80          | 1,591       | 16,601      | 7,903       | 107,906      |
| Gold . . . . .   | fine oz       | 8,668       | 11,069 82,939 | 38          | 515,949     | 36,509      | 126,610     | 781,782      |
| Iron(b) . . . . .  | '000 tons     | ..          | ..            | 3,643       | 12,157      | 601         | 518         | 16,920       |
| Lead . . . . .   | tons          | 249,488     | 116,679       | 43          | 311         | 14,910      | 1,240       | 382,671      |
| Manganese(c) . . . . .   | ..            | 5,334       | ..            | ..          | 69,398      | 246         | 270,121     | 345,099      |
| Manganese dioxide (MnO <sub>2</sub> )(d) . . . . .   | lb            | ..          | ..            | 16          | ..          | ..          | 118         | 134          |
| Molybdenum disulphide (MoS <sub>2</sub> ) . . . . .  | ..            | 124         | 19,040        | ..          | ..          | ..          | ..          | 19,164       |
| Monazite . . . . .   | tons          | 476         | 243           | ..          | 1,130       | ..          | ..          | 1,849        |
| Nickel . . . . .   | ..            | ..          | ..            | ..          | 4,603       | ..          | ..          | 4,603        |
| Osmiridium . . . . .   | ..            | ..          | ..            | ..          | ..          | 12          | ..          | 12           |
| Silver . . . . .   | '000 fine oz  | 9,521       | 9,624         | 1           | 187         | 1,748       | 312         | 21,394       |
| Sulphur(e) . . . . .   | tons          | 203,231     | 41,961        | 35,837      | 14,433      | 53,071      | 1,457       | 349,990      |
| Tantalite-columbite (Ta <sub>2</sub> O <sub>5</sub> + Nb <sub>2</sub> O <sub>5</sub> ) . . . . . | ..            | ..          | ..            | ..          | 56,179      | ..          | ..          | 56,179       |
| Tin . . . . .  | lb            | ..          | ..            | ..          | 624         | 3,126       | 26          | 6,537        |
| Titanium dioxide (TiO <sub>2</sub> ) . . . . .   | tons          | 1,448       | 64 1,247      | ..          | 296,005     | ..          | ..          | 578,720      |
| Tungstic oxide (WO <sub>3</sub> ) . . . . .  | units(a)      | 190,491     | .. 92,224     | ..          | 34          | 140,107     | 1,768       | 144,552      |
| Xenotime . . . . .   | ..            | 43          | .. 2,600      | ..          | 9,500       | ..          | ..          | 9,500        |
| Zinc . . . . .   | lb            | ..          | ..            | ..          | ..          | ..          | ..          | ..           |
| Zinc . . . . .   | tons          | 280,219     | 84,090        | 810         | ..          | 48,739      | 1,864       | 415,722      |
| Zircon . . . . .   | ..            | 184,431     | 78,986        | ..          | 27,502      | ..          | ..          | 290,919      |

(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 recovered.

NOTE. Particulars of production of uranium oxide (U<sub>3</sub>O<sub>8</sub>) are not available for publication.

**CONTENTS OF METALLIC MINERALS PRODUCED: AUSTRALIA, 1964 TO 1968**

| <i>Content of metallic minerals produced</i>   | <i>1964</i>  | <i>1965</i> | <i>1966</i> | <i>1967</i> | <i>1968</i> |         |
|--|--------------|-------------|-------------|-------------|-------------|---------|
| Alumina (Al <sub>2</sub> O <sub>3</sub> ) . . . . .  | '000 tons    | 396         | 613         | 939         | 2,258       | 2,633   |
| Antimony . . . . .   | tons         | 1,116       | 944         | 971         | 930         | 842     |
| Beryllium oxide (BeO) . . . . .  | units(a)     | 1,279       | 457         | 637         | 675         | 178     |
| Bismuth . . . . .  | lb           | ..          | ..          | 717         | 25,536      | 403,200 |
| Cadmium . . . . .  | tons         | 1,154       | 1,155       | 1,212       | 1,324       | 1,359   |
| Chromic oxide (Cr <sub>2</sub> O <sub>3</sub> ) . . . . .  | ..           | 32          | 10          | ..          | 44          | 27      |
| Cobalt . . . . .   | ..           | 73          | 90          | 84          | 146         | 235     |
| Copper . . . . .   | ..           | 104,050     | 90,388      | 109,537     | 90,361      | 107,906 |
| Gold . . . . .   | fine oz      | 963,834     | 877,643     | 916,985     | 805,336     | 781,782 |
| Iron(b) . . . . .  | '000 tons    | 3,655       | 4,297       | 6,956       | 10,831      | 16,920  |
| Lead . . . . .   | tons         | 374,856     | 362,137     | 364,898     | 375,779     | 382,671 |
| Manganese(c) . . . . .   | ..           | 36,564      | 55,280      | 151,401     | 264,660     | 345,099 |
| Manganese dioxide (MnO <sub>2</sub> )(d) . . . . .   | ..           | 1,033       | 1,652       | 4,091       | 228         | 134     |
| Molybdenum disulphide (MoS <sub>2</sub> ) . . . . .  | lb           | ..          | 41,911      | 5,549       | ..          | 19,164  |
| Monazite . . . . .   | tons         | 1,848       | 2,165       | 1,836       | 2,163       | 1,849   |
| Nickel . . . . .   | ..           | ..          | ..          | ..          | 2,061       | 4,603   |
| Osmiridium . . . . .   | oz           | ..          | ..          | ..          | ..          | 12      |
| Silver . . . . .   | '000 fine oz | 18,427      | 17,281      | 18,888      | 19,842      | 21,394  |
| Sulphur(e) . . . . .   | tons         | 346,502     | 345,554     | 371,567     | 392,371     | 349,990 |
| Tantalite-columbite (Ta <sub>2</sub> O <sub>5</sub> + Nb <sub>2</sub> O <sub>5</sub> ) . . . . . | lb           | 12,499      | 10,281      | 5,698       | 32,906      | 56,179  |
| Tin . . . . .  | tons         | 3,642       | 3,849       | 4,807       | 5,586       | 6,537   |
| Titanium dioxide (TiO <sub>2</sub> ) . . . . .   | ..           | 342,646     | 448,318     | 516,745     | 552,894     | 578,720 |
| Tungstic oxide (WO <sub>3</sub> ) . . . . .  | units(a)     | 99,541      | 117,672     | 130,776     | 119,210     | 144,552 |
| Xenotime . . . . .   | lb           | ..          | ..          | ..          | 9,475       | 9,500   |
| Zinc . . . . .   | tons         | 344,600     | 349,231     | 369,341     | 400,527     | 415,722 |
| Zircon . . . . .   | ..           | 182,174     | 224,654     | 232,903     | 280,324     | 290,919 |

(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 recovered.

NOTE. Particulars of production of uranium oxide (U<sub>3</sub>O<sub>8</sub>) are not available for publication.

# MINE PRODUCTION OF PRINCIPAL METALS: AUSTRALIA

(METALLIC CONTENT OF MINERALS)

1936 TO 1968

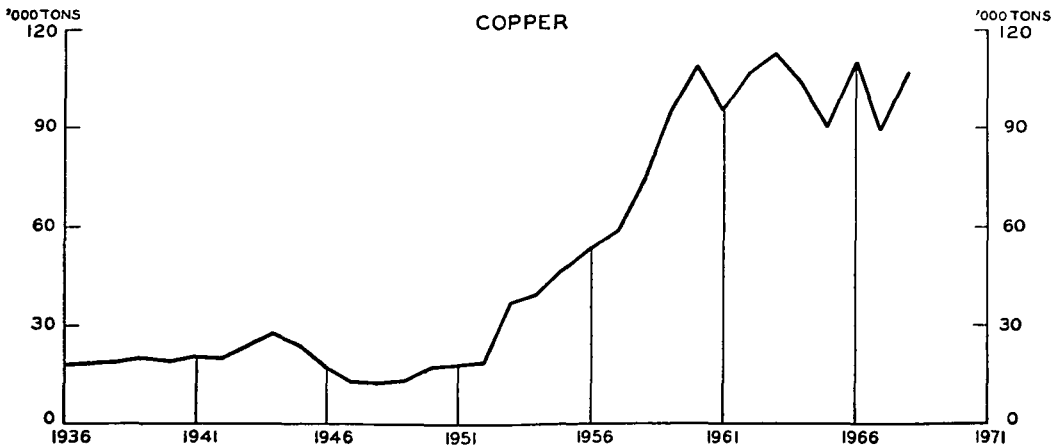
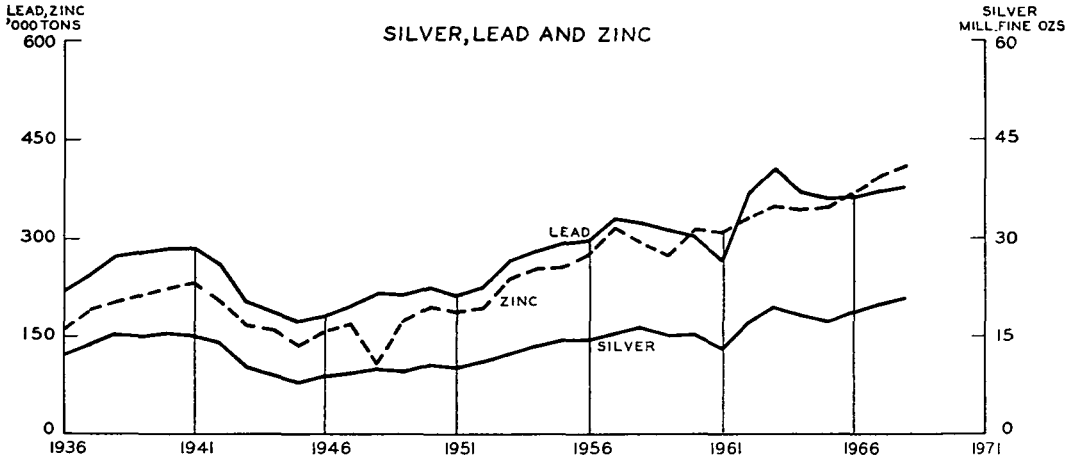
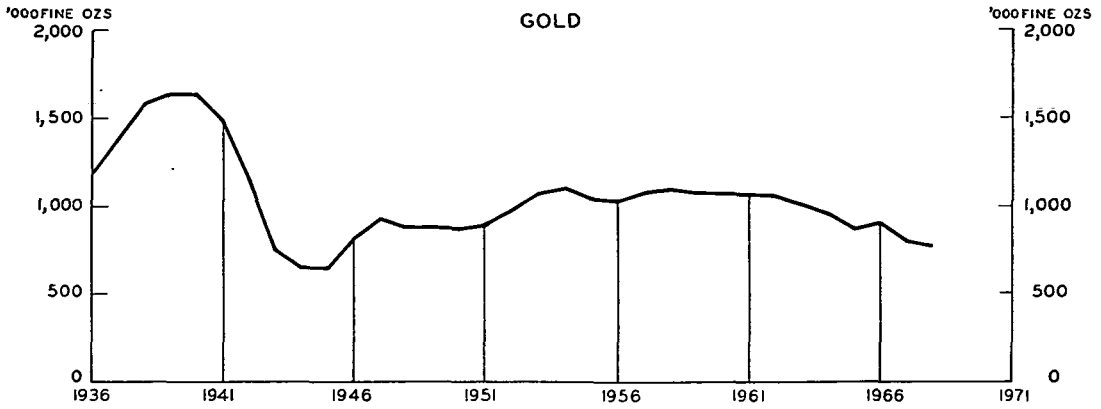
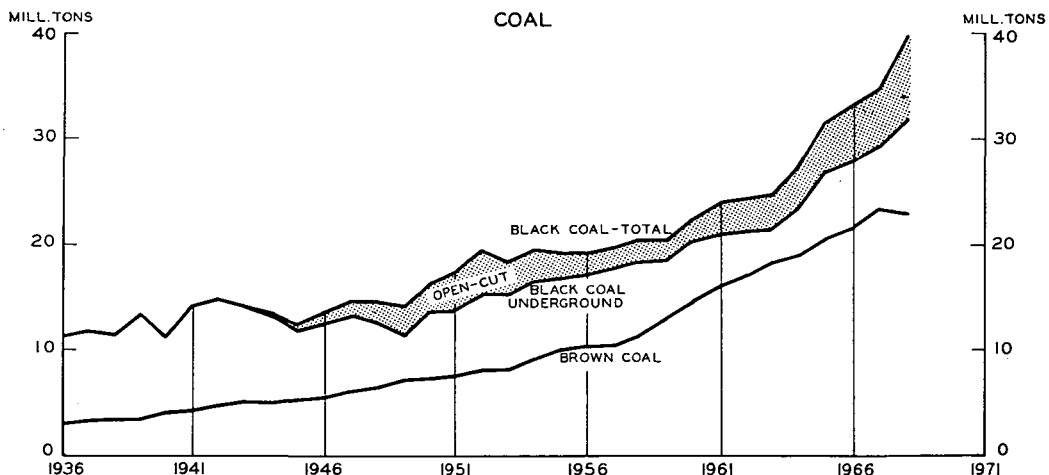
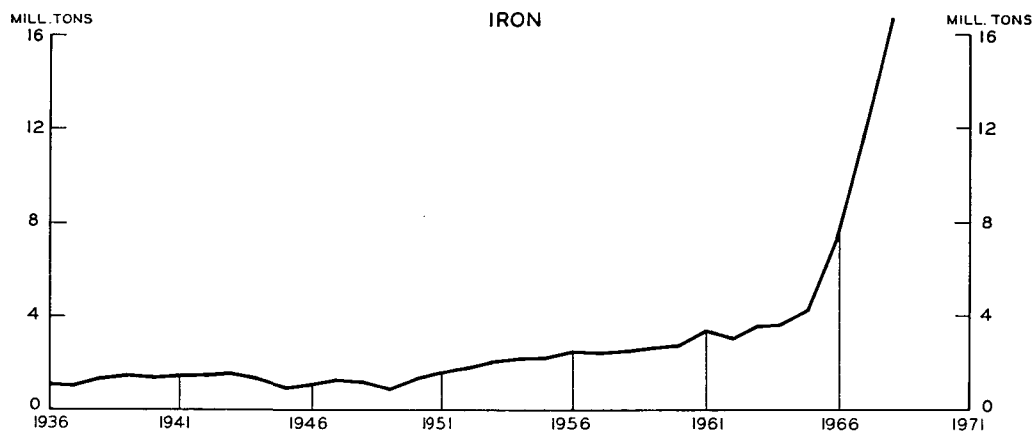
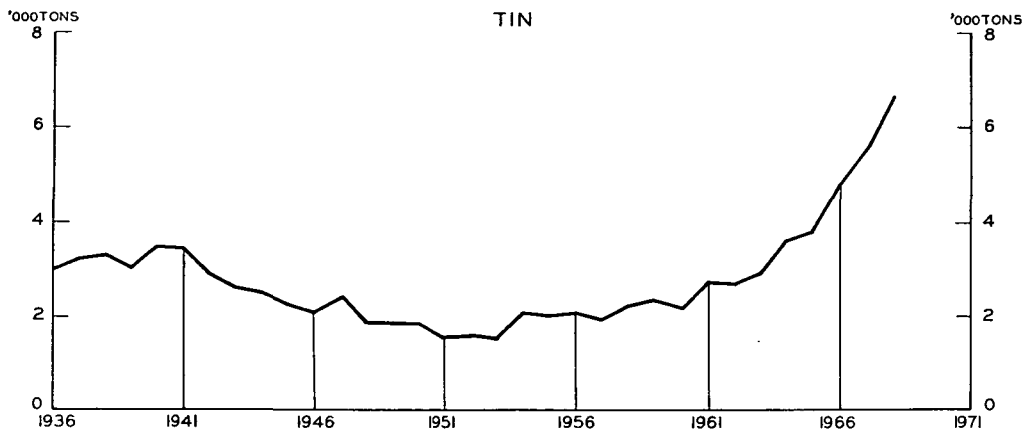


PLATE 48

# MINE PRODUCTION OF PRINCIPAL METALS AND PRODUCTION OF COAL

(METALLIC CONTENT OF MINERALS)

AUSTRALIA, 1936 to 1968



Graphs showing details of the mine production of principal metals (metallic content) and coal from 1936 to 1968 are included on plates 48 and 49, pages 931 and 932.

#### Local value of minerals produced, 1964 to 1968

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.

Due to the fact that the classification of individual mines to industry is on the basis of the principal mineral produced, the values in the table on page 926 for mining industry groups differ slightly in some cases from totals of the corresponding groups of mine products shown in the table below.

#### LOCAL VALUE OF MINERALS PRODUCED: AUSTRALIA, 1964 TO 1968 (\$'000)

| <i>Mineral</i>   | <i>1964</i>    | <i>1965</i>    | <i>1966</i>    | <i>1967</i>    | <i>1968</i>    |
|--|----------------|----------------|----------------|----------------|----------------|
| <b>Metallic minerals—</b>  |                |                |                |                |                |
| Bauxite . . . . .  | 3,064          | 4,600          | (a)            | (a)            | (a)            |
| Copper ore, concentrate, etc. . . . .  | 51,380         | 50,790         | 87,523         | 72,515         | 92,396         |
| Gold ore, concentrate, other forms, etc. . . . .                                   | 26,666         | 25,619         | 26,371         | 24,456         | 23,525         |
| Ilmenite concentrate . . . . .   | 2,208          | 3,755          | 4,242          | 4,390          | 3,746          |
| Iron ore . . . . .   | 12,550         | 14,640         | 41,728         | 82,994         | 131,482        |
| Lead and lead-silver ore and concentrate,<br>lead-copper concentrate, etc. . . . . | 80,806         | 87,947         | 76,831         | 73,654         | 89,705         |
| Manganese ore . . . . .  | 750            | 808            | 3,462          | 8,007          | 8,358          |
| Nickel concentrate . . . . .   | ..             | ..             | ..             | (a)            | (a)            |
| Pyrite concentrate . . . . .   | 3,054          | 3,040          | (a)            | (a)            | 1,842          |
| Rutile concentrate . . . . .   | 12,080         | 15,038         | 17,088         | 19,615         | 21,528         |
| Tin concentrates . . . . .   | 10,224         | 12,237         | 14,332         | 15,011         | 16,691         |
| Tungsten concentrates . . . . .  | 1,420          | 2,692          | 4,469          | 4,509          | 5,514          |
| Zinc ore and concentrate . . . . .   | 35,456         | 36,818         | 32,890         | 29,354         | 30,398         |
| Zircon concentrate . . . . .   | 3,462          | 6,136          | 8,255          | 10,937         | 10,967         |
| Other metallic minerals . . . . .  | 522            | 548            | 610            | 1,251          | 3,354          |
| <i>Total, metallic minerals . . . . .</i>  | <i>243,642</i> | <i>264,668</i> | <i>327,633</i> | <i>370,892</i> | <i>467,347</i> |
| <b>Fuel minerals—</b>  |                |                |                |                |                |
| Coal, black . . . . .  | 128,038        | 143,703        | 151,380        | 160,099        | 188,785        |
| Coal, brown . . . . .  | 17,304         | 18,436         | 20,064         | 20,686         | 21,555         |
| Other fuel minerals . . . . .  | 2,164          | 5,344          | 9,229          | 21,286         | 39,307         |
| <i>Total, fuel minerals . . . . .</i>  | <i>147,506</i> | <i>167,483</i> | <i>180,675</i> | <i>202,071</i> | <i>249,649</i> |
| Non-metallic minerals(b) . . . . .   | 27,814         | 29,244         | 31,921         | 31,946         | 36,928         |
| Construction materials(b) . . . . .  | 73,244         | 80,183         | 83,449         | 91,789         | 96,812         |
| <b>Total, all minerals and construction<br/>materials . . . . .</b>                | <b>492,208</b> | <b>541,578</b> | <b>623,678</b> | <b>696,701</b> | <b>850,736</b> |

(a) Not available for publication. (b) Incomplete owing to difficulties of coverage. See Coverage, page 920.

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

## Overseas participation in Australian mining industry

### Introduction

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

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

#### Scope of the statistics

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

#### Classification of companies

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

- (i) Companies in Australia in which at least 50 per cent of the ordinary shares (or voting stock) is held by individual shareholders or companies resident in one overseas country, or where 25 per cent or more of the ordinary shares (or voting stock) is held by one company, or a group of companies, incorporated in one overseas country.
- (ii) Branches of companies incorporated overseas and registered in Australia as foreign companies.
- (iii) Wholly and partly owned subsidiaries and sub-subsidiaries, etc., of companies included in (i) and (ii) above.

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

#### Further information available

In the following tables the degree of overseas participation is expressed in terms of net value of production only. Further details in terms of the value of power, fuel and materials used, local value of production, value of additions and replacements to fixed assets, salaries and wages paid, and average number of persons employed, as well as the value of production, may be found in the mimeographed bulletin *Overseas Participation in Australian Mining Industry, 1968*. The terms 'net . . .' and 'local value of production' are defined in Chapter 30 Miscellaneous.

### OVERSEAS OWNERSHIP AND CONTROL

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

#### Overseas ownership

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

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



**MINING(a): NET VALUE OF PRODUCTION APPORTIONED TO AUSTRALIAN AND DIRECT OVERSEAS OWNERSHIP, BY INDUSTRY, 1966 TO 1968**

| Industry and ownership                    | Value (\$'000) |                |                | Proportion Australian and overseas (per cent) |              |              |
|---|----------------|----------------|----------------|---|--------------|--------------|
|   | 1966           | 1967           | 1968           | 1966  | 1967         | 1968         |
| <b>Metal mining—</b>                      |                |                |                |   |              |              |
| Australian(b)                             | 144,588        | 149,095        | 187,939        | 53.7  | 50.0         | 49.0         |
| Overseas                                  | 124,622        | 149,013        | 195,907        | 46.3  | 50.0         | 51.0         |
| <b>Fuel mining—</b>                       |                |                |                |   |              |              |
| Australian(b)                             | 109,844        | 118,253        | 134,156        | 76.9  | 74.4         | 67.7         |
| Overseas                                  | 32,918         | 40,593         | 63,966         | 23.1  | 25.6         | 32.3         |
| <b>Non-metal (excluding fuel) mining—</b> |                |                |                |   |              |              |
| Australian(b)                             | 10,830         | 10,870         | 11,767         | 81.1  | 80.4         | 80.0         |
| Overseas                                  | 2,521          | 2,658          | 2,938          | 18.9  | 19.6         | 20.0         |
| <b>Total mining—</b>                      |                |                |                |   |              |              |
| Australian(b)                             | 265,262        | 278,218        | 333,863        | 62.4  | 59.1         | 56.0         |
| Overseas                                  | 160,061        | 192,264        | 262,811        | 37.6  | 40.9         | 44.0         |
| <b>Grand total</b>                        | <b>425,323</b> | <b>470,483</b> | <b>596,674</b> | <b>100.0</b>                                  | <b>100.0</b> | <b>100.0</b> |

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

**MINING(a): NET VALUE OF PRODUCTION APPORTIONED TO DIRECT OVERSEAS OWNERSHIP(b), BY COUNTRY AND BY PROPORTION OF DIRECT OVERSEAS EQUITY, 1966 TO 1968**

| Country, and proportion of direct overseas equity     | Value (\$'000) |                |                | Proportion(c) (per cent) |             |             |
|---|----------------|----------------|----------------|--------------------------|-------------|-------------|
|   | 1966           | 1967           | 1968           | 1966                     | 1967        | 1968        |
| <b>Country—</b>                                       |                |                |                |                          |             |             |
| United Kingdom  | 79,891         | 90,095         | 102,957        | 18.7                     | 19.2        | 17.2        |
| United States of America                              | 64,613         | 87,256         | 142,806        | 15.2                     | 18.5        | 23.9        |
| Other   | 15,557         | 14,913         | 17,048         | 3.7                      | 3.2         | 2.9         |
| <b>Proportion of direct overseas equity—</b>          |                |                |                |                          |             |             |
| 25 per cent but less than 50 per cent                 | 3,094          | 7,527          | 8,303          | 0.7                      | 1.6         | 1.4         |
| 50 per cent but less than 75 per cent                 | 47,901         | 37,642         | 56,836         | 11.3                     | 8.0         | 9.5         |
| 75 per cent and over                                  | 109,066        | 147,095        | 197,672        | 25.6                     | 31.3        | 33.1        |
| <b>Total apportioned to direct overseas ownership</b> | <b>160,061</b> | <b>192,264</b> | <b>262,811</b> | <b>37.6</b>              | <b>40.9</b> | <b>44.0</b> |

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

**Overseas control**

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

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

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

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

**MINING(a): NET VALUE OF PRODUCTION ATTRIBUTED TO DIRECT OVERSEAS AND AUSTRALIAN CONTROL, BY INDUSTRY, 1966 TO 1968**

| Industry and category of control          | Value (\$'000) |                |                | Proportion (per cent) |              |              |
|---|----------------|----------------|----------------|-----------------------|--------------|--------------|
|   | 1966           | 1967           | 1968           | 1966                  | 1967         | 1968         |
| <b>Metal mining—</b>                      |                |                |                |                       |              |              |
| Overseas . . . . .                        | 167,191        | 193,531        | 264,008        | 62.1                  | 64.9         | 68.8         |
| Australian . . . . .                      | 102,019        | 104,577        | 119,839        | 37.9                  | 35.1         | 31.2         |
| <b>Fuel mining—</b>                       |                |                |                |                       |              |              |
| Overseas . . . . .                        | 40,927         | 51,703         | 78,735         | 28.7                  | 32.5         | 39.7         |
| Australian . . . . .                      | 101,835        | 107,143        | 119,387        | 71.3                  | 67.5         | 60.3         |
| <b>Non-metal (excluding fuel) mining—</b> |                |                |                |                       |              |              |
| Overseas . . . . .                        | 3,669          | 3,862          | 4,205          | 27.5                  | 28.5         | 28.6         |
| Australian . . . . .                      | 9,681          | 9,667          | 10,501         | 72.5                  | 71.5         | 71.4         |
| <b>Total mining—</b>                      |                |                |                |                       |              |              |
| Overseas . . . . .                        | 211,788        | 249,096        | 346,947        | 49.8                  | 52.9         | 58.1         |
| Australian . . . . .                      | 213,535        | 221,387        | 249,727        | 50.2                  | 47.1         | 41.9         |
| <b>Grand total . . . . .</b>              | <b>425,323</b> | <b>470,483</b> | <b>596,674</b> | <b>100.0</b>          | <b>100.0</b> | <b>100.0</b> |

(a) Excludes construction material quarrying and clay mining.

**MINING(a): NET VALUE OF PRODUCTION ATTRIBUTED TO DIRECT OVERSEAS CONTROL, BY PROPORTION OF DIRECT OVERSEAS EQUITY, 1966 TO 1968**

| Proportion of direct overseas equity                  | Value (\$'000) |                |                | Proportion(b) (per cent) |             |             |
|---|----------------|----------------|----------------|--------------------------|-------------|-------------|
|   | 1966           | 1967           | 1968           | 1966                     | 1967        | 1968        |
| 25 per cent but less than 50 per cent . . . . .       | 7,948          | 17,492         | 19,217         | 1.9                      | 3.7         | 3.2         |
| 50 per cent but less than 75 per cent . . . . .       | 91,913         | 72,851         | 109,685        | 21.6                     | 15.5        | 18.4        |
| 75 per cent and over . . . . .                        | 111,927        | 158,753        | 218,045        | 26.3                     | 33.7        | 36.5        |
| <b>Total attributed to overseas control . . . . .</b> | <b>211,788</b> | <b>249,096</b> | <b>346,947</b> | <b>49.8</b>              | <b>52.9</b> | <b>58.1</b> |

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

## Mineral exploration (other than for petroleum)

### Definition

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

### Sources of statistics

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

### Scope of mineral exploration census

The scope of the census comprises the following activities.

(a) *Private exploration on production leases*—relates to exploration carried out on the production lease by privately operated mines currently producing or under development for production of minerals other than petroleum. This also includes particulars of exploration within their production leases by business undertakings operated by State government authorities. Mines included in this section of the mineral exploration census are practically the same as those in the annual census of mining and quarrying (see Statistical Bulletin *Mining and Quarrying*, No. 17, 1968 for further details) with the exception of a limited number of itinerant prospectors and small mines for which information was not collected.

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

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

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

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

Prior to 1968 the scope of the census was limited to private exploration on lease or licence areas held for production and exploration purposes, and all Government exploration. The scope was broadened for the 1968 census to include other private exploration activity as described in (c) above.

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

The following table shows expenditure, employment and footage drilled, etc., on mineral exploration other than for petroleum in each State and the Northern Territory during the years 1965 to 1968.

**MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)  
STATES AND NORTHERN TERRITORY, 1965 TO 1968**

| EXPENDITURE(a)<br>(\$'000)                       |               |               |               |               |
|--|---------------|---------------|---------------|---------------|
|  | 1965          | 1966          | 1967          | 1968(b)       |
| <b>PRIVATE EXPLORATION</b>                       |               |               |               |               |
| New South Wales . . . . .                        | 4,460         | 4,872         | 4,594         | 5,620         |
| Victoria . . . . .                               | 1,006         | 1,231         | 1,452         | 1,476         |
| Queensland . . . . .                             | 4,372         | 8,340         | 11,657        | 13,343        |
| South Australia . . . . .                        | 1,048         | 1,358         | 1,203         | 2,661         |
| Western Australia . . . . .                      | 3,948         | 6,534         | 10,203        | 23,148        |
| Tasmania . . . . .                               | 5,136         | 2,870         | 2,180         | 2,059         |
| Northern Territory . . . . .                     | 2,389         | 2,909         | 3,532         | 4,156         |
| <i>Total</i> . . . . .                           | <i>22,360</i> | <i>28,115</i> | <i>34,822</i> | <i>52,463</i> |
| <b>GOVERNMENT EXPLORATION</b>                    |               |               |               |               |
| Commonwealth(c) . . . . .                        | 1,525         | 1,923         | 2,803         | 3,529         |
| State Mines Departments . . . . .                | 1,697         | 1,649         | 1,768         | 2,329         |
| <i>Total</i> . . . . .                           | <i>3,223</i>  | <i>3,572</i>  | <i>4,571</i>  | <i>5,858</i>  |
| <b>TOTAL EXPENDITURE</b>                         |               |               |               |               |
| On drilling . . . . .                            | 10,511        | 13,994        | 15,490        | 20,448        |
| Other . . . . .                                  | 15,071        | 17,693        | 23,903        | 37,873        |
| <b>Australia</b> . . . . .                       | <b>25,582</b> | <b>31,687</b> | <b>39,393</b> | <b>58,321</b> |
| Payments to contractors(d) . . . . .             | 6,372         | 8,380         | 12,181        | 18,506        |
| <b>EMPLOYMENT(e)<br/>('000 man-weeks worked)</b> |               |               |               |               |
|  | 1965          | 1966          | 1967          | 1968          |
| <b>PRIVATE EXPLORATION</b>                       |               |               |               |               |
| New South Wales . . . . .                        | 17.0          | 19.2          | 22.5          | 20.9          |
| Victoria . . . . .                               | 6.7           | 8.3           | 5.6           | 7.0           |
| Queensland . . . . .                             | 26.0          | 35.6          | 27.2          | 33.3          |
| South Australia . . . . .                        | 3.2           | 3.2           | 3.6           | 7.2           |
| Western Australia . . . . .                      | 13.2          | 23.2          | 37.6          | 52.8          |
| Tasmania . . . . .                               | 7.6           | 9.9           | 7.4           | 7.5           |
| Northern Territory . . . . .                     | 10.0          | 8.8           | 8.8           | 11.0          |
| <i>Total</i> . . . . .                           | <i>83.6</i>   | <i>108.2</i>  | <i>112.6</i>  | <i>139.6</i>  |
| <b>GOVERNMENT EXPLORATION</b>                    |               |               |               |               |
| Commonwealth(c) . . . . .                        | 8.3           | 11.1          | 14.2          | 11.9          |
| State Mines Departments . . . . .                | 15.8          | 15.0          | 15.9          | 13.7          |
| <i>Total</i> . . . . .                           | <i>24.1</i>   | <i>26.1</i>   | <i>30.1</i>   | <i>25.5</i>   |
| <b>TOTAL</b>                                     |               |               |               |               |
| By professional persons(f) . . . . .             | 39.7          | 44.0          | 46.7          | 49.9          |
| By non-professional persons(g) . . . . .         | 68.0          | 90.3          | 96.0          | 115.2         |
| <b>Australia</b> . . . . .                       | <b>107.7</b>  | <b>134.3</b>  | <b>142.7</b>  | <b>165.1</b>  |

For footnotes see next page.

MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)  
STATES AND NORTHERN TERRITORY, 1965 TO 1968—*continued*

| FOOTAGE DRILLED, SUNK OR DRIVEN<br>( <sup>'000</sup> ft) |              |              |              |              |
|--|--------------|--------------|--------------|--------------|
|  | 1965         | 1966         | 1967         | 1968(b)      |
| PRIVATE EXPLORATION                                      |              |              |              |              |
| New South Wales . . . . .                                | 767          | 946          | 908          | 1,031        |
| Victoria . . . . .                                       | 172          | 179          | 182          | 128          |
| Queensland . . . . .                                     | 600          | 1,515        | 2,029        | 1,669        |
| South Australia . . . . .                                | 123          | 183          | 161          | 227          |
| Western Australia . . . . .                              | 343          | 640          | 907          | 1,768        |
| Tasmania . . . . .                                       | 188          | 169          | 152          | 149          |
| Northern Territory . . . . .                             | 221          | 248          | 259          | 303          |
| <i>Total</i> . . . . .                                   | <i>2,413</i> | <i>3,880</i> | <i>4,598</i> | <i>5,273</i> |
| GOVERNMENT EXPLORATION                                   |              |              |              |              |
| Commonwealth(c) . . . . .                                | 8            | 6            | 6            | 15           |
| State Mines Departments . . . . .                        | 186          | 194          | 290          | 282          |
| <i>Total</i> . . . . .                                   | <i>194</i>   | <i>200</i>   | <i>296</i>   | <i>297</i>   |
| TOTAL FOOTAGE DRILLED, SUNK OR DRIVEN(h)                 |              |              |              |              |
| Drilled—core . . . . .                                   | 1,139        | 1,645        | 1,727        | 2,003        |
| non-core . . . . .                                       | 1,400        | 2,375        | 3,138        | 3,445        |
| Sunk or driven . . . . .                                 | 68           | 59           | 30           | 122          |
| <i>Australia</i> . . . . .                               | <i>2,607</i> | <i>4,080</i> | <i>4,896</i> | <i>5,570</i> |

(a) Expenditure whether charged as working expenses or capitalised. (b) Includes 'Other private exploration', not collected prior to 1968: see text. (c) Bureau of Mineral Resources and Joint Coal Board. (d) Included in expenditure shown above. Comprises amounts paid to drilling contractors, geological consultants, technical advisers, etc., for exploration services. (e) Operator and staff only (includes time spent on report writing and similar off-site activities associated with exploration); excludes contractors and their employees. (f) Geologists, geophysicists, engineers, etc., engaged on exploration work. (g) Drill operators, field hands, etc. (h) 'Sunk or driven' relates to shafts, winzes, etc., sunk and drives, adits, etc., driven.

**Petroleum exploration**

**Source of statistics**

These statistics were collected and compiled by the Bureau of Mineral Resources, Geology and Geophysics, Canberra. Statistical and other information relating to petroleum exploration is published by the Bureau of Mineral Resources in *The Petroleum Newsletter* (issued quarterly), *The Australian Mineral Industry—Annual Review and Expenditures on Petroleum Exploration and Development*, 1965 (B.M.R. Record No. 1966 (205)).

**Scope**

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

## Operations

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

**EXPENDITURE ON PETROLEUM EXPLORATION BY PRIVATE ENTERPRISE  
AND BY GOVERNMENTS: AUSTRALIA, 1965 TO 1968**  
(\$'000)

|   | 1965          | 1966          | 1967          | 1968          |
|---|---------------|---------------|---------------|---------------|
| <b>PRIVATE SOURCES(a)</b>                                 |               |               |               |               |
| <b>Utilised in—</b>                                       |               |               |               |               |
| New South Wales . . . . .                                 | 3,640         | 1,706         | 1,284         | 1,126         |
| Victoria . . . . .  | 3,796         | 7,007         | 17,557        | 20,403        |
| Queensland . . . . .                                      | 14,883        | 13,670        | 5,116         | 5,392         |
| South Australia . . . . .                                 | 4,559         | 4,059         | 6,257         | 3,261         |
| Western Australia . . . . .                               | 14,245        | 15,267        | 12,047        | 22,118        |
| Tasmania . . . . .  | 829           | 1,293         | 2,424         | 998           |
| Northern Territory . . . . .                              | 6,246         | 6,367         | 6,978         | 6,222         |
| <i>Australia</i> . . . . .                                | <i>48,197</i> | <i>49,369</i> | <i>51,662</i> | <i>59,519</i> |
| <b>GOVERNMENT SOURCES</b>                                 |               |               |               |               |
| <b>Payments under <i>Petroleum Search Subsidy Act</i></b> |               |               |               |               |
| <b>1959-1969—</b>   |               |               |               |               |
| <b>Utilised in—</b>                                       |               |               |               |               |
| New South Wales . . . . .                                 | 633           | 724           | 516           | 474           |
| Victoria . . . . .  | 609           | 640           | 727           | 1,940         |
| Queensland . . . . .                                      | 3,818         | 2,194         | 1,767         | 1,419         |
| South Australia . . . . .                                 | 949           | 769           | 1,058         | 1,407         |
| Western Australia . . . . .                               | 2,487         | 3,355         | 3,441         | 4,027         |
| Tasmania . . . . .  | 107           | 570           | 469           | 497           |
| Northern Territory . . . . .                              | 1,157         | 1,365         | 1,657         | 1,448         |
| <i>Total subsidy payments, Australia</i> . . . . .        | <i>9,759</i>  | <i>9,617</i>  | <i>9,635</i>  | <i>11,212</i> |
| <b>Utilised for—</b>                                      |               |               |               |               |
| Geophysical . . . . .                                     | 5,311         | 4,910         | 4,512         | 3,590         |
| Drilling . . . . .  | 4,448         | 4,707         | 5,123         | 7,622         |
| <b>Other Government sources—</b>                          |               |               |               |               |
| Commonwealth(a) . . . . .                                 | 3,824         | 3,649         | 4,508         | 4,756         |
| State Mines Departments . . . . .                         | 711           | 767           | 466           | 783           |
| <i>Total other sources, Australia</i> . . . . .           | <i>4,535</i>  | <i>4,416</i>  | <i>4,974</i>  | <i>5,539</i>  |
| <i>Total Government sources, Australia</i> . . . . .      | <i>14,294</i> | <i>14,033</i> | <i>14,609</i> | <i>16,751</i> |
| <b>TOTAL FUNDS, PRIVATE AND GOVERNMENT</b>                |               |               |               |               |
| <i>Australia</i> . . . . .                                | <i>62,491</i> | <i>63,402</i> | <i>66,271</i> | <i>76,270</i> |

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

**WELLS AND FOOTAGE DRILLED IN PETROLEUM EXPLORATION  
STATES AND TERRITORIES, 1968(a)**

|  |           | <i>N.S.W.</i> | <i>Vic.</i>    | <i>Qld</i>     | <i>S.A.</i>   | <i>W.A.</i>    | <i>Tas.</i>   | <i>N.T.</i>   | <i>Total</i>     |
|--|-----------|---------------|----------------|----------------|---------------|----------------|---------------|---------------|------------------|
| Wells drilled(b)                           | No.       | 6             | 23             | 51             | 15            | 127            | 2             | 1             | 225              |
| Average total depth of wells drilled       | ft        | 4,765         | 8,626          | 5,501          | 6,167         | 5,832          | 7,166         | 12,843        | 6,135            |
| Wells completed as potential oil producers | No.       | ..            | 5              | 6              | ..            | 53             | ..            | ..            | 64               |
| Wells completed as potential gas producers | "         | ..            | 9              | 6              | 6             | 1              | ..            | ..            | 22               |
| Wells drilled or drilling over 10,000 feet | "         | 1             | 5              | 1              | 1             | 5              | 1             | 1             | 15               |
| Footage drilled—                           |           |               |                |                |               |                |               |               |                  |
| Completed wells                            | ft        | 19,197        | 162,946        | 252,013        | 99,527        | 406,189        | 14,332        | 4,863         | 959,067          |
| Uncompleted holes(c)                       | "         | 2,941         | 5,698          | ..             | ..            | 30,811         | ..            | 20,439        | 59,889           |
| <i>Total footage drilled</i>               | <i>ft</i> | <i>22,138</i> | <i>168,644</i> | <i>252,013</i> | <i>99,527</i> | <i>437,000</i> | <i>14,332</i> | <i>25,302</i> | <i>1,018,956</i> |

(a) With the exception of 'average total depth of wells drilled', these data include particulars for developmental wells.  
 (b) Number of holes which reached total depth during the year. (c) Uncompleted holes means wells suspended or drilling at 31 December 1968.

**WELLS AND FOOTAGE DRILLED IN PETROLEUM EXPLORATION  
STATES AND TERRITORIES TO 31 DECEMBER 1968(a)**

| <i>State or Territory</i> | <i>Cumulative to 31 December 1966</i> |                  | <i>1967</i>  |                  | <i>1968</i>  |                  | <i>Cumulative to 31 December 1968</i> |                  |
|---------------------------|---------------------------------------|------------------|--------------|------------------|--------------|------------------|---------------------------------------|------------------|
|                           | <i>Wells</i>                          | <i>Footage</i>   | <i>Wells</i> | <i>Footage</i>   | <i>Wells</i> | <i>Footage</i>   | <i>Wells</i>                          | <i>Footage</i>   |
| New South Wales           | 99                                    | 366,776          | 9            | 33,022           | 6            | 22,138           | 114                                   | 421,936          |
| Victoria                  | 181                                   | 475,983          | 10           | 81,321           | 23           | 168,644          | 214                                   | 725,948          |
| Queensland                | 581                                   | 2,856,366        | 40           | 215,026          | 51           | 252,013          | 672                                   | 3,323,405        |
| South Australia           | 141                                   | 408,739          | 15           | 112,923          | 15           | 99,527           | 171                                   | 621,189          |
| Western Australia         | 195                                   | 918,892          | 194          | 569,038          | 127          | 437,000          | 516                                   | 1,924,930        |
| Tasmania                  | 23                                    | 28,324           | 5            | 11,881           | 2            | 14,332           | 30                                    | 54,537           |
| Northern Territory        | 37                                    | 173,543          | 1            | 16,730           | 1            | 25,302           | 39                                    | 215,575          |
| <i>Total</i>              | ..                                    | ..               | 274          | 1,039,941        | 225          | 1,018,956        | ..                                    | ..               |
| <b>Cumulative total</b>   | <b>1,257</b>                          | <b>5,228,623</b> | <b>1,531</b> | <b>6,268,564</b> | <b>1,756</b> | <b>7,287,520</b> | <b>1,756</b>                          | <b>7,287,520</b> |

(a) Includes particulars for developmental wells.

### Mineral processing and treatment

The extraction of minerals from ore deposits, as in mining and quarrying, is only part of the wider field of mineral technology. It is only in rare instances that minerals can be used directly in the form in which they are produced by mines, and, much more commonly, minerals must undergo considerable processing and treatment before their full utility and value can be realised. Examples of this processing and treatment are the smelting and refining of metals, the production of coke from coal, the refining of oil, and the treatment of non-metallic minerals as in the production of superphosphate and other chemicals and building materials like bricks and cement. The sectors of the economy which carry out this work are classified for statistical purposes to the manufacturing industry, and particulars relating to those activities which principally involve mineral processing and treatment—i.e. the treatment of non-metalliferous mine and quarry products, the manufacture of mineral oils and chemical fertilisers, the smelting, converting, refining and rolling of iron and steel, the extracting and refining of other metals, and the manufacture of alloys are given in Chapter 22 Manufacturing Industry, pages 714-34.

#### Principal products

The following table shows particulars of the production of certain important manufactured products of mineral origin during the years 1963-64 to 1967-68.

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

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

(a) Excludes secondary metal, with exception of steel ingots. (b) Metallic content. (c) Newly-won gold of Australian origin. (d) Fibrous plaster sheets only.

### Overseas trade

#### Exports and imports

Data of imports and exports of minerals and mineral products have been extracted from the official trade statistics compiled in the Commonwealth Bureau of Census and Statistics. Particulars of the quantities and values (\$ f.o.b. port of shipment) of the principal minerals and mineral products exported from and imported into Australia during the years 1966 to 1968 are shown in the following table.



**EXPORTS AND IMPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS  
AUSTRALIA, 1966 TO 1968**

| Item   | Quantity   |           |           | Value (\$'000 f.o.b.) |         |         |         |
|--|------------|-----------|-----------|-----------------------|---------|---------|---------|
|  | 1966       | 1967      | 1968      | 1966                  | 1967    | 1968    |         |
| <b>EXPORTS(a)</b>  |            |           |           |                       |         |         |         |
| Aluminium and aluminium base alloys(b)—  |            |           |           |                       |         |         |         |
| Unworked shapes . . . . .  | tons       | 16,210    | 10,501    | 5,577                 | 7,050   | 4,926   | 2,745   |
| Rolled, drawn and extruded shapes . . . . .  | "          | 6,470     | 4,835     | 3,985                 | 3,851   | 3,304   | 2,449   |
| Coal . . . . .   | "          | 8,240,920 | 9,250,297 | 12,096,102            | 66,487  | 76,203  | 103,746 |
| Copper—  |            |           |           |                       |         |         |         |
| Ore and concentrate . . . . .  | "          | 47,455    | 44,830    | 36,494                | 9,603   | 9,526   | 8,657   |
| Ingots, pigs (refined) . . . . .   | "          | 7,484     | 9,325     | 16,518                | 9,050   | 8,975   | 16,810  |
| Rolled, drawn and extruded shapes . . . . .  | "          | 11,907    | 7,043     | 7,164                 | 12,896  | 8,102   | 8,381   |
| Gold, refined . . . . .  | fine oz    | 752,782   | 537,922   | 358,761               | 23,583  | 16,942  | 13,118  |
| Iron and steel—  |            |           |           |                       |         |         |         |
| Iron ore . . . . .   | tons       | 2,011,979 | 9,017,084 | 16,134,492            | 16,863  | 75,372  | 139,816 |
| Pig iron . . . . .   | "          | 95,590    | 149,587   | 241,869               | 3,870   | 6,169   | 8,925   |
| Ingots, blooms and slabs . . . . .   | "          | 347,841   | 398,635   | 470,527               | 19,806  | 23,719  | 27,474  |
| Tinplate . . . . .   | "          | 87,945    | 56,252    | 42,576                | 10,651  | 7,452   | 5,359   |
| Scrap . . . . .  | "          | 378,673   | 475,056   | 401,801               | 8,510   | 14,226  | 10,389  |
| Lead—  |            |           |           |                       |         |         |         |
| Ore and concentrate . . . . .  | "          | 109,134   | 124,106   | 121,122               | 19,386  | 23,166  | 23,636  |
| Lead-silver bullion . . . . .  | "          | 79,534    | 100,394   | 107,325               | 21,905  | 26,901  | 34,457  |
| Pig . . . . .  | "          | 159,504   | 147,558   | 137,542               | 37,786  | 30,282  | 28,419  |
| Opals . . . . .  | "          | ..        | ..        | ..                    | 7,652   | 8,635   | 10,653  |
| Petroleum oils—  |            |           |           |                       |         |         |         |
| Gasolines and solvents . . . . .   | '000 gal   | 39,734    | 55,593    | 90,814                | 4,842   | 6,582   | 10,075  |
| Kerosenes . . . . .  | "          | 23,686    | 21,655    | 31,815                | 2,535   | 2,553   | 3,720   |
| Automotive distillate industrial and marine diesel fuels and heavy distillate, n.e.i. . . . .  | "          | 91,881    | 62,964    | 62,677                | 7,287   | 5,310   | 5,467   |
| Residual oils . . . . .  | "          | 117,694   | 123,441   | 98,553                | 5,954   | 5,851   | 6,291   |
| Lubricating oil . . . . .  | "          | 17,654    | 28,664    | 21,703                | 5,557   | 8,577   | 6,707   |
| Rutile concentrate . . . . .   | tons       | 231,289   | 258,791   | 284,995               | 17,844  | 19,692  | 21,865  |
| Zinc—  |            |           |           |                       |         |         |         |
| Ore and concentrate . . . . .  | "          | 226,561   | 297,927   | 312,643               | 15,442  | 19,873  | 21,164  |
| Refinery type shapes . . . . .   | "          | 120,759   | 96,471    | 97,177                | 31,069  | 23,562  | 22,597  |
| Zircon concentrate . . . . .   | "          | 210,428   | 247,179   | 266,121               | 8,978   | 10,720  | 11,013  |
| <b>IMPORTS</b>   |            |           |           |                       |         |         |         |
| Alumina . . . . .  | tons       | 51,091    | 37,047    | 2,964                 | 3,365   | 2,543   | 551     |
| Aluminium, refined ingots . . . . .  | "          | 461       | 361       | 11,975                | 351     | 232     | 5,822   |
| Asbestos . . . . .   | short tons | 55,152    | 52,584    | 66,741                | 6,437   | 6,435   | 8,318   |
| Gold, unrefined bullion(c) . . . . .   | fine oz    | 128,099   | 128,127   | 122,758               | 4,003   | 4,019   | 4,133   |
| Ferro-alloys . . . . .   | tons       | 20,019    | 23,491    | 23,418                | 4,496   | 6,689   | 6,401   |
| Petroleum oils—  |            |           |           |                       |         |         |         |
| Crude . . . . .  | '000 gal   | 3,653,396 | 4,038,853 | 4,202,570             | 160,139 | 167,008 | 169,892 |
| Enriched crude and other refinery feedstock . . . . .  | "          | 962,162   | 999,338   | 956,716               | 41,783  | 43,976  | 43,100  |
| Gasolines and solvents . . . . .   | "          | 190,718   | 141,888   | 158,605               | 20,936  | 13,949  | 15,379  |
| Kerosene . . . . .   | "          | 47,143    | 33,563    | 29,118                | 4,973   | 3,515   | 3,146   |
| Automotive distillate, industrial and marine diesel fuels and heavy distillate, n.e.i. . . . . | "          | 43,084    | 18,370    | 44,250                | 3,505   | 1,578   | 3,610   |
| Residual oils . . . . .  | "          | 10,116    | 23,973    | 32,249                | 536     | 1,149   | 1,522   |
| Lubricating oil . . . . .  | "          | 13,009    | 11,363    | 12,121                | 3,864   | 3,565   | 3,664   |
| Phosphate rock . . . . .   | '000 tons  | 3,286     | 3,265     | 3,431                 | 27,479  | 30,355  | 34,140  |
| Sulphur . . . . .  | tons       | 434,045   | 513,962   | 548,563               | 11,930  | 17,296  | 21,632  |
| Tin, refined . . . . .   | "          | 203       | 693       | 159                   | 661     | 2,066   | 448     |
| Titanium oxide (pigments) . . . . .  | "          | 1,349     | 1,110     | 1,527                 | 525     | 449     | 604     |

(a) Australian produce. (b) In addition to refined aluminium significant quantities of alumina and bauxite are exported, but details are not available for publication. (c) Gold content.

Considerable quantities of metallic ores, concentrates, slags, and residues are exported from Australia for refining overseas. The following table shows the quantities of selected items exported during 1968 and their principal metallic content as estimated by assay.

**PRINCIPAL METALLIC CONTENTS OF SELECTED ORES AND CONCENTRATES  
ETC., EXPORTED FROM AUSTRALIA, 1968**

| Ores and concentrates, etc.   | Metallic contents—estimated from assay |                |                |              |                   |                |              |               |                |                 |
|-------------------------------|--|----------------|----------------|--------------|-------------------|----------------|--------------|---------------|----------------|-----------------|
|                               | Copper                                 | Lead           | Zinc           | Tin          | Tungstic<br>oxide | Man-<br>ganese | Bis-<br>muth | Iron          | Gold           | Silver          |
|                               | tons                                   | tons           | tons           | tons         | tons              | tons           | tons         | '000<br>tons  | fine oz        | '000<br>fine oz |
| Copper concentrate(a)         | 8,682                                  | ..             | ..             | ..           | ..                | ..             | ..           | ..            | 15,490         | 104             |
| Blister copper                | 7,040                                  | ..             | ..             | ..           | ..                | ..             | ..           | ..            | 62,785         | 31              |
| Copper matte, slags, etc.(b)  | 3,382                                  | 5,589          | ..             | 54           | ..                | ..             | ..           | ..            | 57             | 422             |
| Lead concentrate              | 1,631                                  | 83,633         | 6,833          | ..           | ..                | ..             | ..           | ..            | 28,899         | 2,735           |
| Lead-silver bullion           | ..                                     | 106,547        | ..             | ..           | ..                | ..             | ..           | ..            | ..             | 7,674           |
| Lead slags and residues       | 231                                    | 1,474          | 2              | 74           | ..                | ..             | ..           | ..            | ..             | 7               |
| Zinc concentrate              | ..                                     | 2,071          | 165,506        | ..           | ..                | ..             | ..           | ..            | ..             | 298             |
| Zinc slags and residues       | 11                                     | 82             | 4,978          | 3            | ..                | ..             | ..           | ..            | ..             | ..              |
| Tin concentrate               | 7                                      | 1              | ..             | 3,001        | ..                | ..             | ..           | ..            | ..             | ..              |
| Wolfram concentrate           | ..                                     | ..             | ..             | 3            | 347               | ..             | ..           | ..            | ..             | ..              |
| Scheelite concentrate         | ..                                     | ..             | ..             | ..           | 975               | ..             | ..           | ..            | ..             | ..              |
| Iron ore                      | ..                                     | ..             | ..             | ..           | ..                | ..             | ..           | 10,475        | ..             | ..              |
| Manganese ore                 | ..                                     | ..             | ..             | ..           | ..                | 251,035        | ..           | ..            | ..             | ..              |
| Bismuth concentrate           | 44                                     | ..             | ..             | ..           | ..                | ..             | 39           | ..            | 7,894          | 1               |
| <b>Total metallic content</b> | <b>21,028</b>                          | <b>199,397</b> | <b>177,319</b> | <b>3,135</b> | <b>1,322</b>      | <b>251,035</b> | <b>39</b>    | <b>10,475</b> | <b>115,125</b> | <b>11,272</b>   |

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

#### Direction of trade

The distribution of Australia's mineral exports according to principal destinations, and imports according to principal sources, for the years 1966 to 1968, are shown in the following table.

**VALUE OF OVERSEAS MINERAL TRADE, BY COUNTRY OR REGION  
AUSTRALIA(a), 1966 TO 1968**

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

| Country or region   | Value (\$m f.o.b.) |              |              | Percentage   |              |              |
|---|--------------------|--------------|--------------|--------------|--------------|--------------|
|   | 1966               | 1967         | 1968         | 1966         | 1967         | 1968         |
| <b>EXPORTS</b>  |                    |              |              |              |              |              |
| Japan   | 130.0              | 213.8        | 305.9        | 38.3         | 47.8         | 48.6         |
| Other Asian and Pacific   | 41.4               | 51.2         | 48.8         | 12.2         | 11.5         | 7.8          |
| United Kingdom  | 65.3               | 63.5         | 100.4        | 19.2         | 14.2         | 16.0         |
| European Economic Community   | 38.7               | 39.7         | 61.0         | 11.4         | 8.9          | 9.7          |
| United States   | 48.2               | 53.9         | 88.8         | 14.2         | 12.0         | 14.1         |
| Other   | 15.8               | 24.9         | 23.9         | 4.7          | 5.6          | 3.8          |
| <b>Total</b>  | <b>339.4</b>       | <b>447.0</b> | <b>628.8</b> | <b>100.0</b> | <b>100.0</b> | <b>100.0</b> |
| <b>IMPORTS</b>  |                    |              |              |              |              |              |
| Middle East   | 139.3              | 143.3        | 137.8        | 50.2         | 47.1         | 42.8         |
| Indonesia   | 51.1               | 52.4         | 55.1         | 18.6         | 17.2         | 17.1         |
| Other Asian   | 16.9               | 23.0         | 24.7         | 6.1          | 7.6          | 7.7          |
| Pacific   | 19.9               | 23.1         | 29.3         | 7.2          | 7.6          | 9.1          |
| United States   | 16.0               | 19.7         | 17.5         | 5.8          | 6.5          | 5.4          |
| Canada  | 12.2               | 14.3         | 23.8         | 4.4          | 4.7          | 7.4          |
| Europe (including United Kingdom<br>and European Economic Com-<br>munity) | 8.5                | 12.7         | 14.7         | 3.1          | 4.2          | 4.6          |
| Other   | 12.7               | 15.5         | 18.8         | 4.6          | 5.1          | 5.9          |
| <b>Total</b>  | <b>276.6</b>       | <b>304.0</b> | <b>321.7</b> | <b>100.0</b> | <b>100.0</b> | <b>100.0</b> |

(a) Excludes gold movements.

## REVIEW OF RECENT DEVELOPMENTS IN THE AUSTRALIAN MINERAL INDUSTRY

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

Expansion of the Australian mineral industry was maintained during 1969, with the preliminary value of mineral production increasing by 29 per cent from \$855 million in 1968 to \$1,100 million in 1969. The major reasons for this increase in the value of mineral production were continued expansion of iron ore mining, and the increased production of black coal in New South Wales and Queensland. The total value of mineral exports continued to increase, mainly because of the increase of iron ore and coal shipments to Japan.

### Bauxite

The history of the aluminium industry and recent significant developments in the industry were reviewed in previous issues of the Year Book (No. 51, page 1168 and No. 52, page 1048). The year 1969 was a period of continued growth in the industry both in mining and processing as detailed below.

Bauxite production from deposits at Weipa, Queensland, increased to a rate of 6 million tons in 1968 following completion of a further stage in the development of the mine and associated township, and of ore treatment and loading facilities. It is expected that production will rise to 7 million tons in 1970. Approximately 2.3 million tons from Weipa will be used by the Gladstone, Queensland, alumina refinery, and the requirements of the small refinery at Bell Bay, Tasmania, is estimated as 120,000 tons yearly; the remaining production will be available for export.

Bauxite deposits at Gove, Northern Territory, covering reserves of the order of 250 million tons of ore, are being developed by a consortium of seven Australian and one overseas company. The consortium plans to construct an alumina plant at Gove by mid-1972 with an initial capacity of 500,000 metric tons per annum, increasing to 1,000,000 metric tons annually by mid-1974.

An agreement was signed in Perth in December 1968 with the Western Australian Government for the development of a bauxite/alumina project in the Admiralty Gulf area.

### Alumina

Expansion of the alumina refinery at Gladstone, Queensland, was completed by the end of 1968, increasing the capacity of the refinery to 900,000 tons per annum; the plant will be further expanded to 1,275,000 tons yearly by mid-1971 and to 2,000,000 tons per annum by mid-1972. Plans have also been announced to increase the capacity of the alumina refinery at Kwinana, Western Australia, from 830,000 metric tons per annum to 1,040,000 metric tons by the middle of 1970, and to 1,250,000 metric tons per annum by the end of that year. Bauxite supplies for the Kwinana refinery are obtained from deposits 28 miles away at Jarrahdale, Western Australia, the reserves of which are assessed as 500 million tons.

### Aluminium

Construction of an aluminium smelter with an initial capacity of 30,000 tons per annum at Kurri Kurri near Newcastle, New South Wales, was completed in 1969. Operating capacity is expected to reach 50,000 tons yearly in the latter half of 1970, and the smelter will be expanded to 100,000 tons following the signing of an agreement with Kobe Steel Ltd for the supply of aluminium ingots. An aluminium powder and paste plant, capable of supplying the whole of Australia's needs, was commissioned in 1968 at Bell Bay, Tasmania. The capacity of the smelter at Bell Bay will be increased to 94,000 tons per annum by early 1971. Additional capacity at Port Henry, Victoria, was commissioned in 1969 bringing the smelter's total operating capacity to 90,000 tons yearly. A letter of intent has been received by the Western Australian Government regarding the possible establishment of an aluminium smelter at Kwinana in ten to twelve years.

### Copper

Copper production at Mount Isa will be increased to 150,000 tons yearly by 1974. The expansion programme provides for a new hoisting shaft, extensions to the existing copper smelter and a new concentrator, as well as enlargement of ancillary facilities.

A new copper-gold ore body is being developed near Tennant Creek, Northern Territory. The first stage of development, which will cost \$10 million, will have an installed mining capacity of 400,000 tons of ore per annum. Production is scheduled to commence in 1970-71.

Since the beginning of 1967 the Australian Producers' price has been adjusted regularly to reflect movements in the London Metal Exchange daily settlement price. In the early part of 1970, after reaching a record 73 cents per pound (\$1,685.2 per long ton) in March, the Australian price eased to 61 cents (\$1,366.4) by mid-June.

### Iron

The major development of recent years has been the establishment in Australia of a large scale iron ore export industry based principally on steelmaking requirements in Japan. Exports of iron ore and iron ore pellets in 1969 to Japan and elsewhere were 26.4 million tons valued at \$230 million.

Additional major contracts for the supply of iron ore and iron ore pellets to overseas steel mills were signed in 1969. In mid-1970 contracts signed for the shipment of ore overseas during 1966 to 1992 exceeded 820 million tons valued at \$6,400 million.

At Mount Tom Price, Western Australia, iron ore production capacity is to be expanded from a 1970 level of 17.5 million tons per year to a level of 22.5 million tons per year by the end of 1971. At Paraburdoo, 35 miles south of Mount Tom Price, iron ore deposits are to be developed so that the mine will be capable of producing 5 million tons of ore per year by 1972 and 15 million tons per year by 1974. Port capacity at Dampier, Western Australia, is to be expanded to handle the increased ore production from Mount Tom Price and the new production from Paraburdoo.

Shipments of iron ore from Mount Newman, Western Australia, commenced through Port Hedland in April 1969. Shipments of 12.5 million tons are planned for 1970 and capacity is being further increased to enable ore to be mined and shipped at a rate of 19 million tons per year by April 1971; capacity is expected to exceed 30 million tons per year by 1975.

Annual production from the Mount Goldsworthy, Western Australia, iron ore project is being increased to 6 million tons by 1970 and 8 million tons by 1973. Production at the existing Mount Goldsworthy mine will be increased and deposits at Shay Gap and Kennedy Gap nearby will be developed.

Firm plans are in hand for the construction at Dampier, Western Australia, of a plant to produce metallised agglomerates. Early in 1970 it was announced that letters of intent had been signed for the purchase by Japanese buyers of 6.5 million tons of agglomerates. Delivery is proposed over 10 years from April 1973.

### Lead and zinc

Due to the completion of an expansion programme at Mount Isa, Queensland, the Australian production of lead bullion rose 32 per cent and zinc concentrates 20 per cent in 1969. Production of zinc metal set a new record due to the installation of a new zinc fuming plant at Port Pirie, where metal is recovered from lead slags. It is expected that zinc will also be extracted from the residue dump at Risdon by mid-1971. Plans have been announced for the development of a new mine near Mount Isa, and the expansion of the mine at Rosebery in Tasmania. Major increases in exports of lead and zinc, both metal and concentrates, are therefore expected in the early 1970's.

### Black coal

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

The expansion of the export trade has been of major significance. In 1955 exports were about 200,000 tons valued at about \$1.7 million; in 1969 exports were 15.8 million tons valued at \$142.5 million. These increased exports have been almost wholly to Japan for use in the iron and steel industry. As a result of this increased demand, new mines have been opened and others are under development in Queensland and New South Wales, and many established mines are being expanded. Exploration for coal has been stimulated and further rich deposits of coking coal have been located, particularly in Queensland.

### **Petroleum**

Developments in the last few years were reviewed in previous issues of the Year Book and the following is a summary of developments in 1969 and early 1970.

At the end of 1969, there were five Australian oil fields in production, namely, Moonie and Alton, Queensland; Barrow Island, Western Australia; and Barracouta and Halibut in the Gippsland Shelf area offshore from Victoria. Another major field, Kingfish also in the Gippsland Shelf area, was ready to start developmental drilling in July 1970. In addition, a small amount of oil is being produced from Bennett No. 1 and several other wells in the Roma area in Queensland. In 1969 commercial and domestic use of natural gas began in Brisbane, Melbourne and Adelaide.

In 1969 and early 1970, additional gas discoveries were made at Tirrawarra No. 1, about 25 miles north of Gidgealpa in South Australia, at Roseneath No. 1 in the far south-west of Queensland, at Palm Valley No. 2 and Petrel No. 1 in the Northern Territory, at Pelican No. 1 off the north coast of Tasmania and most recently an undisclosed amount of hydrocarbons in Emperor No. 1 in the Gippsland Shelf area. The provisional figure for footage drilled in petroleum exploration and development in Australia in 1969 was 1,342,274 feet which is a record; the previous highest figure was 1,141,174 feet in 1965. About 701,800 feet (52 per cent) of the 1969 total was attributed to exploration drilling and about 365,900 feet (27 per cent) was for offshore drilling. A preliminary result shows that 260 wells were completed in 1969 of which 101 were exploration wells.

### **Nickel**

Output from Australia's first major nickel mining operation at Kambalda in Western Australia has grown to more than 25,000 tons of nickel per annum since mining commenced in 1967. Mines at Nepean and Scotia also commenced production in early 1969 and a fourth mine is being developed at Carr Boyd Rocks; all of these mines are located in the vicinity of Kambalda. By late 1970 a refinery at Kwinana, Western Australia, will be producing more than 15,000 tons of nickel metal per annum from concentrates; the remaining concentrates will be exported until further smelting and refining facilities are constructed.

Plans have been drawn for the development of the lateritic nickel deposit at Greenvale in Northern Queensland. Subject to the success of current pilot plant tests, construction of a railway and an ammonia leach treatment plant at Townsville, northern Queensland, is expected to commence in mid-1971. Production of 23,000 tons of nickel oxide sinter per annum could commence during 1974.

### **Phosphate**

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

