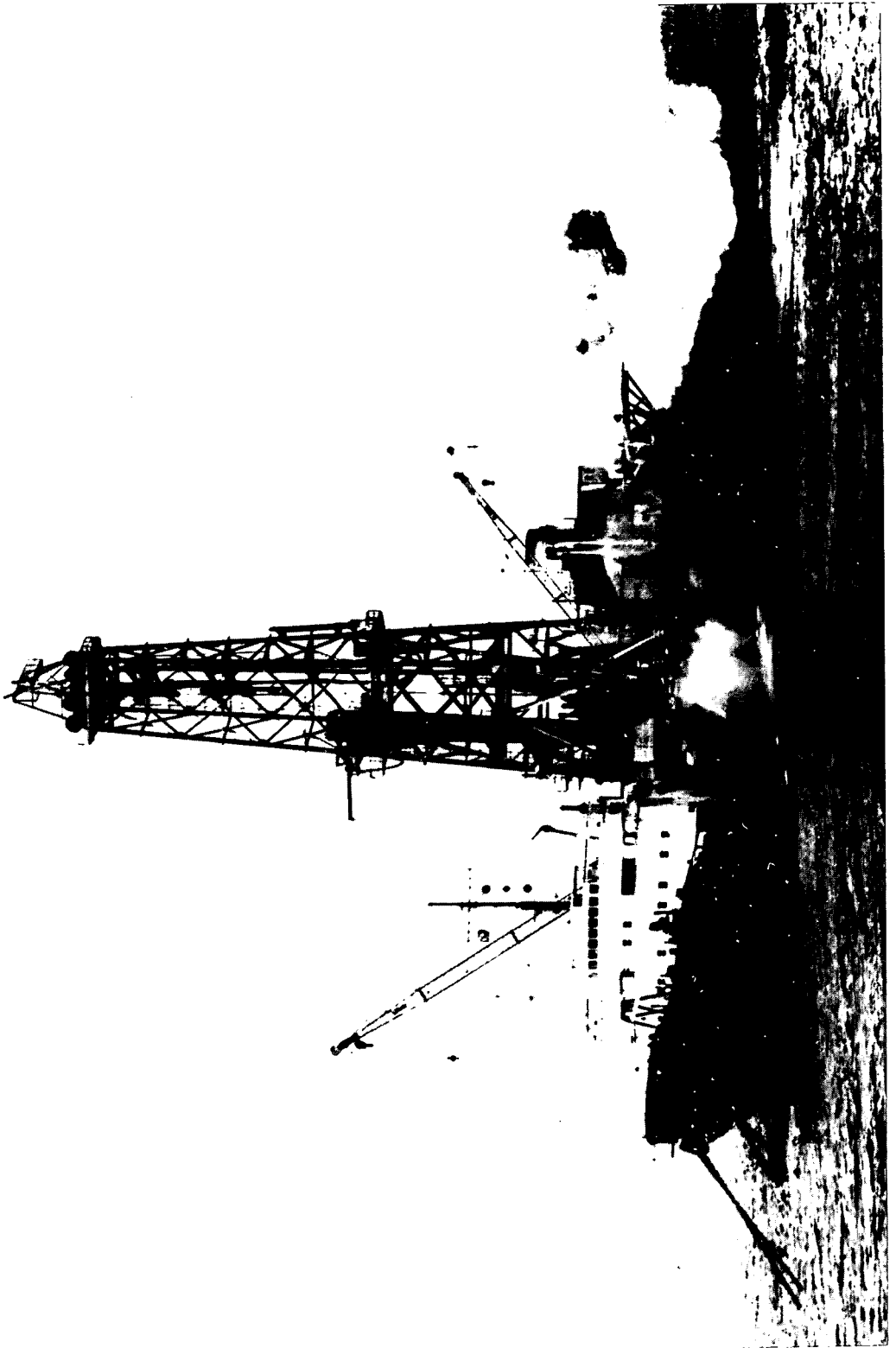


CHAPTER 16

MINERAL INDUSTRY



CHAPTER 16

MINERAL INDUSTRY

GENERAL

Geology and mineral resources

General geology

Most of the western and central part of the Australian continent consists of basement rocks of Precambrian age. Younger Palaeozoic rocks, mostly of geosynclinal origin, form a discontinuous 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: one of Precambrian rocks in the west and central areas of the continent; and one of younger Palaeozoic rocks in the east.

Mineral resources

Australia is self-sufficient in most minerals of economic importance (and much more than self-sufficient in some). Known adequate reserves of minerals with production sufficient for domestic demand and exports include aluminium (bauxite), black coal, copper, gold, iron ore, lead, natural gas, nickel, salt, silver, tin, tungsten and zinc. Adequate reserves sufficient for domestic demand include clays (except light grade china clay), brown coal, dolomite and felspar.

For further details of principal Australian mineral deposits, and notes on principal mineral resources, *see* Year Book No. 61, pages 925-932.

Administration

All mineral rights in Australia are vested in the Crown except those on land which was granted before the Crown began to reserve mineral rights. In practice, these private mineral rights are important only in the New South Wales coalfields. In the States, these rights are held by the State Governments and in the Territories of the Commonwealth they 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 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 different in detail. They all make provision for a miner's right to prospect and for small mining leases for mineral production. The principles embodied 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 negotiations 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). Mining legislation enacted in recent years is simpler and more suited to modern conditions.

Control of mineral 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.

As a result of the introduction of large-scale modern prospecting methods (particularly airborne 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 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 (usually 50 per cent) as a result of work done during the life of the initial agreement. It does not give the holder any rights over, or authority 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 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 title:

- (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.

Off-shore. The *Sea and Submerged Lands Act* 1973 asserted Commonwealth sovereignty over the territorial sea and continental shelf. However, for the purpose of administering petroleum exploration in off-shore areas, complementary legislation was passed by the Commonwealth Government and each State Government in 1967 and the arrangements under this legislation are still applied. Thus 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. Each State Government administers the Act in relation to its adjacent off-shore area, but refers certain matters to the Commonwealth Government. The Commonwealth Government has the administrative responsibility for the area adjacent to the Northern Territory. However, after 1 October 1978, certain administrative changes may be necessary in respect to the Designated Authority, but these changes will not affect the general administration of the Act.

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 Commonwealth Governments on a 60 : 40 basis; however, overriding royalty is payable to the State under certain conditions.

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 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 following table.

MINERAL ROYALTY RECEIPTS: GOVERNMENTS
(S'000)

	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
New South Wales(a)	9,592	13,496	37,864	32,660	46,354	49,062
Victoria(b)	18,025	23,922	26,657	29,893	32,696	48,446
Queensland(a)	3,525	4,319	34,867	36,753	50,842	53,651
South Australia	1,807	1,944	2,500	2,788	3,346	4,109
Western Australia	27,666	33,615	39,385	43,111	51,638	54,519
Tasmania	498	506	342	576	1,496	2,093
Northern Territory(c)	910	242	99	545	362	277
Commonwealth Government(d)	7,896	10,786	12,155	13,440	13,805	23,002
Total	69,921	88,831	153,869	159,766	200,539	235,159

(a) Includes royalty on sand and gravel from Crown lands. (b) Includes royalty on brown coal paid by State Electricity Commission. (c) Excludes Aboriginal Benefits Trust Fund royalties from mining operations for which details are not available. (d) Includes royalties received under the *Petroleum (Submerged Lands) (Royalty) Act 1967*.

Control of Exports

The Commonwealth Government has constitutional power over exports from Australia. Under the Customs (Prohibited Exports) Regulations exports of certain raw or semi processed minerals are prohibited unless permission is granted by the Minister for Trade and Resources or an authorised person.

The fundamental objectives of the controls are:

- (i) to protect the national interest and ensure fair and reasonable market prices are achieved;
- (ii) to ensure adequate supplies are available to domestic industry;
- (iii) to meet international and strategic obligations.

Export controls are administered on coal, iron ore, bauxite, alumina, petroleum and petroleum products, copper, tin, uranium and other materials of atomic significance; salt, and mineral sands. With regard to mineral sands, approvals to export are freely issued except where the Commonwealth considers there are environmental reasons which would make such exports undesirable.

Ores, concentrates, oxides, etc. of nickel, lead, zinc, manganese, tungsten, scheelite, wolfram and bismuth are subject to blanket approvals. All other minerals were removed from control on 12 June 1979.

Joint Coal Board

The Joint Coal Board was established in 1946 under joint legislation of the Commonwealth Government 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. In summary, the Board's functions are:

- (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.

Queensland Coal Board

The Queensland Coal Board has functions similar to those of the Joint Coal Board. It also carries out research and sampling tests of Queensland coals. It makes funds available to colliery proprietors for equipment and makes grants and/or loans for the provision of amenities for employees and for communities in coal mining districts. The price fixing of coal sold within Queensland is another important function.

Australian Atomic Energy Commission

For details of the functions of the Australian Atomic Energy Commission see Chapter 18, Energy.

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 on the following pages.

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 (BMR) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Income taxation concessions. Income derived from mining principally for gold in Australia 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.

Special deductions for capital expenditure incurred in the discovery and mining of petroleum (including natural gas) are allowable to a petroleum mining enterprise engaged in these operations in Australia. Capital expenditure allowable to petroleum mining enterprises includes, broadly, the costs of exploratory surveys, drilling and well-head plant; plant for the liquefaction of natural gas; and of access roads and expenditure on housing and welfare. The enterprise is entitled to these special deductions against income from any source. While the special deductions for exploration expenditure are deductible immediately against the net income of the enterprise, the deductions for capital expenditure on development are allowable over the life of the oil or gas field or over five years, whichever is less on a reducing balance basis.

An enterprise 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 enterprise, other than costs of exploration, may be deducted against income from any source over the life of the mine, or over five years, whichever is the less. Expenditure incurred by a mining enterprise in exploring for general minerals is allowable as an immediate deduction against net income derived from mining operations. Annual deductions for depreciation on petroleum mining plant or general mining plant may be allowed in lieu of spreading the cost over the life of the oil field or mine. The cost of exploration plant may also be deducted under the depreciation provisions of the law. The investment allowance scheme may permit a deduction at the rate of 40 per cent of the cost of certain new plant in its initial phase, or at 20 per cent in its second phase.

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, pipeline or similar transport facility and on certain port facilities or other facilities for ships. Allowable expenditure on transport facilities is deductible in equal annual instalments over a period of ten or twenty years at the option of the mining enterprise.

An income tax rebate of 30 cents for each dollar of share capital subscribed after 24 August 1977 is available to shareholders of petroleum mining companies exploring or mining for petroleum in off-shore areas of Australia where those companies lodge appropriate declarations with the Commissioner of Taxation in respect of the moneys subscribed. By lodging those declarations, certifying that the capital subscriptions have been, or will be, spent on eligible outgoings within a specified period, the petroleum mining companies forgo deductions to which they might otherwise be entitled for capital expenditure incurred in off-shore operations after 24 August 1977.

Petroleum search subsidy. The petroleum search subsidy scheme, introduced in 1957, was terminated on 30 June 1974. For details see Year Book No. 61, pages 936-7.

Pricing of Australian crude oil. In August 1977, the Commonwealth Government announced new arrangements in the pricing, allocating, and levying arrangements of crude oil. These will take the price of indigenous crude oil from presently known fields in the direction of import parity. This will be achieved through a uniform method of price determination. The new scheme, which took effect from 17 August 1977, applies to each known field in Australia.

Producers receive the import parity price for a specified part of their production. Import parity is received for either the first 6 million barrels of oil produced from each field per annum, or for a proportion of production per annum which will be increased over time according to a specified schedule, whichever is the greater in any particular case. The schedule is 10 per cent from 17 August 1977 until the end of the 1977-78 financial year, rising to 20 per cent for the financial year 1978-79, 35 per cent for 1979-80 and 50 per cent for 1980-81. The phasing-in will then continue only for fields producing

less than 15 million barrels per annum. For all additional production from each field or new development, the producers receive the price which was current up to the time of the introduction of the new arrangements, i.e. \$2.33 per barrel in the case of the Bass Strait fields, and \$2.88 per barrel in the case of the Barrow Island field. All production from the Moonie and Alton fields and other small fields will, in practice, receive import parity prices, as the output from those fields is well below 6 million barrels per annum.

The Government will review the position before June 1981 to decide the rate at which the further progression to full import parity should take place for presently known fields. Oil from fields discovered after 14 September 1975 will continue to receive full import parity.

The import parity price will be set every six months by the Commonwealth Government and will be calculated on the basis of the price of Arabian light oil at the nearest refinery port, adjusted to allow for an appropriate quality differential. This differential will take account of the suitability of indigenous crude oil for the local market. For the period after 1 July 1979, the import parity price is set at \$18.66 per barrel for Bass Strait crude oil, \$18.84 for Barrow Island crude, and \$19.71 for Moonie crude delivered to Westernport, Kwinana, and Brisbane/Roma respectively.

Payments to producers of phosphate fertilisers. The *Phosphate Fertilisers Bounty Act 1963* provides for a bounty to be paid on phosphatic substances produced and sold in Australia as a fertiliser. Phosphatic substances used as a supplement to stock food are also regarded as being used as a fertiliser. Bounty is payable at the rate of \$12 per tonne in respect of superphosphate where the available phosphorus content is not less than 8.5 per cent or more than 8.9 per cent by weight. Outside this range, bounty is payable at \$138 per tonne of the available phosphorus content of the substance. The intention of the Act is to assist consumers of phosphate fertilisers (primary producers). The Act expires on 30 June 1982.

Bureau of Mineral Resources, Geology and Geophysics. The functions of the BMR are as follows:

- (i) as a primary function, to obtain, study, publish and provide basic geological and geophysical information necessary for the exploration and development of the nation's mineral resources (this is to be done, where appropriate, in co-operation with State and Territorial authorities);
- (ii) to undertake experimental studies and research into geology and geophysics in order to support the function of obtaining basic information;
- (iii) to make basic investigations of the earth's magnetic and gravitational fields and in seismology and volcanology;
- (iv) to complement the work of the State and Territorial authorities by undertaking geological and geophysical investigations into the occurrence and distribution of underground water;
- (v) to undertake geological and geophysical investigations on behalf of other Commonwealth Government Departments and authorities including the provision of resident staff by arrangement with the Territories;
- (vi) to obtain basic information on, and review the mineral resources of Australia and its Territories; to study the various sectors of the mineral industry both in the national and international spheres; and to publish and provide information about the mineral industry;
- (vii) to undertake such investigations in mining engineering and petroleum technology as are relevant to (i) and (vi) above;
- (viii) to prepare advice for Government on the mineral industry, including the exploration and development of mineral resources in the national interest;
- (ix) when directed by Government, to administer schemes for the assistance of sectors of the mineral industry and to undertake special mineral projects.

The BMR comprises five branches under the Director: Operations, Mineral Resources, Geological, Geophysical, and Petroleum Exploration. The Operations Branch consists of five sections: Planning and Co-ordination, Publications and Information, Automatic Data Processing Applications, Cartography and Administrative. It carries out central office functions, including planning and control of program, assessment of results, co-ordination of activities, liaison, distribution of information and provision of ADP and cartographic services. The Mineral Resources Branch comprises the sections Mineral Economics and Mining Engineering and is concerned largely with those aspects of the BMR's work which involve studies of the mineral industry as a whole, including the assessment of Australia's mineral resources 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 BMR and the operation of observatories. The Petroleum Exploration Branch is concerned with the technical administration of the *Petroleum (Submerged Lands) Act 1967*, the assessment of sedimentary basins in Australia and its Territories, and monitors the level of petroleum exploration, development, and production activity and associated economic factors. At 30 June 1979,

501 officers were employed at the BMR, this included 225 professional officers (geologists, geophysicists, chemists, engineers and mineral economists).

The BMR maintains laboratories in Canberra engaged on geochemical, geochronological and petroleum technological studies and basic research into the design and testing of geophysical equipment. It also maintains geophysical observatories at Kowen Forest (Australian Capital Territory), Mundaring (Western Australia), Mawson (Antarctica), and Macquarie Island. The geophysical observatories are engaged in geomagnetic, ionospheric, and seismology 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 generally give a free technical service to the mining industry.

New South Wales. The Department of Mineral Resources and Development renders scientific, technical and financial assistance to the mining industry. Grants are made to cover up to half the cost of prospecting and drilling operations. These grants are repayable if sufficient payable minerals are discovered or if certain other conditions are met. A quantity of equipment is also available for hire in several localities. The Department has itself undertaken a program of contract drilling to investigate the existence of mineral deposits in the State (including the testing and proving of coal resources). Expenditure on exploration and prospecting in 1977-78 amounted to \$687,644, including \$303,530 on grants and \$369,384 on the Department's own drilling program.

Victoria. The Department of Minerals and Energy comprises the following Divisions:— Administration, Energy, Geological Survey, Hazardous Materials, Oil and Gas, Mining. These divisions conduct geological and mineral surveys and produce geological maps, and issues scientific and technical reports thereon. Rotary, percussion and auger drilling operations are carried out and the results used in sedimentary basin studies and to evaluate petroleum, mineral and groundwater potential. A comprehensive library and a geological museum are maintained, and a core library retains cores and cuttings from drilling operations. The administration of petroleum, pipeline, mining and extractive industry legislation by the various Divisions of the Department ensures that petroleum exploration and production (both on-shore and off-shore), mining and quarrying are carried on in a safe and effective manner. Technical assistance and limited loans and grants are available for mineral exploration and prospecting and for approved development operations. Five stamp batteries located throughout the State provide an ore crushing service to enable test crushings to be made at nominal cost. Information is available on mining law and mineral statistics. Assays of ores, analytical services, advice on metallurgical treatments, industrial pollution and chemical problems are available, together with information on the manufacture, handling and use of explosives and inflammable liquids. Financial assistance is available to municipalities to reclaim mine-damaged land in areas where a reclamation committee recommends such action.

Queensland. The Department of Mines provides assistance to mining by way of geological services, grants for construction and maintenance of roads in mining areas, repayable advances or subsidies for mine development, hiring and equipment, and assistance to prospectors. The Department maintains a concentration plant for tin ores at Irvinebank, an assay office at Cloncurry and diamond drilling plants in various parts of the State. The Queensland Coal Board carries out research and sampling tests of Queensland coals. It also makes funds available to colliery proprietors for equipment and makes grants and/or loans for the provision of amenities for employees and for communities in coal mining districts.

South Australia. The Department of Mines and Energy provides the following services and facilities to the mineral industry in South Australia: geological surveys, geophysical surveys; geological maps and publications, mineral analyses and identification, analyses of underground water, mineral research, regulation and control of mining operations, regulation and control of petroleum operations, mines and allied works inspections, data storage and retrieval, minerals production statistics and royalty assessment, energy resource assessment, development and application.

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 fifteen 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 and lead ores to State batteries for treatment. Provision is made for loans to mine-owners who require assistance to develop mines.

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. Other assistance is rendered to the industry through geological and engineering advice, 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 Department of Mines and Energy operates two batteries for the treatment of ores for miners. The Tennant Creek Battery is treating parcels of gold ore, while the Mount Wells Battery is crushing parcels of gold, tin, lead, copper and wolfram ore. Experimental work on more complex ores is carried out in Darwin. The crushing charges are subsidised by the Government. Mining plant such as drills, compressors, pumps, and small hoists are available for hire to prospectors. Financial assistance is available to prospectors for mine development such as shaft sinking, driving, rising or winzing, and for cartage subsidies. Roads and water supply services are provided and maintained for mines under active development throughout the Northern Territory.

The Northern Territory Geological Survey undertakes geological and geophysical investigations including engineering geology projects, and is also available to assist with the evaluation of individual mineral occurrences for prospectors and exploration companies. Technical libraries and collections of drill cores and cuttings are maintained in Darwin, Alice Springs and Tennant Creek.

Research

Research investigations into problems of exploration, mining, ore-dressing and metallurgy are conducted by Government bodies, by universities, by private enterprise, and by combined efforts of these bodies. A summary of their functions follows. (For further information on research *see* Chapter 25, Science and Technology).

Australian Atomic Energy Commission

For a more detailed description of the activities of the Australian Atomic Energy Commission *see* Chapter 18, Energy.

The Australian Mineral Development Laboratories

Technical consulting, contract research and process design 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, petrology, chemical metallurgy and mineral engineering, process instrumentation and control, water and waste water treatment and materials technology. Both long and short term applied research is carried out and all investigations are conducted on a strictly confidential basis. Services in the field of pollution and environmental control are also available through the Amdel group, Amdel (Aspect).

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 416).

Much of the biological research has involved studies on the biology and biochemistry associated with mineralisation processes. The expertise gained is applied to *in situ* examinations of sulphide mineralisation in carbonate-rich sediments. On the geological side, research is co-ordinated with the field programs of the Bureau of Mineral Resources, and includes studies on the McArthur and Georgina Basins and the Adelaide Geosyncline.

Bureau of Mineral Resources, Geology and Geophysics

The Bureau of Mineral Resources is the largest geoscience research organisation in Australia. Its fundamental role is to obtain, study and publish information on the geological framework and mineral resources of the Australian continent, its Territories and offshore areas, as a basis for management and policy formulation at the national level, and for assistance to mineral exploration and development. The main effort is in field research supported and complemented by laboratory and office studies. The BMR's activities include:

- geological, geophysical, and geochemical surveys to provide the basic information for further studies;

- compilation, review, and synthesis of information on and detailed investigations of sedimentary basins and metallogenic provinces, leading to an understanding of their origin and history, and to assessment of their prospectiveness and resources;
- studies of specific commodities, including research into the occurrence and origin of their deposits, assessment of potential for new discoveries, resource inventories, and market trends;
- engineering geology, urban geology and hydrogeological investigations;
- maintenance of seismological and magnetic observatories, and related studies;
- assessment of geophysical techniques in Australian conditions and development of new techniques and equipment;
- fundamental geoscience research with an orientation to the activities listed above; and
- provision and dissemination of the results of BMR's work and information on the geosciences generally.

For details of the functions of the Bureau of Mineral Resources, Geology and Geophysics, *see* page 413.

Commonwealth Scientific and Industrial Research Organization

Mineral research by the Commonwealth Scientific and Industrial Research Organization (CSIRO) is undertaken mainly within the Institute of Earth Resources with the objective of contributing to the location, extraction and processing of minerals through development of procedures which are efficient and economic and involve safe working practices which do not impose irreparable damage on the environment. The Divisions and independent units of CSIRO that comprise the Institute of Earth Resources are the Division of Applied Geomechanics at Syndal (Vic.), the fuel Geoscience Unit at North Ryde (N.S.W.) the Division of Land Resources Management at Perth (W.A.); Division of Land Use Research at Canberra (A.C.T.), the Division of Mineral Chemistry at Clayton (Vic.), the Division of Mineralogy at Perth (W.A.) and North Ryde (N.S.W.), the Division of Mineral Physics at North Ryde (N.S.W.) and Port Melbourne (Vic.), the Physical Technology Unit at Chatswood (N.S.W.); the Division of Process Technology at North Ryde (N.S.W.) and the Division of Soils at Adelaide (S.A.).

Department of National Development and Energy

The National Coal Research Advisory Committee, established in December 1964, no longer exists as such but has been incorporated into the Energy Research and Development Division of the Department of National Development and Energy. For details of this Division's functions and those of the National Energy Advisory Committee (NEAC) which advises the Minister for National Development and Energy on matters relating to national energy policy *see* Chapter 18, Energy and Chapter 25, Science and Technology, respectively.

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

Many of the large companies in the mineral industry conduct their own research in dealing with their particular Company's interests. In 1959 the major companies in the industry, formed the Australian Mineral Industries Research Association Limited to co-ordinate and manage sophisticated research programmes on a co-operative basis, carried out by the Australian Mineral Development Laboratories, CSIRO, Universities and by research groups.

Since then, the research activity has grown considerably in magnitude and currently involves many of the seventy five companies which comprise the Company, Associate and Division members within the Association.

Fields of research cover geology, ore genesis and exploration techniques, mining and rock mechanics, mineral processing, ecology, energy, analytical methods and miscellaneous other items and the expenditure in these fields in 1978-79 was approximately \$1,100,000.

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, Third and Fourth International Tin Agreements, which came into force on 21 February 1962, 21 March 1967 and 1 July 1971 respectively. Details of the Second and Third Agreements are given in Year Book No. 57, pages 911–12. Details of the Fourth Agreement are given in Year Book No. 61, page 942.

Australia has signed and ratified the Fifth International Tin Agreement which came into operation on 1 July 1976 for a period of 5 years. Australia joined the Fourth and Fifth Agreements as a 'producing' (i.e. exporting) member, whereas in the first three agreements Australia's status had been that of a 'consuming' (i.e. importing) member.

The objectives and provisions of the present Agreement are essentially the same as for its predecessors. The International Tin Agreement establishes floor and ceiling prices for tin and, by the medium of a buffer stock and remedial trading, aims at confining the prices within these limits. Producing countries are required to contribute to a buffer-stock equivalent in cash or tin up to 20,000 tonnes of tin metal, which is used to buffer short-term fluctuations in the world price market. In addition, consuming countries may also make contributions in either cash or tin metal up to the equivalent of 20,000 tonnes of tin metal. In the event of persistent market disequilibrium through causes beyond the control of the buffer stock mechanism, the agreement also provides for the regulation of exports and stocks to stabilise the market.

The International Tin Agreement is operated by the International Tin Council, which is made up of the following governments: *Producers*—Australia, Bolivia, Indonesia, Malaysia, Nigeria, Thailand, Zaire; *Consumers*—Austria, Belgium-Luxembourg, Bulgaria, Canada, Czechoslovakia, Denmark, France, Germany (Federal Republic of), Hungary, India, Ireland (Republic of), Italy, Japan, Netherlands, Norway, Poland, Romania, Spain, Turkey, United Kingdom, United States of America, Union of Soviet Socialist Republics and Yugoslavia. 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 quantities consumed. The allocation of votes in each category is periodically reviewed.

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, Germany (Federal Republic of), Hungary, India, Ireland (Republic of), Italy, Japan, Mexico, Morocco, Netherlands, Norway, Peru, Poland, South Africa (Republic of), Spain, Sweden, Tunisia, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland, United States of America, Yugoslavia and 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.

Association of Iron Ore Exporting Countries (APEF)

Australia is a founder member of the Association of Iron Ore Exporting Countries (APEF). Other members include Algeria, India, Liberia, Mauritania, Peru, Sierra Leone, Sweden and Venezuela.

The objectives of the Association are to promote close co-operation among Member countries with a view to safeguarding their interests in relation to the iron ore export industry; to ensure the orderly and healthy growth of export trade in iron ore; to assist Member countries to secure fair and remunerative returns from the exploitation, processing and marketing of iron ore with a view to improving their export earnings and terms of trade; to contribute to the economic and social development of Member countries and, in particular, to encourage further processing of iron ore in Member countries including into iron and steel; and to provide a forum for the exchange of information and effective and meaningful consultations on problems relating to the iron ore export industry with a view to enabling Member countries to take appropriate action.

Although meetings of the Association have been mainly concerned with administrative matters, it has been agreed that the Secretariat's work programme should give priority to the preparation of statistical material. The Association has also discussed the attitudes of APEF members to iron ore matters raised under the UNCTAD Integrated Programme on Commodities.

Intergovernmental Council of Copper Exporting Countries (CIPEC)

The CIPEC was established in 1967 by the Governments of Chile, Peru, Zaire and Zambia as an intergovernmental consultative organisation.

Australia and Papua-New Guinea were admitted as Associate Members and Indonesia as a Full Member in 1975; Yugoslavia was admitted as an Associate Member in 1977. Associate Members may participate in meetings but have no voting rights and are not bound by CIPEC's decisions.

The key objectives of CIPEC are to co-ordinate measures to achieve continuous growth in real earnings from copper exports and to harmonise the decisions and policies of members relating to copper production and marketing.

International Bauxite Association

Australia joined the International Bauxite Association (IBA) as a founder member in October 1974. Other members are Dominican Republic, Ghana, Guinea, Guyana, Haiti, Indonesia, Jamaica, Sierra Leone, Surinam and Yugoslavia. Members account for about three-quarters of world bauxite production with Australia accounting for over one quarter of world production.

The objectives of the Association are to promote the orderly and rational development of the bauxite industry; to secure for members fair and reasonable returns from the exploration, processing and marketing of bauxite and its products for the economic and social development of their peoples, bearing in mind the recognised interests of consumers; and generally to safeguard the interests of member countries in relation to the bauxite industry.

The Association consists of a Council of Ministers which meets once a year and is the supreme organ, an Executive Board consisting of senior officials which meets three times a year and a Secretariat which is located in Kingston, Jamaica.

The IBA provides members with an opportunity to discuss common problems and evolve co-operative policies to facilitate further development of their bauxite/alumina/aluminium industries. To date the Association's work has been mostly concerned with exchanging views and information on a range of industry matters. The commercial and technical aspects of formulating minimum export prices for bauxite and alumina has received particular attention. In December 1978 the Council adopted recommendations on minimum CIF prices for bauxite and alumina. Australia was not included in the majority that voted for the recommendations and is not bound by them. The Association publishes a Quarterly Review and a bi-monthly newsletter.

MINERAL INDUSTRY STATISTICS

Statistics in the following pages refer mainly to the mining industry, mineral production, mineral exploration, mineral processing and treatment, and overseas trade.

Mining industry statistics

This section contains statistics of the mining industry in Australia obtained from the annual census of mining establishments. Commencing with the year ended June 1969, the annual mining census has been conducted throughout Australia on an integrated basis with other economic censuses, e.g. the annual census of manufacturing establishments, the periodic censuses of electricity and gas establishments and the retail and wholesale trade establishments censuses; it is therefore on a different basis to those of earlier years.

Statistics are also available for *enterprises* engaged in the mining industry. The latest statistics for mining are in respect of 1968-69 and were published in *Enterprise Statistics: Details by Industry Class, Australia, 1968-69* (8103.0). Enterprise statistics for mining will be produced annually commencing with data for 1977-78 and should be available within two years of the end of the financial year to which they relate.

Further information regarding these differences and mining industry statistics for years prior to 1968-69 is contained in Year Book No. 57, and earlier issues.

The following table shows key items of data for establishments in Australia for 1977-78 based on the 1978 edition of the *Australian Standard Industrial Classification* (ASIC). The 1978 edition of the classification replaces the 1969 preliminary edition which has been in use since the 1968-69 census. However, in order to provide a link between past and future series, 1977-78 data are shown in the publication *Census of Mining Establishments, Details of Operations by Industry Class, Australia* (8402.0) according to both editions of ASIC.

A document fully describing the differences between the 1969 and 1978 editions of the ASIC is available on request.

MINING ESTABLISHMENTS: SUMMARY OF OPERATIONS BY INDUSTRY CLASS, 1977-78 (BASED ON 1978 EDITION OF ASIC)

1978 ASIC code	Industry Description	Establish- ments at 30 June	Average employment over whole year(a)			Wages and salaries (b)		Stocks		Total pur- chases, transfers in and selected expenses	Value added	Rent and leasing expenses	Fixed capital expendi- ture less disposals
			Males	Females	Persons	\$'000	\$'000	Opening	Closing				
		No.	No.	No.	No.	\$'000	\$'000	\$'000	\$'000	\$'000	\$'000	\$'000	\$'000
	Metallic minerals—												
	Ferrous metal ores—												
1111	Iron ores	23	6,511	817	7,328	123,039	959,143	95,896	105,155	413,744	554,658	3,712	214,481
1112	Iron ore pelleising	4	1,279	85	1,364	22,386	197,013	27,222	23,014	169,189	23,616	562	1,075
	Non-ferrous metal ores—												
1121	Bauxite	6	1,750	177	1,927	27,294	n.p.	15,587	16,567	n.p.	146,681	1,102	33,008
1122	Copper ores	11	4,200	229	4,429	61,028	166,347	19,525	18,241	71,186	93,876	611	8,742
1123	Gold ores	31	1,231	77	1,308	17,104	91,812	9,932	11,779	26,645	67,014	105	11,815
1124	Mineral sands	21	2,062	139	2,201	27,588	118,244	44,086	37,483	52,385	59,256	2,004	13,989
1125	Nickel ores	8	2,679	213	2,892	44,423	193,766	15,643	11,203	62,628	126,697	884	67,653
1126	Silver-lead-zinc ores	8	6,215	290	6,505	97,858	380,352	62,128	72,720	83,275	307,670	713	74,118
1127	Tin ores	38	1,393	96	1,489	17,157	104,309	5,405	7,392	28,034	78,262	469	8,795
1128	Uranium ores	1											
1129	Non-ferrous metal ores n.e.c.	15	1,685	179	1,864	23,986	n.p.	23,482	28,852	n.p.	99,837	207	23,457
11	Total metallic minerals	166	29,005	2,302	31,307	461,863	2,533,217	318,906	332,405	989,148	1,557,567	10,369	457,133
	Coal, oil and gas—												
1201	Black coal	115	23,019	494	23,513	407,830	1,944,717	168,680	199,127	630,894	1,344,270	9,583	193,080
1202	Brown coal	4	2,985	102	3,087	44,514	795,250	35,199	42,047	82,973	719,125	1,681	108,085
1300	Oil and gas	10											
	Construction materials—												
1401	Sand and gravel	305	1,383	113	1,496	16,673	105,951	6,927	7,475	44,702	61,797	3,536	4,258
1404	Construction materials n.e.c.	421	3,849	321	4,170	48,997	238,136	22,674	26,325	101,167	140,619	7,351	23,158
14	Total construction materials	726	5,232	434	5,666	65,670	344,087	29,602	33,800	145,869	202,416	10,888	27,416
	Other non-metallic minerals—												
1501	Limestone	50	690	12	702	8,486	36,784	2,020	2,535	16,188	21,111	704	3,572
1502	Clays	139	244	20	264	2,561	17,026	2,373	2,302	9,787	7,168	203	790
1504	Salt	24	723	69	792	9,902	36,753	8,026	10,419	13,650	25,497	445	6,898
1505	Non-metallic minerals n.e.c.	118	1,144	82	1,226	12,580	68,975	13,946	16,034	43,229	27,834	2,750	7,004
15	Total other non-metallic minerals	331	2,801	183	2,984	33,530	159,537	26,364	31,290	82,853	81,609	4,102	18,264
	Total mining (excl. services to mining)	1,352	63,042	3,515	66,557	1,013,407	5,776,807	578,752	638,668	1,931,737	3,904,987	36,622	803,978

(a) Includes working proprietors.

(b) Excludes amounts drawn by working proprietors.

Mining accidents

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. A table setting out mining accidents by States is shown below.

MINING ACCIDENTS(a)

	Metal mining		Fuel mining		Construction material quarrying(b)		Non-metal (excluding fuel) mining		Total mining and quarrying	
	Number of casualties		Number of casualties		Number of casualties		Number of casualties		Number of casualties	
	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured
1977-78—										
New South Wales	1	189	6	80	3	7	1	10	11	286
Victoria	-	-	-	35	1	39	-	1	1	75
Queensland	(d)3	(d)166	(d)1	(d)222	(d)2	(d)13	-	(d)14	(d)6	(d)415
South Australia	1	33	-	18	-	18	4	11	5	80
Western Australia	3	422	-	90	-	10	-	18	3	540
Tasmania	1	171	-	5	-	1	-	1	1	178
Northern Territory	1	33	-	-	-	-	-	-	1	33
Australian Capital Territory	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Australia(b)(c)	10	1,014	7	450	6	88	5	55	28	1,607
1976-77	20	987	13	426	2	128	3	47	38	1,588

(a) See text regarding comparability between States. (b) Mining accident data for construction material quarrying in the A.C.T. are not available. (c) These figures include some accidents in the mineral processing industry, and, in Western Australia, in electricity generating plants at the mine site. (d) Year ended 31 December 1977.

Mineral production

This section contains details of the output (quantity and value) of minerals produced and the metallic content of ores, concentrates, etc.

The statistics shown have been derived from data collected in the annual mining census and in returns to the various State Mines Departments, supplemented in some cases by information made available by the Department of National Resources and from other sources.

For details of the scope of mineral production statistics and their relation to mining industry statistics, and the principles for measuring the output of minerals, see Year Book No. 61 and earlier issues.

Quantity of minerals produced

The following tables show particulars of the quantities of minerals produced during 1977-78 and earlier years, together with details of the aggregate quantity of each metal, metallic oxide or elements contained in the various metallic minerals produced.

QUANTITY OF MINERALS PRODUCED AND METALLIC CONTENTS OF ORES CONCENTRATES, ETC.

Mineral	1975-76	1976-77	1977-78	
METALLIC MINERALS				
Antimony concentrate	tonnes	1,649	n.p.	n.p.
Antimony content	"	1,089	n.p.	n.p.
Antimony ore	tonnes	507	1,230	464
Antimony content	"	n.p.	111	61
Bauxite	'000 tonnes	19,755	22,806	24,642
Alumina (Al ₂ O ₃) content	"	n.p.	n.p.	n.p.
Beryllium ore	tonnes	-	-	-
Beryllium oxide (BeO) content	mtu(a)	-	-	-
Bismuth concentrate	tonnes	4,829	5,338	5,743
Bismuth content	tonnes	817	853	756
Copper content	tonnes	695	1,116	1,227
Gold content	kg	729	485	533

For footnotes see end of table.

QUANTITY OF MINERALS PRODUCED AND METALLIC CONTENTS OF ORES CONCENTRATES,
ETC.—continued

<i>Mineral</i>		1975-76	1976-77	1977-78
Selenium content	tonnes	—	28	31
Silver content	kg	286	191	210
Copper concentrate	tonnes	788,703	755,714	750,431
Copper content	"	202,865	198,069	198,290
Bismuth content	tonnes	34	203	183
Gold content	kg	2,000	2,369	2,210
Lead content	tonnes	507	364	363
Silver content	kg	32,232	28,362	27,477
Zinc content	tonnes	1,655	1,210	1,259
Copper ore	tonnes	4,364	11,874	1,271
Copper content	"	372	2,029	101
Gold content	kg	3	1	—
Silver content	"	15	216	231
Copper ore for fertilizer	tonnes	—	—	—
Copper content	"	—	—	—
Copper oxide	tonnes	2,316	2,735	3,810
Copper content	"	1,784	2,129	2,953
Copper precipitate	tonnes	68	45	51
Copper content	"	50	29	36
Gold bullion(b)	kg	15,964	15,608	21,127
Gold content	"	12,550	11,004	16,291
Silver content	kg	2,383	1,734	1,407
Gold ore	tonnes	294	115	25
Gold content	kg	59	2	1
Iron ore(c)	'000 tonnes	92,687	94,766	89,872
Iron content	"	58,263	60,164	54,739
Iron oxide(d)	tonnes	55,758	56,934	51,156
Lead concentrate	tonnes	576,481	632,210	621,670
Lead content	"	369,466	391,286	385,510
Antimony content	"	580	535	513
Cadmium content	"	54	64	51
Copper content	"	3,347	4,057	4,235
Gold content	kg	307	260	276
Silver content	kg	559,923	682,578	662,685
Sulphur content	tonnes	45,362	48,536	49,576
Zinc content	"	31,283	34,314	32,424
Lead-copper concentrate	tonnes	19,480	25,709	46,654
Lead content	"	4,823	6,215	12,845
Copper content	"	2,656	3,328	3,658
Gold content	kg	986	1,132	1,333
Silver content	"	42,780	49,533	67,382
Sulphur content	tonnes	5,527	7,674	11,478
Zinc content	"	1,942	2,490	6,685
Lead ore (e)	tonnes	42,997	34,760	51,066
Lead content	"	2,718	1,923	2,857
Silver content	kg	3,503	2,175	3,234
Lead-zinc middlings	tonnes	9,483	21,656	628
Lead content	"	1,745	1,992	208
Antimony content	"	9	—	1
Cadmium content	"	19	43	1
Copper content	"	114	260	8
Gold content	kg	25	58	2
Silver content	"	13,674	21,764	200
Sulphur content	tonnes	2,702	6,172	179
Zinc content	"	3,139	9,334	188
Manganese ore—				
Metallurgical grade	'000 tonnes	1,576	1,681	1,325
Manganese content	"	765	806	628
Mineral sands (f)—				
Ilmenite concentrate (g)	tonnes	929,269	990,444	1,137,062
Titanium dioxide content	"	523,527	541,079	626,662
Leucoxene concentrate	tonnes	14,821	8,818	17,423
Titanium dioxide content	"	13,082	7,700	16,284
Monazite concentrate	tonnes	4,766	7,019	9,294
Monazite content	"	4,392	6,487	8,646

For footnotes see end of table.

QUANTITY OF MINERALS PRODUCED AND METALLIC CONTENTS OF ORES CONCENTRATES,
ETC.—*continued*

<i>Mineral</i>		1975-76	1976-77	1977-78
Rutile concentrate	tonnes	367,763	370,532	274,181
Titanium dioxide content	"	352,710	354,966	262,990
Xenotime concentrate	tonnes	14	13	16
Yttrium oxide content	kg	4,200	3,900	4,848
Zircon concentrate	tonnes	386,604	407,603	365,140
Zirconium dioxide content	"	316,075	325,542	284,956
Nickel concentrate	tonnes	471,662	450,224	466,638
Nickel content	"	57,307	54,578	56,850
Cobalt content	"	135	171	234
Copper content	"	4,585	4,438	4,839
Palladium content	kg	192	213	356
Platinum content	"	79	81	141
Nickel ore	'000 tonnes	1,922	2,238	2,560
Nickel content	tonnes	23,646	26,521	30,141
Pyrite concentrate	tonnes	213,348	227,532	252,469
Sulphur content	"	101,352	109,807	114,690
Tantalite-columbite concentrate	kg	119,970	104,990	207,331
Tantalite-columbite content	"	52,160	41,050	89,040
Tin concentrates	tonnes	19,143	20,944	22,684
Tin content	"	9,609	10,253	11,726
Tin-copper concentrate	tonnes	2,896	2,610	1,806
Tin content	"	76	72	45
Copper content	"	628	535	390
Tungsten concentrates—				
Scheelite concentrate	tonnes	2,360	3,190	n.p.
Tungstic oxide content	mtu(<i>a</i>)	167,000	n.p.	n.p.
Wolfram concentrate	tonnes	641	567	n.p.
Tungstic oxide content	mtu(<i>a</i>)	45,422	39,735	n.p.
Zinc concentrate	tonnes	839,627	822,367	850,143
Zinc content	"	432,661	426,194	441,888
Cadmium content	"	1,500	1,441	1,472
Cobalt content	"	103	109	108
Copper content	"	1,200	1,226	1,228
Gold content	kg	204	215	227
Lead content	tonnes	17,405	16,446	16,943
Manganese content	"	5,785	5,241	5,534
Mercury content	kg	332	21	—
Silver content	kg	65,072	53,199	59,512
Sulphur content	tonnes	268,068	261,861	269,214
Zinc ore	tonnes	22,851	4,643	4,137
Zinc content	"	8,583	1,764	1,874

COAL

Black coal	'000 tonnes	69,269	75,982	79,338
Bituminous	"	63,967	70,467	73,654
Sub-bituminous	"	5,302	5,516	5,684
Brown coal (lignite)(<i>h</i>)	"	26,711	28,231	27,644
Brown coal briquettes	"	946	1,035	1,064

OIL AND GAS (*i*)

Crude oil	'000 cu m	23,839	24,549	24,941
Natural gas	mil. cu m	5,172	6,093	6,720
Natural gas condensate(<i>j</i>)	cu m	6,619	5,612	6,125
Ethane	'000 cu m	73,208	103,350	110,455
Liquefied petroleum gases (<i>k</i>)—				
Propane	'000 cu m	1,053	1,208	1,269
Butane	'000 cu m	1,182	1,325	1,388

For footnotes see end of table.

QUANTITY OF MINERALS PRODUCED AND METALLIC CONTENTS OF ORES CONCENTRATES, ETC.—*continued*

<i>Mineral</i>		1975-76	1976-77	1977-78
CONSTRUCTION MATERIALS(<i>l</i>)				
Sand	'000 tonnes	23,206	24,950	24,345
Gravel	"	14,832	15,071	14,394
Dimension stone	"	169	87	91
Crushed and broken stone	"	54,293	53,012	60,576
Other	"	31,858	30,222	26,905
OTHER NON-METALLIC MINERALS				
Asbestos	tonnes	57,235	55,814	50,590
Barite	"	n.p.	n.p.	11,035
Carbon dioxide	"	n.p.	n.p.	n.p.
Chlorite	"	208	—	—
Clays—				
Brick and shale	'000 tonnes	8,856	8,571	8,549
Other(<i>m</i>)	"	1,202	1,190	n.p.
Diatomite	tonnes	1,681	1,371	2,630
Dolomite	"	515,094	535,330	622,939
Felspar (including cornish stone)	"	4,123	2,998	2,505
Garnet concentrate	"	1	658	1,187
Gypsum	'000 tonnes	912	992	900
Limestone (including shell and coral)	"	10,185	10,528	10,750
Magnesite, crude	tonnes	n.p.	16,873	18,138
Mineral pigments—red ochre	"	874	166	193
Peat(<i>n</i>)	"	n.p.	n.p.	n.p.
Pebbles—for grinding	"	1,799	1,260	1,673
Perlite	"	2,136	4,621	829
Phosphate rock	"	168,601	455,986	397,041
Pyrophyllite	"	15,542	12,112	12,774
Salt	'000 tonnes	5,350	5,023	5,410
Silica	"	1,188	1,406	1,314
Sillimanite	tonnes	567	7,228	589
Talc (including steatite)	"	74,098	86,222	123,196

(*a*) Metric ton unit (mtu) equals 10 kilograms. (*b*) Includes alluvial gold. (*c*) Includes iron concentrate. (*d*) For cement manufacture, coal washing. (*e*) Includes silver-lead ore, silver-lead slimes and lead slag. (*f*) Details relating to rutile-zircon concentrates produced in one State and finally separated in another State are included in separate form in the Data of the State of origin. (*g*) Includes Beneficiated Ilmenite. Also includes ilmenite from which titanium dioxide is not commercially extractable. (*h*) Excludes brown coal used for briquette production. (*i*) Source: Department of National Development and State Mines Departments. (*j*) Sales—excludes condensate blended and other petroleum products. (*k*) Excludes refinery production. (*l*) Incomplete. (*m*) Incomplete owing to difficulties of coverage. (*n*) Comprises peat for fertiliser and peat moss.

CONTENTS OF METALLIC MINERALS PRODUCED

<i>Contents of metallic minerals produced</i>		1975-76	1976-77	1977-78
Alumina (Al ₂ O ₃)	'000 tonnes	n.p.	n.p.	n.p.
Antimony	tonnes	n.p.	n.p.	n.p.
Beryllium oxide (BeO)	mtu(<i>a</i>)	—	—	—
Bismuth	kg	890,703	1,056,199	890,703
Cadmium	tonnes	1,573	1,548	1,573
Cobalt	"	2,026	2,210	2,646
Copper	"	218,296	217,216	217,083
Gold	kg	16,901	15,666	21,047
Iron(<i>b</i>)	'000 tonnes	58,263	60,164	54,739
Lead	tonnes	396,664	418,226	418,801
Manganese	"	771,060	811,414	633,047
Mercury	kg	332	21	—
Monazite	tonnes	4,392	6,487	8,646
Nickel	"	80,953	81,099	86,991
Palladium	kg	192	213	356
Platinum	"	79	81	141
Selenium	tonnes	—	28	31

CONTENTS OF METALLIC MINERALS PRODUCED—continued

Contents of metallic minerals produced		1975-76	1976-77	1977-78
Silver	kg	721,544	840,084	837,315
Sulphur	tonnes	423,011	434,050	445,137
Tantalite-columbite (Ta ₂ O ₅ + Nb ₂ O ₅)	'000 grams	52,160	41,050	89,040
Tin	tonnes	9,685	10,325	11,771
Titanium dioxide (TiO ₂)	"	889,460	903,756	905,536
Tungstic oxide (WO ₃)	mtu(a)	212,422	n.p.	n.p.
Yttrium oxide (Y ₂ O ₃)	kg	4,200	3,900	4,848
Zinc	tonnes	479,263	475,306	484,376
Zirconium dioxide (ZrO ₂)	"	316,131	325,572	284,956

(a) Metric ton unit (mtu) equals 10 kilograms.

(b) Excludes iron content of iron oxide not intended for metal extraction. Includes iron contained in iron concentrate.

Value of minerals produced

The following table shows the value of minerals produced in the past six years.

VALUE OF MINERALS PRODUCED
(\$'000)

Mineral	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
METALLIC MINERALS						
Antimony—						
Concentrate	546	932	1,904	1,462	n.p.	n.p.
Ore	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Bauxite	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Beryllium ore	23	23	1	—	—	—
Bismuth concentrate	6,813	7,609	14,085	10,591	12,183	7,923
Copper—						
Concentrate	154,748	267,873	168,047	159,876	182,448	151,487
Ore(a)	701	n.p.	766	305	1,202	109
Ore for fertiliser	9	5	3	—	—	—
Oxide	757	982	1,406	1,900	2,730	3,656
Precipitate	101	168	31	42	31	27
Gold—						
Bullion(b)	25,730	26,839	43,139	43,735	47,501	82,122
Concentrate	n.a.	n.a.	—	—	219	215
Ore	—	3	8	10	3	3
Iron ore	395,189	427,518	613,169	674,515	746,577	769,408
Iron oxide	1,150	n.p.	855	915	1,000	1,020
Lead concentrate	(c)72,060	110,875	124,519	117,099	177,760	208,343
Lead-copper concentrate	6,089	8,799	7,609	8,363	10,822	15,745
Lead ore(d)	494	403	579	566	527	964
Lead-zinc middlings	2,560	2,002	2,422	2,094	5,630	110
Manganese ore	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Mineral sands—						
Ilmenite concentrate(e)	8,155	7,953	14,270	15,835	17,753	21,860
Leucoxene concentrate	722	1,060	2,079	2,078	1,318	2,265
Monazite concentrate	551	542	515	774	1,178	1,621
Rutile concentrate	36,510	36,750	53,674	71,750	75,654	50,631
Xenotime concentrate	22	7	12	9	9	15
Zircon concentrate	11,821	16,726	58,128	60,935	42,026	25,729
Nickel concentrate	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Nickel ore	n.p.	—	n.p.	n.p.	n.p.	n.p.
Pyrite concentrate	139	238	441	771	709	833
Tantalite-columbite concentrate	670	777	942	1,256	1,127	3,670
Tin concentrate	32,282	43,448	49,138	49,060	70,022	108,927
Tin-copper concentrate	516	860	390	435	383	287
Tungsten ores and concentrates	5,550	5,292	11,385	15,497	34,204	n.p.
Uranium concentrate	n.a.	n.a.	—	2,641	15,460	24,077
Zinc concentrate	61,820	97,122	138,385	133,340	132,922	120,217
Zinc ore	—	1,551	2,439	1,600	325	362
Other metallic minerals	—	—	84	2,928	n.p.	n.p.
Total metallic minerals	995,416	1,281,782	1,572,746	1,676,273	1,986,680	2,059,716

For footnotes see end of table.

VALUE OF MINERALS PRODUCED—*continued*

<i>Mineral</i>	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
COAL						
Black coal	390,980	449,855	874,879	1,211,199	1,438,289	1,576,914
Brown coal (lignite) (f)	24,716	27,251	40,556	48,346	55,905	64,925
Brown coal briquettes	9,173	11,011	11,391	11,974	14,925	16,536
<i>Total coal</i>	<i>424,869</i>	<i>488,116</i>	<i>926,827</i>	<i>1,271,519</i>	<i>1,509,119</i>	<i>1,658,375</i>
OIL AND GAS(g)						
<i>Oil and Gas</i>	<i>311,903</i>	<i>378,750</i>	<i>446,298</i>	<i>488,419</i>	<i>534,815</i>	<i>671,233</i>
CONSTRUCTION MATERIALS(h)						
<i>Construction materials</i>	<i>170,484</i>	<i>196,611</i>	<i>238,044</i>	<i>256,328</i>	<i>272,774</i>	<i>308,174</i>
OTHER NON-METALLIC MINERALS						
Asbestos	3,256	4,140	7,960	18,406	20,382	20,514
Barite	208	98	303	n.p.	n.p.	404
Carbon dioxide	47	52	45	56	163	180
Chlorite	n.a.	n.a.	10,084	8,723	—	—
Clay—						
Brick clay and shale	9,355	11,153	10,241	12,634	12,821	13,676
Other clays	2,682	n.p.	n.p.	4,335	4,774	7,085
Diatomite	43	70	45	60	71	310
Dolomite	888	1,087	991	1,262	1,421	1,654
Felspar (including cornish stone)	35	48	87	97	77	63
Garnet concentrate	2	2	—	—	11	21
Gems	40,911	47,262	37,032	41,972	64,006	70,219
Gypsum	2,826	3,665	3,176	3,069	4,216	4,061
Limestone (including shell and coral)	16,932	20,794	24,221	26,087	30,154	34,159
Magnesite, crude	318	291	722	n.p.	340	411
Mineral pigments—red ochre	10	6	—	15	3	4
Peat (i)	n.p.	143	146	n.p.	n.p.	n.p.
Pebbles—for grinding	36	43	27	38	35	27
Perlite	18	11	32	12	45	17
Phosphate rock	6	6	894	1,508	4,477	1,672
Pyrophyllite	112	103	156	200	187	229
Salt	12,655	16,410	21,951	29,394	33,623	38,558
Silica	4,484	5,353	6,301	6,559	n.p.	n.p.
Sillimanite	17	19	22	18	141	27
Talc (including steatite)	n.p.	1,363	1,348	n.p.	n.p.	n.p.
Vermiculite	35	n.p.	n.p.	—	n.p.	7
<i>Total other non-metallic minerals</i>	<i>95,943</i>	<i>116,062</i>	<i>120,097</i>	<i>149,398</i>	<i>188,057</i>	<i>205,143</i>
TOTAL						
Total, all minerals and construction materials	1,998,615	2,461,320	3,304,012	3,841,444	4,491,445	4,902,640

(a) Includes value of copper slag. (b) Includes alluvial gold. (c) Excludes value of Western Australian production. (d) Includes value of silver-lead ore, silver-lead slimes and lead slag. (e) Includes beneficiated ilmenite. (f) Excludes value of coal used in making briquettes. (g) The values shown are estimates based on prices prescribed in legislation quoted market prices and information from government departments. Includes values for crude oil natural gas, natural gas condensate, ethane, propane and butane. (h) Incomplete owing to difficulties of coverage in some States. (i) Comprises peat for fertiliser and peat moss.

Foreign control of the mining industry in Australia

Summary information on foreign ownership and control of the mining industry in Australia is shown in Chapter 24, Overseas Transactions. More detailed statistics are available in *Foreign Ownership and Control of the Mining Industry* (5317.0) and *Foreign Control in Mineral Exploration* (5323.0).

Mineral exploration (other than for petroleum)

Definition

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

Sources of statistics

The statistics of exploration for minerals *other than petroleum* are derived from the annual mineral exploration census conducted by the Australian Bureau of Statistics in each State and the Northern Territory (in New South Wales the census is conducted jointly with the State Mines Department).

Classification

The data obtained in the mineral exploration census are divided into the following categories:

(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 the production of minerals.

(b) *Other private exploration*—relates to exploration carried out by private enterprises on areas covered by exploration licences, authorities to enter, authorities to prospect and similar licences and authorities issued by State Governments for exploration of minerals. Also included is exploration by private enterprises which is not directly connected with areas under lease, licence, etc.

(c) *Exploration by government*—relates to exploration of minerals carried out by Federal and State Government Departments, local government authorities and business undertakings operated by those departments or authorities.

Expenditure, metres drilled

The following table show expenditure and metres drilled on mineral exploration other than for petroleum in Australia during the last six years.

MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)

	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
Expenditure (\$'000)—						
On drilling	29,039	28,824	36,172	35,104	40,888	56,277
Other	79,088	83,714	88,029	82,033	108,605	120,058
Australia	108,127	112,539	124,200	117,137	149,493	176,336
Metres drilled ('000)—						
Drilled-core	769	657	733	530	529	638
Drilled-non-core	2,181	1,854	1,775	1,589	1,434	1,893
Australia	2,949	2,511	2,509	2,119	1,963	2,531

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) and *The Australian Mineral Industry Annual Review*, and by the Australian Bureau of Statistics in its quarterly publication, *Petroleum Exploration, Australia* (8409.0).

Scope

Petroleum exploration consists of the search for and/or appraisal of deposits of crude oil and/or natural gas and natural gas liquids by geological, geophysical, geochemical, and other exploration methods, 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 costs 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. Details of developmental oil and/or gas wells are excluded.

Operations

The following table shows particulars of expenditure, and wells and metres drilled in petroleum exploration in recent years.

PETROLEUM EXPLORATION

		1975	1976	1977
Expenditure—				
Private sources	\$'000	59,990	49,125	84,970
Government sources	\$'000	4,941	5,131	4,704
Total	\$'000	64,931	54,256	89,674
Wells—				
Drilled (i.e. those which reached final depth)—				
As oil producers	No.	—	—	2
As gas producers	No.	3	6	2
As oil and gas producers	No.	1	—	—
Plugged and abandoned	No.	21	11	17
Total	No.	25	17	21
Average final depth of wells drilled	m	1,953	2,342	2,577
Drilling still in progress at 31 December (uncompleted holes)	No.	1	3	3
Wells drilled or drilling over 3,000 metres	No.	5	4	10
Metres drilled—				
Completed wells	m	47,617	40,198	49,307
Uncompleted holes	m	620	7,314	10,176
Total	m	48,237	47,512	59,483

Mineral processing and treatment

The extraction of minerals from ore deposits, as in mining and quarrying, is only a part of mineral technology, as few minerals can be directly used in the form in which they are mined. In most cases minerals must undergo considerable processing and treatment before utilisation. The sectors of the economy which carry out this work are classified for statistical purposes to Manufacturing Industry (see Chapter 17, Manufacturing and Internal Trade).

Principal products

The following table shows particulars of the production of certain important manufactured products of mineral origin during recent years.

PRODUCTION OF PRINCIPAL MANUFACTURED PRODUCTS OF MINERAL ORIGIN

Commodity		1975-76(a)	1976-77(a)	1977-78(a)
METALS(b)				
Non-ferrous—				
Alumina	'000 tonnes	5,619	6,474	6,741
Refined aluminium	tonnes	220,027	236,943	259,592
Blister copper(c)	"	174,230	164,041	167,947
Refined copper	"	164,279	157,452	155,353
Lead bullion (for export)(c)	"	152,299	158,656	155,641
Refined lead	"	168,183	165,582	207,939
Refined zinc	"	204,534	261,914	262,615
Refined tin	"	5,386	5,373	5,994
Ferrous—				
Pig iron(d)	'000 tonnes	7,331	7,055	7,096
Steel ingots(d)	"	7,832	7,558	7,445
Precious—				
Refined gold(e)	'000 grams	12,829	11,127	17,869
Refined silver	"	226,209	253,268	259,217

PRODUCTION OF PRINCIPAL MANUFACTURED PRODUCTS OF MINERAL ORIGIN—*continued*

Commodity		1975-76(a)	1976-77(a)	1977-78(a)
FUELS				
Coal products—				
Metallurgical coke	'000 tonnes	4,732	4,501	4,429
Brown coal briquettes	"	946	1,035	1,064
Petroleum products—				
Motor spirit	mil. litres	12,061	12,811	14,073
Furnace fuel	'000 tonnes	4,469	4,666	4,138
Automotive distillate	"	4,652	4,833	5,613
Industrial diesel fuel	"	1,561	1,281	1,291
BUILDING MATERIALS				
Clay bricks	millions	1,815	2,033	1,908
Portland cement	'000 tonnes	5,100	5,083	5,021
Plaster of paris	"	347	384	369
Plaster sheets	'000 sq m	44,794	49,947	48,129
CHEMICALS				
Sulphuric acid	'000 tonnes	1,281	1,752	1,799
Caustic soda	tonnes	139,436	134,247	131,246
Superphosphate(f)	'000 tonnes	2,316	3,180	3,388

(a) Some products exclude production of single establishment manufacturing establishments employing less than four persons and production of establishments predominantly engaged in non-manufacturing activities but which may carry on in a minor way, some manufacturing. (b) Excludes secondary metal with the exception of pig iron and steel ingots. (c) Metallic content. (d) Year ended 31 May. (e) Newly-won gold of Australian origin. (f) Includes double and triple superphosphate and ammonium phosphate expressed in terms of single superphosphate, i.e. 22% P₂O₅ equivalent.

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 Australian Bureau of Statistics. Particulars of the quantities and values (\$f.o.b. port of shipment) of the principal minerals and products exported from and imported into Australia during recent years are shown in the following table.

EXPORTS AND IMPORTS OF PRINCIPAL MINERALS AND MINERAL PRODUCTS

Commodity(a)	Quantity			Value f.o.b. (\$'000)			
	1976-77	1977-78	1978-79p	1976-77	1977-78	1978-79p	
EXPORTS(b)							
Non-ferrous—							
Copper—							
Concentrate	tonnes	143,012	109,157	131,661	50,960	31,996	43,845
Blister	"	7,247	7,542	12,094	13,254	14,938	26,244
Refined	"	75,278	62,671	53,677	90,973	67,157	76,816
Matte, slags, etc.	"	12,057	11,683	4,472	5,688	5,088	2,560
Lead—							
Concentrate	"	68,472	140,572	71,996	20,348	41,988	31,682
Bullion	"	156,794	157,915	159,637	106,203	116,897	150,618
Refined	"	132,493	138,595	152,240	55,784	71,593	101,400
Slags and residues	"	13,403	2,589	18,560	1,655	846	2,459
Zinc—							
Concentrate	"	379,113	389,247	453,118	58,950	44,751	57,127
Refined	"	170,675	184,290	193,826	109,390	96,066	110,963
Slags and residues	"	6,494	5,446	6,441	1,880	1,404	1,072
Tin—							
Concentrate	"	11,461	14,682	14,244	28,837	49,841	74,678
Refined	"	1,838	2,787	1,288	13,335	27,375	14,674
Aluminium—							
Alumina	'000 tonnes	5,877	6,368	6,408	566,976	667,606	718,939
Refined	tonnes	75,533	75,921	81,026	60,084	69,270	82,219
Ferrous and alloy—							
Iron ore—							
Pellets	'000 tonnes	8,792	8,548	8,130	164,713	175,747	165,390
Fines	"	37,443	34,999	38,851	323,717	367,089	391,287
Lump	"	34,540	31,143	32,565	413,234	409,087	411,021
Tungsten—							
Scheelite concentrate	tonnes	3,101	3,341	3,853	22,450	33,813	38,448
Wolfram concentrate	"	525	767	1,578	3,894	6,861	12,101
Pig iron	"	763,421	519,176	784,415	56,813	39,583	70,546
Steel ingots, blooms	"	1,550,193	1,084,249	1,241,224	172,545	137,906	193,911
Mineral sands—							
Ilmenite concentrate	'000 tonnes	1,167	1,039	977	17,985	22,503	22,421
Rutile concentrate	"	289	315	336	63,430	62,031	63,499
Zircon concentrate	"	351	366	423	47,727	30,706	29,920
Precious—							
Gold, refined	'000 grams	7,924	8,194	13,900	29,642	40,998	22,329
Silver, refined	"	129,002	103,411	89,074	16,134	14,262	16,767
Coal, black	'000 tonnes	34,432	37,161	36,888	1,281,944	1,457,178	1,519,198
Crude oil(c)	'000 cu m	206	210	(f)368	15,462	16,125	40,156
IMPORTS							
Tin, refined	tonnes	17	215	204	117	1,959	2,701
Nickel (pigs, anodes, etc.)	"	1,210	2,008	1,532	5,033	8,154	5,905
Ferro-alloys	"	28,663	20,048	26,300	16,938	11,378	15,451
Gold—							
Unrefined bullion(d)	'000 grams	1,905	1,241	512	6,468	5,537	2,737
Refined	"	110	228	40	308	796	267
Crude oil(e)	'000 cu m	10,092	11,261	(g)12,750	646,499	799,135	923,004
Asbestos	tonnes	70,731	58,265	29,443	29,415	25,978	13,038
Diamonds—							
Industrial	m e t r i c carats	1,015,153	833,964	1,187,540	4,512	4,263	6,501
Gemstone	"	91,336	132,815	63,337	22,717	31,202	31,375
Phosphate rock	'000 tonnes	1,329	1,510	2,380	42,227	55,279	83,266
Potassium fertilisers	tonnes	165,470	157,397	168,527	9,625	9,137	9,839
Sulphur	"	315,432	475,708	424,660	10,697	14,442	15,077

(a) In addition to the commodities listed, significant quantities of bauxite and nickel ores and concentrates are exported but details are not available for publication. (b) Quantities shown for metallic minerals are gross quantities, not metallic contents. (c) Includes also partly refined oil, topped crudes and enriched crudes. (d) Gold content. (e) Includes also partly refined oil, topped crudes, enriched crudes and refinery feed stock. (f) '000 litres. (g) Million litres.

Considerable quantities of metallic ores, concentrates, slags, and residues are exported from Australia for refining overseas. The following table shows selected items exported during 1977-78 and their principal metallic content as estimated by assay.

PRINCIPAL METALLIC CONTENTS OF SELECTED ORES AND CONCENTRATES ETC. EXPORTED FROM AUSTRALIA, 1977-78

<i>Metallic contents—estimated from assay</i>								
<i>Ores and concentrates, etc.</i>	<i>Copper</i>	<i>Lead</i>	<i>Zinc</i>	<i>Tin</i>	<i>Iron</i>	<i>Tungstic Oxides</i>	<i>Gold</i>	<i>Silver</i>
	tonnes	tonnes	tonnes	tonnes	'000 tonnes	tonnes	kg	kg
Copper concentrate . . .	35,175	193	—	—	—	—	480	6,489
Blister copper . . .	7,495	—	—	—	—	—	1,714	894
Copper matte, slags, etc.(a) . . .	3,464	5,493	65	—	—	—	—	12,682
Lead concentrate . . .	2,154	73,143	6,931	—	—	—	879	122,034
Lead bullion . . .	34	156,895	—	—	—	—	27	308,357
Lead slags and residues . . .	166	1,317	30	2	—	—	—	1,427
Zinc concentrate . . .	—	2,368	199,231	—	—	—	—	17,961
Zinc slags and residues . . .	—	—	4,334	—	—	—	—	—
Tin concentrate . . .	5	—	—	5,787	—	—	—	—
Iron ore—								
Pellets	—	—	—	—	5,442	—	—	—
Fines	—	—	—	—	21,269	—	—	—
Lump	—	—	—	—	20,304	—	—	—
Scheelite concentrate . . .	—	—	—	—	—	2,453	—	—
Wolfram concentrate . . .	—	—	—	—	—	534	—	—
Total metallic content . . .	48,493	239,409	210,591	5,789	47,015	2,987	3,100	469,844

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

Prices

The following table shows average prices of some principal refined metals and ores and concentrates on Australian and certain major overseas markets. Prices of minerals such as iron ore, coal and bauxite are not shown as these minerals are commonly sold on a contract basis rather than on an open market basis.

AVERAGE DAILY PRICES OF SELECTED METALS AND METALLIC ORES AND CONCENTRATES: AUSTRALIAN AND OVERSEAS MARKETS

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

METALS(a)										
<i>Period</i>	<i>Tin</i>		<i>Aluminium</i>				<i>Gold</i>		<i>Silver</i>	
	<i>Aust. (\$A—tonne)</i>	<i>L.M.E. (£Stg—metric ton)</i>	<i>Straits (\$Mal—picul)</i>	<i>Nickel U.S.A. (\$US—16)</i>	<i>Aust. (\$A—tonne)</i>	<i>U.S.A. (USc—lb)</i>	<i>Premium markets (\$A—f. oz) Australia and Overseas</i>	<i>U.K. (\$US—f. oz)</i>	<i>Aust. (\$A—kg)</i>	<i>U.K. (£Stg new pence—f. oz)</i>
	1975-76 . . .	5,698.3	3,402.7	1,014.9	2.17	751.7	41.1	110.40	139.32	112.4
1976-77 . . .	8,404.2	5,263.7	1,344.6	2.38	860.3	46.6	114.8	131.3	127.6	262.9
1977-78 . . .	10,919.3	6,441.0	1,677.2	2.10	968.4	48.2	148.1	167.2	140.9	267.8
1977-78										
Highest	12,444.0	7,340.0	1,895.0	2.20	1,019.0	50.5	162.1	184.9	154.5	299.8
Lowest	9,351.0	5,695.0	1,448.0	2.06	964.0	45.5	128.9	144.1	130.1	249.7
<i>Period</i>	<i>Copper</i>		<i>Lead</i>			<i>Zinc</i>				
	<i>Aust. (\$A—tonne)</i>	<i>L.M.E. (£Stg—metric ton)</i>	<i>Aust. (\$A—tonne)</i>	<i>L.M.E. (£Stg—metric ton)</i>	<i>U.S.A. (USc—lb)</i>	<i>Aust. (\$A—tonne)</i>	<i>L.M.E. (£Stg—metric ton)</i>	<i>Prod. (£Stg—ton)</i>	<i>U.S.A. (USc—lb)</i>	
	1975-76 . . .	1,017.9	655.3	300.8	194.9	20.32	628.7	364.3	(b)795.0	37.99
1976-77 . . .	1,239.9	823.6	475.3	323.7	27.5	694.8	390.4	(b)783.8	37.08	
1977-78 . . .	1,108.3	676.2	512.5	323.5	32.0	544.7	287.8	(b)620.8	33.4	
1977-78										
Highest	1,180.0	768.0	550.0	356.0	33.0	639.0	319.0	(b)700.0	34.0	
Lowest	1,040.0	620.0	500.0	293.5	31.0	489.0	242.5	(b)550.0	29.0	

For footnotes see next page.

AVERAGE DAILY PRICES OF SELECTED METALS AND METALLIC ORES AND CONCENTRATES:
AUSTRALIAN AND OVERSEAS MARKETS—*continued*

ORES AND CONCENTRATES					
Period	Tin Aust. (\$A-mtu)	Wolfram Europe (\$Sig-mtu)	Ilmenite Europe (\$A-metric ton)	Rutile Europe (\$A-metric ton)	Zircon Europe (\$A-metric ton)
1975-76	47.89	36.75-64.00	15.00-18.00	290.00-330.00	140.00-330.00
1976-77	71.93	(c)143.50-186.50	15.00-18.00	200.00-330.00	90.00-160.00
1977-78	95.98	(c)150.62-158.75	15.58-18.33	187.50-197.50	73.75-83.75
1977-78					
Highest	106.04	(c)178.00	19.00	210.00	100.00
Lowest	86.14	(c)130.00	12.00	180.00	65.00

(a) Where a daily price does not actually exist for a commodity, daily prices have been imputed from price data which are available. (b) From 2 January 1976 prices quoted in \$US per tonne. (c) From 1 December 1976 prices quoted in \$US per metric ton unit.

NOTE: Prices data shown are those quoted in the relevant markets and are mainly derived from information collected and compiled by the Bureau of Mineral Resources. Overseas data are supplied to the Bureau of Mineral Resources by the *Metal Bulletin* and *Metals Week*.

REVIEW OF RECENT DEVELOPMENTS IN THE AUSTRALIAN MINERAL INDUSTRY

Major developments in the Australian mineral industry, particularly during 1978 and the first half of 1979, are reviewed briefly in subsequent parts of this section. Additional information on developments in the industry is available in *Australian Mineral Industry Annual Review 1977* 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 the year.

General Review of 1978

The major economic indicators of the Australian mining industry, with the exception of ex-mine index of output at constant prices, rose during 1978, indicating at least a partial recovery from the depressed conditions of the previous year. Ex-mine value of output rose by 4 per cent to \$4,983 million and value added rose by 10 per cent to \$3,905 million. Nevertheless conditions of world oversupply adversely affected a number of commodities, particularly iron ore, manganese ore, rutile, zircon, bauxite, zinc ores and concentrates and nickel ores and concentrates. However, buoyant demand and higher prices were reflected in rises in the quantities and values of production of gold bullion, lead ores and concentrates, tin concentrates, and copper ores and concentrates. The quantity and value of production of uranium oxide also rose significantly.

'Mines and Quarries' was easily the largest single export-earning group in 1978-79, 28.8 per cent of total exports. This figure however, excludes some exports by the smelting and refining section of the industry'.

Imports—1978. The value of imports rose by 11 per cent to \$1,024 million. Crude oil remained the largest single import at \$786 million, an increase of 10 per cent over the previous year. Other significant mineral imports were phosphate rock, diamonds, elemental sulphur, and nickel (pig, ingots and anodes). Imports of mineral primary products accounted for 8.1 per cent of mineral primary products in 1978, compared with 8.3 per cent in 1977.

Exports—1978. Exports rose by 3 per cent to \$4,905 million, the smallest increase in several years. As with production this reflected world conditions of oversupply of a number of commodities particularly iron ore, iron and steel, copper and nickel. Despite the fall in copper exports, however base metals generally experienced a recovery of prices in the latter part of the year as producer inventories declined and world demand strengthened, as also did the mineral sands rutile and zircon.

Black coal strengthened its position as the largest single mineral export earner in 1978, its value increasing by 5 per cent to \$1,466 million; it accounted for 30 per cent of the total value of mineral exports.

Following was iron ore which decreased in value by 5 per cent to \$906 million, and by alumina whose value increased by 3 per cent to \$671 million. These three items in 1978 accounted for 62 per cent of the total value of exports of mineral primary products.

National sufficiency in minerals—1978. The mineral industry's contributions to the national economy can also be assessed by considering the ability of the industry to satisfy domestic mineral, metal, and fuel requirements. Crude oil, phosphate rock, asbestos, diamonds, ferro-alloys, elemental sulphur and potassium fertilisers were the main deficiencies in 1978. Australia is a net exporter of nickel,

but refined nickel is still imported to meet demand for forms not produced locally. In 1978, domestic production supplied about 70 per cent of estimated consumption of crude oil. Output of asbestos has mainly been directed to the export market, and about 42,000 tonnes of asbestos was imported in 1978.

Bauxite and Alumina

In 1977, production of bauxite increased to more than 26 million tonnes, alumina production to 6.7 million tonnes, and aluminium to 247,577 tonnes. Australia was again the world's largest producer of bauxite and alumina.

An alumina refinery of initial rated capacity of 500,000 tonnes per year will be commissioned in 1981 at Wagerup, W.A. Capacity will be increased over 15 years to 2 million tonnes per year. Bauxite will be supplied from Mount William, W.A. All alumina produced will be exported.

The first stage of the alumina refinery at Worsley, W.A., will be completed in 1982. Initial rated capacity is one million tonnes per year, and ultimate capacity two million tonnes per year. Bauxite will be supplied from Mount Saddleback, W.A. All alumina produced will be exported.

The production capacity of the aluminium smelter at Kurri Kurri, N.S.W., is to be increased from 67,900 tonnes to 90,000 tonnes per year by 1981. New furnaces commissioned at the Bell Bay, Tasmania, aluminium smelter in mid-1977 increased capacity from 93,000 to 112,000 tonnes per year. It was announced in 1978 that an aluminium smelter will be constructed at Gladstone, Queensland; the first stage will have a design capacity of 206,000 tonnes per year. The rated capacity of the other Australian aluminium smelter, at Point Henry, Victoria, supplied with Western Australian alumina, is 100,000 tonnes per year and will be expanded to 157,000 tonnes per year by early 1981.

In 1979 the construction of several new aluminium smelters and alumina refineries was announced. The smelter to be built at Portland (Victoria) will have a capacity of 120,000 tonnes per year and be completed in 1983. A new smelter to be built at Gladstone (Queensland) will also be completed in 1983 and have an initial capacity of 100,000 tonnes per year. Two smelters will be constructed near Newcastle (New South Wales). One, to be completed in 1983, will have an initial capacity of 109,000 tonnes annually, which will be expanded to 218,000 tonnes per year in 1985, while the other, to be completed in 1984 will have an initial capacity of 236,000 tonnes per year to be expanded to 360,000 tonnes.

Copper

A summary of the copper mining industry in Australia 1953-1975 and the sufficiency of present ore reserves was published in the *Australian Mineral Industry Quarterly Review*, Vol. 30 No. 1.

The Commonwealth Government continued its assistance to the Mount Lyell mine, Tasmania, in the form of an interest-free loan, to June 1980.

Drilling at Teutonic Bore, W.A., has revealed a deposit of between 2-3 million tonnes of ore containing 3.5 per cent copper, 9.5 per cent zinc, and 150g/t silver. A mine will be in production in 1981. The SECOR copper rod line at Townsville, Queensland, was commissioned in December 1977. A substantial copper-zinc deposit has been indicated by drilling near Benambra, Victoria.

Iron

A summary of growth of the Australian iron ore industry 1965 to 1975 has been published in the *Australian Mineral Industry Quarterly Review*, Vol. 29 No. 1.

A heavy-media beneficiation plant is being constructed at Mount Whaleback, W.A., near Newman. It will have the capacity to treat seven million tonnes per year of low-grade ore to produce five million tonnes per year of high-grade concentrates. Completion date is late 1979.

Hammersley Iron Pty Ltd is increasing production capacity from 40 to 46 million tonnes per annum of saleable iron ore by construction of a concentration plant to treat low grade ore at Mount Tom Price. Cliffs Robe River Iron Associates is expanding mine production capacity at Robe River from 16 to 20 million tonnes per annum. Exploration drilling is continuing at the copper-uranium-gold deposit at the Olympic Dam prospect, Roxby Downs, S.A. At Tennant Creek, N.T. the Warrego mine will be expanded and the Gecko mine developed with the emphasis on copper rather than gold as before. The smelter will be recommissioned in 1980 and will supply 15,000 tonnes of blister copper annually to Japan.

Silver, lead and zinc

Mine production of lead and zinc metal in 1978 was 398,429 tonnes and 469,284 tonnes respectively both less than the 1977 production.

A summary of the Australian lead and zinc industry from 1953 to 1973 was published in the *Australian Mineral Industry Quarterly Review*, Vol. 27 No. 4.

Production from the Woodlawn, N.S.W., mine commenced in 1978. A decline shaft is being sunk at the Sorby Hills, W.A., lead deposit. The copper-lead-zinc mine at Que River, Tasmania, with reserves of 3 million tonnes (7 per cent lead; 12.5 per cent zinc; 171 grams/tonnes silver; 3.4 grams/tonnes gold, 0.3 per cent copper) will continue production in 1981.

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. However, in 1979 the price of fuel oil was such that consumers are reverting to the use of coal.

The expansion of the export trade has been of major significance. In 1955 exports were about 200,000 tonnes valued at about \$1.7 million; in 1978 exports were 38.7 million tonnes valued at \$1,500 million. These increased exports have been largely to Japan and Europe, but tonnages of steaming coal greater than previously are being exported to U.S.A. and south-east Asia 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 and steaming coal have been located. Raw coal production in 1978 increased to 89.4 million tonnes; saleable coal output totalled 71.9 million tonnes.

A paper entitled *Coal Exploration in Australia* has been published in the *Australian Mineral Industry Quarterly Review*, Vol. 31, No. 1.

Petroleum

At the end of 1978, there were nine oil fields in production: Moonie, Alton and Bennett in Queensland; Barrow Island, Yardarino and Dongara in Western Australia; and Barracouta, Halibut, Mackerel and Kingfish offshore from Victoria in Bass Strait. The production of stabilised crude oil in 1977 amounted to 24,986,000 cubic metres representing 71 per cent of the year's total input to Australian refineries. In 1978, it was 25,187,000 cubic metres, 71.1 per cent of that year's refinery input. The average daily production of 68,454 cubic metres in 1977 was one per cent higher than in 1976; in 1978, it was 69,006 cubic metres, 0.8 per cent higher than in 1977. Natural gas production in 1977 amounted to 6,728 million cubic metres, 13.5 per cent more than in 1976. In 1978, it was 7,320 million cubic metres, 11 per cent more than in 1977. About 13 per cent of this, compared with about 10 per cent in 1977 was used in the field and processing plants and the balance was sold, mainly as fuel, to markets in Victoria, South Australia, Western Australia, New South Wales and Queensland.

During 1977 the major onshore discovery was gas in the Kidman No. 1 well in the Cooper Basin, South Australia. Offshore there were no major discoveries but shows of gas were reported in Haycock No. 1 and Scott Reef No. 2A, both on the Northwest Shelf, off Western Australia. In 1978, there were major onshore discoveries of gas in Kirby No. 1, in South Australia, Wackett No. 1 and Ashby No. 1, in Queensland, and significant oil discoveries in Boggo Creek No. 2 (No. 1 was dry) in Queensland, and Strzelecki No. 3, South Australia. Offshore new oil discoveries were made in Seahorse No. 1 and West Halibut No. 1 (the Fortescue Field), both in the Gippsland Basin, offshore from Victoria.

During the first eight months of 1979, in the offshore Gippsland Basin, the Tuna Platform came into production for oil and the Cobia No. 2 well became Australia's first sub-sea completion. In September 1979 it was producing some 3,000 barrels of oil per day and is connected to the Mackerel Platform. 1979 saw the start of exploration drilling in the deep waters of the Exmouth Plateau offshore from northwestern Australia. In September 1979, there were three dynamically positioned drillships drilling the Plateau in waters in excess of 1,000 metres deep.

The provisional figure for metres drilled in petroleum exploration and development in Australia in 1977 was 111,489 metres, 55.4 per cent more than that drilled in 1976; 60,562 metres were in exploration drilling, including 36,826 metres offshore. Of the forty-one wells completed in 1977, twenty-one were exploration wells, including thirteen offshore. Compared with 1976, there was a rise of two in the number of exploration wells and an increase of seven in the number of development wells drilled. There was also an increase of ten in the number of offshore exploration wells. Two exploration wells were completed as gas producers and two as oil producers. Of the twenty development wells, seventeen were completed as gas producers and two as oil producers; one was abandoned.

In 1978 the provisional figure for metres drilled in petroleum exploration and development was 209,870 metres, 88 per cent more than that drilled in 1977; 111,289 metres were in exploration drilling of which 58,364 metres was offshore. Of the 92 wells completed in 1978, 55 were exploration

wells, including 25 offshore. Compared with 1977 there was a rise of 34 in the number of exploration wells and an increase of 17 in the number of development wells drilled. There was also an increase of 9 in the number of offshore exploration wells. Of the exploration wells drilled, 6 were completed as oil producers, 3 as gas producers and 1 as an oil and gas producer, 16 of the development wells were completed as oil producers, 18 as gas producers and 3 were abandoned.

Nickel

A summary of the growth of the Australian nickel industry was published in the *Australian Mineral Industry Quarterly Review*, Vol. 28 No. 4.

Mine production of nickel in ore and concentrates was 82,359 tonnes in 1978, about 14 per cent of world mine production. Production commenced at Agnew, W.A., in 1978. The concentrates are toll-smeltered at the Kalgoorlie smelter, the capacity of which was increased.

Mineral sands

The history of the mineral sands industry is presented in the *Australian Mineral Industry Quarterly Review*, Vol. 25 No. 1.

Plans have been announced for considerable expansion in the Western Australian production capacity for the beneficiation of ilmenite. There has been increasing rationalisation in the industry by the amalgamation of operating companies, particularly in Western Australia.

Phosphate

Australia's only phosphate mine, at Duchess, Qld, closed for economic reasons on 30 June 1978. It is now on care and maintenance.

Uranium

The Australian Government has announced that uranium mining will go ahead, subject to controls. Mines are being developed at the Ranger and Nabarlek deposits in the Northern Territory, and construction of the pilot plant at the Yeelirrie deposit (W.A.) will commence in 1979.

Diamonds

Diamond exploration in the Kimberley region of Western Australia has resulted in the discovery of a number of kimberlite pipes. On the basis of diamonds found, Conzinc Riotinto of Australia has set up a pilot plant to treat kimberlite at Ashton, W.A.

REFERENCES

Further detailed statistics and information on the subjects dealt with in this chapter are contained in the annual printed publication *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 the ABS a quarterly publication, *Australian Mineral Industry Quarterly Review* (8403.0). The annual ABS statistical publications, *Census of Mining Establishments, Summary of Operations, Australia (Preliminary)* (8401.0), *Census of Mining Establishments, Details of Operations, by Industry Class, Australia* (8402.0); *Mineral Production, Australia* (8405.0); *Mineral Exploration, Australia* (8407.0) and the irregular publications *Mining Industry, Foreign Ownership and Control* (5317.0) and *Foreign Control in Mineral Exploration* (5323.0), 2nd *Census of Mining Establishments, Industry Concentrations Statistics, Australia* (8411.0), contain economic statistics of the industry prepared and published as soon as possible after the data have been compiled. A monthly statistical publication, *Minerals and Mineral Products* (8404.0) is issued also, and other current statistics on mining or mine products are contained in the *Monthly Summary of Statistics, Australia* (1304.0), the *Digest of Current Economic Statistics, Australia* (1305.0), and the monthly publication *Production Statistics, Australia* (8302.0).