

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 made provision for miner's rights 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 negotiation with the appropriate Minister for Mines and having the agreed terms and conditions embodied in an Act of the State Parliament. This method of acquisition has been used in several cases where the leasing company undertook an obligation (such as the erection of a large treatment works) in return for leases over large areas for a long period, and has become more common in recent years (e.g. iron ore in Western Australia, coal and bauxite in Queensland, bauxite in the Northern Territory). Mining legislation enacted in recent years is simpler and more suited to modern conditions.

AREAS OCCUPIED UNDER MINING ACTS AND ORDINANCES(a)
(^{'000 hectares})

Year (31 December)	N.S.W.(b)	Vic.(c)	Qld(d)	S.A.(b)	W.A.	Tas.	N.T.(b)	Total
1972 . .	656	133	1,405	59	1,721	26	48	4,048
1973 . .	(e)1,115	25	1,258	58	1,850	36	51	4,393
1974 . .	n.a.	24	1,217	48	1,653	36	59	n.a.
1975 . .	n.a.	24	1,294	43	1,298	47	62	n.a.
1976 . .	n.a.	17	1,193	73	1,278	n.a.	64	n.a.

(a) Excludes areas held under special arrangements; see following text. (b) At 30 June. (c) Includes land held under *Extractive Industries Act 1966*. (d) Excludes lands held under miners' rights and dredging claims. (e) Figures not comparable with previous years; Includes some new coal titles, as defined by the *Coal Mining Act 1973*.

Control of exploration

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

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 authorities to prospect on, land already held under a mining title within the agreed area. Unless specifically stated in an agreement, the discovery of minerals; whether inside or outside an area covered by an authority to prospect, gives the discoverer no legal rights except the right to apply for a mining lease over the area in which the discovery was made. Suitable prospects are converted to mining tenements by making application for lease under the appropriate mining Act.

Control of petroleum exploration

On-shore. In Australia, all petroleum is 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.

Further details of the petroleum legislation are given in Year Book No. 55, pages 996-7.

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.

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 royalty receipts of a government under these Acts are included in the table on page 397.

AREAS OCCUPIED UNDER PETROLEUM EXPLORATION AND DEVELOPMENT TITLES

Year (31 December)	N.S.W.	Vic.	Qld	S.A.(a)	W.A.	Tas.	N.T.(a)	Total
ON-SHORE AREAS (square kilometres)								
1972 . .	86,728	51,442	1,296,085	567,187	n.a.(b)	..	149,530	n.a.
1973 . .	158,164	34,582	692,500	599,293	n.a.(b)	16	163,504	n.a.
1974 . .	101,564	20,064	618,600	596,415	n.a.(b)	..	152,422	n.a.
1975 . .	44,612	9,704	532,500	290,900	n.a.(b)	..	127,040	n.a.
1976 . .	30,000	18,553	633,563	257,000	n.a.(b)	..	76,503	n.a.
OFF-SHORE AREAS (5 minute blocks) (c)								
1972 . .	503	1,178	2,918	3,089	10,171	1,498	3,535	22,892
1973 . .	433	1,178	2,918	3,089	9,828	1,498	4,283	23,227
1974 . .	53	939	2,221	2,685	7,138	475	3,485	16,996
1975 . .	..	529	1,954	1,398	2,231	256	2,642	9,010
1976 . .	..	161	1,954	400	2,643	n.a.	689	n.a.

(a) At 30 June. (b) Available only in terms of 5 minute blocks of which there were 8,036 at 31 December 1972, 7,260 at 31 December 1973, 5,408 at 31 December 1974, 1,755 at 31 December 1975, and 1,219 at 31 December 1976. (c) Area bounded by 5 minutes of latitude and 5 minutes of longitude; figures include partial blocks.

Mineral royalties

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

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

MINERAL ROYALTY RECEIPTS: GOVERNMENTS

(\$'000)

	1971-72	1972-73	1973-74	1974-75	1975-76
New South Wales(a)	10,237	9,592	13,496	37,864	32,660
Victoria(b)	16,875	18,025	23,922	26,657	29,894
Queensland(a)	3,805	3,525	4,319	34,863	36,758
South Australia	1,821	1,807	1,944	1,999	2,310
Western Australia	25,247	27,666	33,615	39,385	43,111
Tasmania(c)	489	498	506	503	710
Northern Territory	634	910	(d)242	(d)999	(d)545
Commonwealth Government(e)	7,567	7,896	10,786	12,172	13,457
Total	66,676	69,921	88,831	153,543	159,445

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

Control of Exports

The Commonwealth Government maintains export controls over certain metals, petroleum and petroleum products, and all raw and semi-processed minerals. A primary objective of the controls is to protect the national interest in the sale and export of Australia's minerals by assisting in the achievement of fair and reasonable market prices. Other objectives are to ensure adequate supplies to domestic industry and to meet international and strategic obligations.

The export controls are administered under the authority of the Customs (Prohibited Exports) Regulations. These regulations provide that the exportation from Australia of the minerals subject to export control is prohibited unless approval in writing is issued by the Minister for National Resources or an authorised person.

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

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

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

Government assistance

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

Commonwealth Government assistance

Assistance provided by the Commonwealth Government takes the form of income taxation concessions, subsidies, bounties, and technical assistance, mainly through the work of the Bureau of Mineral Resources and the Commonwealth Scientific and Industrial Research Organization.

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; of the liquefaction of natural gas; and of access roads and expenditure on housing and welfare. The enterprise is entitled to these deductions against income from any source. While the special deductions for 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 twenty-five years, whichever is the lesser, 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 lesser. 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.

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. 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 until 31 December 1977, the import parity price is set at \$13.00 per barrel.

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 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 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.

BMR comprises five branches under the Director: Operations, Mineral Resources, Geological, Geophysical, and Petroleum Exploration. The Operations Branch consists of four sections: Planning and Co-ordination, Publications and Information, Automatic Data Processing Applications 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 services. The Mineral Resources Branch comprises the sections Mineral Economics and Mining Engineering and is concerned largely with those aspects of 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 BMR and the operation of observatories, while the Petroleum Exploration Branch is concerned with the technical administration of the *Petroleum (Submerged Lands) Act 1967* and the assessment of sedimentary basins in Australia and its Territories. The establishment of BMR is 609 officers (at 30 June 1977), including 261 professional officers (geologists, geophysicists, chemists, engineers and mineral economists).

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 magnetic, ionospheric, and seismic investigations and are base stations for field operations.

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 State Mines Department 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 pay 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 financial assistance in 1975-76 amounted to \$906,230, including \$535,625 on the Department's own drilling program.

Victoria. The Department of Minerals and Energy conducts geological and mineral surveys and produces geological maps, and issues scientific and technical reports thereon. Extensive rotary, percussion and auger drilling operations are carried out and, in conjunction with these, sedimentary basin studies are made 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 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 and drilling assistance and loans or grants are available for mineral exploration and prospecting and for approved development operations. Six stamp batteries 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 of 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 provides the following services and facilities to the mineral industry: drilling and testing of mineral deposits; geophysical investigation; well logging; development of sub-surface water supplies for farming, pastoral, irrigation, and mining purposes; geological examination of mineral deposits, ground water supplies, dam foundation and drainage problems; and publication and issue of geological bulletins and maps. It also provides, through the Australian Mineral Development Laboratories, facilities for chemical, metallurgical, analytical and assay investigations, testing and treatment of ores and minerals, and petrographic, mineragraphic and radiometric determinations. Pilot scale metallurgical and chemical treatment plants are maintained and operated for the development of mineral extraction processes.

Western Australia. Prospectors receive assistance of either \$15 or \$17.50 a week according to the prospecting locality. North of the 26th parallel and within a defined area south of this lying largely outside the agricultural areas, assistance is given to the extent of \$17.50 a week. In the remainder of the State prospectors receive \$15 a week. Provision is also made for the supply of some tools required for prospecting. There are sixteen 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, as well as a complete plant for small shaft sinking and tunnelling. 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 Mines Branch of the Department of the Northern Territory 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, and carrying out experimental work on more complex ores. 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 some 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 mining, ore-search, 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

The Australian Atomic Energy Commission conducts research at its laboratories at Lucas Heights in Sydney on the development of nuclear power, including research on nuclear materials and on metals and ceramics used for nuclear power.

The Australian Mineral Development Laboratories

Technical consultation, 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 and petrology, chemical metallurgy and mineral engineering, operations research/computer services 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 Beeking Geobiological Research Laboratory

In 1965, the Baas Beeking 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 403).

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 work is directed towards an integrated study of the origin, composition and structure of the rocks forming the Australian continent to the lower limits of the continental slope, particularly as these affect the genesis and distribution of mineral deposits. The main effort is in field research supported and complemented by laboratory and office studies. 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;
- 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 400.

Commonwealth Scientific and Industrial Research Organization

Mineral research by the Commonwealth Scientific and Industrial Research Organization is undertaken mainly in the Minerals Research Laboratories comprising the Divisions of Chemical Engineering, Mineral Chemistry, Mineralogy, and Mineral Physics and Process Technology. Major laboratories are located at Clayton (Vic.), Port Melbourne, Sydney and Perth. Current research program objectives and sub-program titles are:

Exploration techniques. To improve and develop procedures for locating mineral deposits (geochemistry, geophysics and geological pattern recognition);

Ore deposits. To elucidate the nature, mode of origin and factors controlling the location of economic mineral deposits (regional studies, nickel deposits, mineralising processes, depositional environment, mineralogical research techniques);

Mining, beneficiation and control. To increase the overall efficiency of mining operations and mineral beneficiation processes (mineral dressing, reactive mineral systems, iron ores, mine roof failures, phosphate ores);

Process metallurgy and engineering. To improve existing technology and initiate new processes in the field of process metallurgy (process development and control, hydrometallurgy, structures and bonding, pyrometallurgy);

Environment. To protect and improve the quality of the human and natural environment (air pollution, solid and liquid wastes, aquatic environment, urban air quality); and

Energy. To support national plans developed to ensure the availability of energy in forms required by consumers and based on indigenous resources (coal utilisation, coal and oil resource characterisation, energy conservation, solar conversion and energy storage and coal utilisation).

The minerals industry provides strong support in the form of co-operative research planning, collaborative investigation of specific projects, and financial grants for appropriate developmental work.

National Coal Research Advisory Committee

The National Coal Research Advisory Committee was established in December 1964 following agreement between the Commonwealth Government, State Governments and private industry for increased applied research in Australia into coal utilisation. This was later extended to cover research into coal winning and beneficiation. Initially, a pool of funds amounting to \$520,000 per annum was jointly contributed for the sponsorship of this research. These funds were allocated on the advice of the Committee, whose membership was representative of the contributing groups. This agreement was terminated on 30 June 1969 and a new National Coal Research Advisory Committee was nominated by the Commonwealth Government alone. A sum of up to \$260,000 per year for up to three years was set aside by the Government for allocation on the advice of this Committee.

As from 30 June 1972, the scheme of assistance to coal research was extended for a further five years, with yearly allocations of \$260,000. In 1974-75 the yearly allocation was increased by \$100,000 to \$360,000 for the specific purpose of initiating an 'oil-from-coal' research program in Australia. The allocation of \$360,000 was maintained in 1975-76 and increased to \$395,000 in 1976-77.

The major beneficiary under this scheme is the Australian Coal Industry Research Laboratories; other beneficiaries are University Departments.

The functions of the Committee are:

- to keep under review all coal research carried on throughout Australia and overseas, in relation to conservation, winning, beneficiation and utilisation;
- to reach conclusions on scientific, technical and economic grounds as to the directions in which this research in Australia should be strengthened; and
- to review annually all relevant research programs in Australia, and to recommend to the Minister for National Resources those programs that should be supported, and the amount of financial contributions which should be made to each of them from the funds provided.

University Research

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

Research by private enterprise

Most large mining and smelting companies have laboratories dealing with their own individual problems. Private industry formed the Australian Mineral Industries Research Association in 1959 to provide industry with representation in the management of the Australian Mineral Development Laboratories. The Association now finances research work into geology, mining and mineral processing at Universities, the CSIRO and the Australian Mineral Development Laboratories. Membership of the Association at 30 June 1977 was: full members 44, associate members 20, registered divisions 11. Expenditure on research projects during the year 1976-77 was \$429,403.

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 (Federal Republic of), Thailand, Zaire (Republic of); *Consumers*—Austria, Belgium-Luxembourg, Bulgaria, Canada, Czechoslovakia, Denmark, France, Germany (Federal Republic of), Hungary, India, Ireland (Republic of), Italy, Japan, Netherlands, 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.

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 mining censuses. Commencing with the year ended June 1969, the annual mining census has been conducted on an integrated basis with the annual census of manufacturing and with the periodic electricity and gas and retail and wholesale trade censuses; it is therefore on a different basis to those of earlier years.

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 table below shows key items of data for Australia for 1975-76 and summary data for 1972-73 to 1974-75.

MINING ESTABLISHMENTS: SUMMARY OF OPERATIONS BY INDUSTRY CLASS

Industry class		Number of establishments operating at end of June	Persons employed at end of June(b)				Wages and salaries (c)	Turnover	Stocks at 30 June		Purchases, transfers in and selected expenses	Value added	Fixed capital expenditure (outlay on fixed tangible assets less disposals)
ASIC Code (a)	Description		Males	Fe- males	Persons	1975			1976				
1975-76													
		No.	No.	No.	No.	\$'000	\$'000	\$'000	\$'000	\$'000	\$'000	\$'000	
	Metallic minerals—												
1101	Bauxite	6	1,591	176	1,767	20,092	n.a.	12,950	13,364	n.a.	142,426	26,857	
1102	Copper (including copper-gold)	21	5,027	295	5,322	70,747	216,322	29,238	28,286	75,571	139,798	27,185	
1103	Gold	41	1,238	46	1,284	14,847	37,427	9,079	5,570	9,845	24,073	9,651	
1104	Iron ore	27	6,912	1,009	7,921	93,795	804,741	62,086	86,010	289,964	538,701	65,747	
1105	Mineral sands	25	3,114	253	3,367	33,979	150,611	28,794	42,717	61,383	103,151	34,671	
1106	Nickel	8	3,340	233	3,573	37,175	199,790	10,673	12,095	76,613	124,599	31,910	
1107	Silver-lead-zinc	9	6,246	258	6,504	73,334	262,881	45,466	66,840	71,509	212,746	22,813	
1108	Tin	43	1,342	84	1,426	12,782	49,603	6,991	8,359	18,695	32,276	4,742	
1109	Metallic minerals n.e.c.	9	1,328	139	1,467	16,327	n.a.	10,846	18,614	n.a.	30,937	25,459	
11	Total metallic minerals	189	30,138	2,493	32,631	373,080	1,972,174	216,122	281,853	689,198	1,348,707	249,035	
	Coal and crude petroleum (including natural gas)—												
1201	Black coal	127	22,201	418	22,619	289,183	1,381,585	72,807	126,989	452,349	983,417	159,624	
1202	Brown coal	4	2,830	108	2,938	34,899	568,029	19,924	23,887	60,960	511,032	88,629	
1300	Crude petroleum (including natural gas)	9											
	Construction materials—												
1401	Sand and gravel	321	2,046	200	2,246	19,227	92,732	4,277	6,133	36,471	58,117	9,231	
1402	Crushed and broken stone	312	3,935	336	4,271	40,283	176,620	18,291	23,312	74,493	107,148	14,543	
1403	Dimension stone and other construction materials n.e.c.	56	154	13	167	736	2,850	389	356	1,134	1,683	190	
14	Total construction materials	689	6,135	549	6,684	60,246	272,203	22,957	29,802	112,099	166,949	23,964	
	Other non-metallic minerals—												
1501	Limestone	49	646	11	657	6,850	28,153	1,853	2,049	13,797	14,553	1,511	
1502	Clays	90	231	19	250	1,399	12,559	1,605	1,728	6,800	5,883	587	
1503	Non-metallic minerals n.e.c.	110	1,687	143	1,830	16,866	81,090	11,005	12,271	44,642	37,714	24,931	
15	Total other non-metallic minerals	249	2,564	173	2,737	25,115	121,803	14,462	16,048	65,239	58,150	27,028	
	Total mining (excluding services to mining)	1975-76	1,267	63,868	3,741	67,609	782,522	4,315,793	346,272	478,579	1,379,485	3,068,254	548,280
		1974-75	1,315	65,447	3,675	69,122	675,442	3,725,629	242,290	341,432	1,155,702	2,669,069	496,199
		1973-74	1,315	61,006	3,050	64,056	481,006	2,798,062	216,389	242,586	828,164	1,996,096	338,573
		1972-73	1,330	60,140	2,920	63,060	402,894	2,265,129	210,951	211,775	668,651	1,597,301	322,930
		1971-72	1,410	60,222	2,957	63,179	373,999	1,994,261	165,244	211,178	611,888	1,428,307	482,611

(a) Australian Standard Industrial Classification.

(b) Includes working proprietors.

(c) 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)

	<i>Metal mining</i>		<i>Fuel mining</i>		<i>Construction material quarrying(b)</i>		<i>Non-metal (excluding fuel) mining</i>		<i>Total mining and quarrying</i>	
	<i>Number of casualties</i>		<i>Number of casualties</i>		<i>Number of casualties</i>		<i>Number of casualties</i>		<i>Number of casualties</i>	
	<i>Killed</i>	<i>Injured</i>	<i>Killed</i>	<i>Injured</i>	<i>Killed</i>	<i>Injured</i>	<i>Killed</i>	<i>Injured</i>	<i>Killed</i>	<i>Injured</i>
1975-76—										
New South Wales	3	221	4	61	1	14	..	18	8	314
Victoria . . . . .	..	..	..	43	1	(c)58	1	(c)1	2	102
Queensland	(d)2	(d)145	(d)18	(d)253	..	(d)5	..	(d)4	(d)20	(d)407
South Australia . . . . .	..	29	..	11	..	39	3	7	3	86
Western Australia	(c)11	(c)482	..	84	..	13	..	17	11	596
Tasmania	2	163	..	3	..	3	..	..	2	169
Northern Territory . . . . .	..	24	..	..	..	..	..	..	..	24
Australian Capital Territory . . . . .	..	..	..	..	(b)	(b)	..	..	(b)	(b)
Australia(b)(c)	18	1,064	22	455	2	132	4	47	46	1,698
1974-75	22	1,130	17	477	3	84	1	50	43	1,741

(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 1975.

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 1975-76 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		1971-72	1972-73	1973-74	1974-75	1975-76
METALLIC MINERALS						
Antimony concentrate	tonnes	611	1,440	1,346	1,555	1,649
Antimony content	"	338	930	860	990	1,089
Antimony ore	tonnes	(a)	(a)	(a)	(a)	507
Antimony content	"	(a)	(a)	(a)	(a)	(a)
Bauxite	'000 tonnes	13,697	14,702	18,545	22,205	19,755
Alumina (Al ₂ O ₃) content	"	(a)	(a)	(a)	(a)	(a)
Beryllium ore	tonnes	61	118	180	6	..
Beryllium oxide (BeO) content	mtu	678	1,386	2,123	72	..
Bismuth concentrate	tonnes	1,281	1,609	2,701	4,388	4,829
Bismuth content	kg	325,474	343,349	444,473	690,488	817,175
Copper content	tonnes	114	157	400	575	695
Gold content	'000 grams	2,239	2,026	956	974	729
Selenium content	tonnes	36	31	5	..	..
Silver content	'000 grams	436	520	274	386	286
Copper concentrate	tonnes	636,018	824,772	938,235	894,062	788,703
Copper content	"	159,239	186,763	233,371	220,257	202,865
Bismuth content	kg	22,353	12,100	580,664	484,060	34,478
Gold content	'000 grams	2,985	2,463	3,402	2,522	2,000
Lead content	tonnes	341	633	754	599	507
Palladium content	'000 grams	..	..	..	..	..
Platinum content . . . . .	"	..	..	..	..	..
Silver content	"	32,342	38,343	40,900	39,000	32,232
Zinc content	tonnes	994	2,058	2,324	1,800	1,655
Copper ore	tonnes	18,890	12,504	23,252	15,336	4,364
Copper content	"	1,261	946	1,407	996	372
Gold content	'000 grams	..	1	..	..	3
Silver content	"	84	..	..	18	15
Copper ore for fertilizer	tonnes	152	3,048	1,516	1,000	..
Copper content	"	7	24	6	8	..
Copper oxide	tonnes	663	976	861	1,446	2,316
Copper content	"	517	752	663	1,111	1,784
Copper precipitate	tonnes	247	170	173	44	68
Copper content	"	179	130	129	32	50
Gold content	'000 grams	..	..	..	..	..
Silver content . . . . .	"	..	..	..	..	..
Gold bullion (b)	'000 grams	20,762	17,930	13,906	12,903	15,964
Gold content	"	16,179	13,938	10,412	10,022	12,550
Silver content	"	3,769	3,264	2,519	2,014	2,383
Gold ore	tonnes	..	..	116	236	294
Gold content	'000 grams	..	..	1	2	59
Iron ore (c)	'000 tonnes	62,103	74,645	91,508	98,159	92,687
Iron content	"	39,255	47,204	57,801	60,860	58,263
Iron oxide (d)	tonnes	66,908	86,569	71,117	62,886	55,758
Lead concentrate	tonnes	(e)622,592	(e)582,178	563,036	615,212	576,481
Lead content	"	395,214	356,695	345,290	390,848	369,466
Antimony content	"	711	619	574	(a)	(a)
Cadmium content	"	83	53	47	57	54
Copper content	"	3,603	3,176	2,988	3,679	3,347
Gold content	'000 grams	383	312	276	383	307
Silver content	"	540,465	490,615	497,096	560,391	559,923
Sulphur content	tonnes	56,831	50,826	44,236	51,153	45,362
Zinc content	"	33,922	31,786	29,758	31,127	31,283
Lead-copper concentrate	tonnes	18,025	16,605	19,919	19,952	19,480
Lead content	"	5,127	5,034	5,138	4,207	4,823
Copper content	"	2,133	1,828	2,350	2,652	2,656
Gold content	'000 grams	1,260	1,038	972	913	986
Silver content	"	49,602	49,357	53,034	45,211	42,780
Sulphur content	tonnes	5,005	4,427	5,673	6,055	5,527
Zinc content	"	2,360	2,333	2,657	2,409	1,942

For footnotes see end of table.

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

<i>Mineral</i>		1971-72	1972-73	1973-74	1974-75	1975-76
METALLIC MINERALS—<i>continued</i>						
Lead ore (<i>f</i>)	tonnes	31,284	39,760	32,711	47,562	42,997
Lead content	"	1,774	2,553	1,847	2,613	2,718
Copper content	"	..	4	..	..	..
Silver content	'000 grams	2,044	3,480	2,153	2,939	3,503
Zinc content	tonnes	18	63	..	..	..
Lead-zinc middlings	tonnes	20,055	26,553	11,609	10,654	9,483
Lead content	"	4,910	5,733	2,136	2,371	1,745
Antimony content . . . . .	"	..	..	..	10	9
Cadmium content	"	22	29	22	21	19
Copper content	"	133	175	134	128	114
Gold content	'000 grams	17	23	22	28	25
Silver content	"	16,746	23,880	15,643	16,842	13,674
Sulphur content	tonnes	4,309	5,515	3,223	3,036	2,702
Zinc content	"	5,373	8,038	4,011	3,359	3,139
Manganese ore—						
Metallurgical grade	'000 tonnes	1,164	1,295	1,619	1,410	1,576
Manganese content	tonnes	554,616	624,042	765,146	666,780	765,275
Other grades	"	96	16	17	..	..
Manganese content	"	28	4	..	..	..
Mineral sands (<i>g</i>)—						
Ilmenite concentrate	tonnes	(h)705,259	(h)720,996	(h)676,566	(h)891,090	(h)929,269
Titanium dioxide content	"	398,243	396,514	337,363	503,582	523,527
Leucoxene concentrate	tonnes	12,343	10,465	11,374	17,559	14,821
Titanium dioxide content	"	11,112	9,336	10,128	15,642	13,082
Monazite concentrate	tonnes	5,148	4,534	4,052	3,371	4,766
Monazite content	"	4,735	4,148	3,715	3,108	4,392
Rutile concentrate	tonnes	355,675	318,698	308,050	334,205	367,763
Titanium dioxide content	"	343,378	305,962	295,514	320,496	352,710
Xenotime concentrate	tonnes	14	17	10	16	14
Yttrium oxide content	kg	3,658	4,318	4,378	4,880	4,200
Zircon concentrate	tonnes	390,515	373,024	347,014	392,751	386,604
Zirconium dioxide content	"	258,767	247,545	290,519	322,191	316,075
Molybdenite concentrate	tonnes	18	..	8	..	..
Molybdenum disulphide	kg	15,676	..	7,360	..	..
Nickel concentrate	tonnes	299,144	268,349	323,142	405,380	471,662
Nickel content	"	35,559	36,104	42,247	49,106	57,307
Cobalt content	"	167	203	109	79	135
Copper content	"	2,590	2,659	3,407	4,449	4,585
Palladium content	kg	..	..	71	147	192
Platinum content . . . . .	"	..	..	17	62	79
Nickel ore	'000 tonnes	..	(a)	..	1,042	1,922
Nickel content	tonnes	..	(a)	..	(a)	23,646
Pyrite concentrate	tonnes	261,481	198,096	239,274	219,066	213,348
Sulphur content	"	120,586	93,839	114,340	104,126	101,352
Gold content	kg	..	..	..	..	..
Silver content . . . . .	"	..	..	..	..	..
Tantalite-columbite concentrate	kg	162,019	236,831	231,520	178,700	119,970
Tantalite-columbite content	"	76,217	84,744	91,108	53,734	52,160
Tin content	tonnes	..	..	..	..	..
Tin concentrates	tonnes	19,722	22,513	20,040	19,552	19,143
Tin content	"	10,913	11,625	10,518	10,095	9,609
Copper content . . . . .	"	..	..	6	..	..
Tantalite-columbite content	kg	..	..	(a)	..	..
Tin-copper concentrate	tonnes	5,187	4,586	3,241	2,506	2,896
Tin content	"	157	129	81	73	76
Copper content	"	977	878	652	522	628

For footnotes see end of table

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

<i>Mineral</i>		1971-72	1972-73	1973-74	1974-75	1975-76
METALLIC MINERALS—<i>continued</i>						
Tungsten concentrates—						
Scheelite concentrate	tonnes	1,842	1,789	1,630	1,672	2,360
Tungstic oxide content	m.t.u.	135,347	131,973	117,100	120,700	167,000
Wolfram concentrate	tonnes	841	761	374	524	641
Tungstic oxide content	m.t.u.	61,025	55,528	25,676	36,862	45,422
Bismuth content . . . . .	"	..	..	..	..	..
Wolfram ore	tonnes	..	122	..	..	..
Tungstic oxide content	m.t.u.	..	100	..	..	..
Zinc concentrate	tonnes	867,143	865,248	768,753	879,612	839,627
Zinc content	"	454,874	462,717	399,526	457,700	432,661
Cadmium content	"	1,520	1,547	1,361	1,523	1,500
Cobalt content	"	116	107	92	116	103
Copper content	"	1,167	1,226	1,156	1,181	1,200
Gold content	'000 grams	188	201	198	170	204
Lead content	tonnes	13,431	14,360	15,266	15,862	17,405
Manganese content	"	7,711	8,443	5,426	6,146	5,785
Mercury content	kg	483	512	313	86	332
Silver content	'000 grams	54,677	61,023	62,717	62,245	65,072
Sulphur content	tonnes	273,583	324,960	241,868	278,915	268,068
Zinc ore	tonnes	..	..	18,315	33,493	22,851
Zinc content . . . . .	"	..	..	3,010	11,779	8,583

COAL

Black coal	'000 tonnes	53,549	59,755	59,344	70,142	69,269
Semi-anthracite . . . . .	"	..	..	..	..	..
Bituminous	"	50,340	56,444	55,924	65,475	63,967
Sub-bituminous	"	3,208	3,311	3,420	4,667	5,302
Brown coal (lignite)(i)	"	19,998	20,922	23,258	24,441	26,711
Brown coal briquettes	"	1,308	1,228	1,164	1,092	946

PETROLEUM (j)

Crude oil	'000 cu m	19,038	20,669	23,096	23,096	23,839
Natural gas	mil. cu m	2,628	3,713	4,360	4,633	5,172
Natural gas condensate(k)	cu m	(a)	(a)	8,181	7,719	6,619
Ethane(e)	'000 cu m	3,087	27,436	46,176	63,677	73,208
Liquefied petroleum gases(l)—						
Propane	'000 cu m	577	798	1,124	1,026	1,053
Butane	'000 cu m	662	988	930	1,148	1,182

CONSTRUCTION MATERIALS(m)

Sand	'000 tonnes	19,501	21,869	24,684	24,807	23,206
Gravel	"	12,871	14,520	15,982	17,315	14,643
Dimension stone	"	411	288	119	163	169
Crushed and broken stone	"	50,475	51,037	54,803	57,337	53,780
Other	"	26,405	42,113	33,264	33,697	31,826

For footnotes see end of table

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

Mineral	1971-72	1972-73	1973-74	1974-75	1975-76
OTHER NON-METALLIC MINERALS					
Asbestos	tonnes (e) 3,077	32,358	37,651	36,558	57,235
Barite	" 23,750	23,175	6,436	12,013	(a)
Carbon dioxide	" (a)	(a)	(a)	(a)	(a)
Clays—					
Brick and shale	'000 tonnes 7,872	8,098	9,246	7,844	8,856
Other(n)	" 1,207	1,321	1,382	1,311	1,202
Diatomite	tonnes 1,758	4,792	8,313	6,035	1,681
Dolomite	" 390,832	402,312	421,471	411,541	515,094
Felspar (including cornish stone)	" 2,948	2,916	3,049	4,278	4,123
Fluorspar	" 380	1,700	874	..	..
Garnet concentrate	" 525	111	109	..	1
Gypsum	'000 tonnes 1,011	962	1,193	1,008	912
Limestone (including shell and coral)	" 10,154	10,960	11,312	11,209	10,185
Lithium ores(o)	tonnes 1,930	695	1	..	..
Lithia (Li ₂ O) content	mtu 8,108	2,828	4	..	..
Magnesite, crude	tonnes 18,684	21,822	20,543	36,273	(a)
Mineral pigments—red ochre	" 23	625	608	..	874
Peat(p)	" 4,489	(a)	3,747	3,384	(a)
Pebbles—for grinding	" 1,927	1,509	1,611	998	1,799
Perlite	" 295	1,834	1,739	3,555	2,136
Phosphate rock	" 2,512	1,494	1,484	35,815	168,601
Pyrophyllite	" 6,972	12,718	11,357	14,264	15,542
Salt	'000 tonnes 3,503	3,671	4,683	5,057	5,350
Silica	" 1,012	1,169	1,385	1,388	1,188
Sillimanite	tonnes 654	654	719	703	567
Talc (including steatite and chlorite)	" 43,997	47,927	63,068	72,072	74,306
Vermiculite	" 171	636	(a)	(a)	..

(a) Not available for publication. (b) Includes alluvial gold. (c) Includes iron concentrate. (d) For cement manufacture, coal washing. (e) Excludes Western Australian production. (f) Includes silver-lead ore, silver-lead slimes and lead slag. (g) Details relating to rutile-zircon concentrates produced in one State and finally separated in another State are included in separated form in the data of the State of origin. (h) Includes Beneficiated Ilmenite. Also includes ilmenite from which titanium dioxide is not commercially extractable. (i) Excludes brown coal used for briquette production. (j) Source: Department of National Resources and State Mines Departments. (k) Sales—excludes condensate blended and other petroleum products. (l) Excludes refinery production. (m) Incomplete, see individual States. (n) Incomplete owing to difficulties of coverage. (o) Used mainly for non-metallic purposes. (p) Comprises peat for fertiliser and peat moss.

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

CONTENTS OF METALLIC MINERALS PRODUCED

<i>Contents of metallic minerals produced</i>	<i>1971-72</i>	<i>1972-73</i>	<i>1973-74</i>	<i>1974-75</i>	<i>1975-76</i>
Alumina (Al ₂ O ₃) '000 tonnes	(a)	(a)	(a)	(a)	(a)
Antimony tonnes	1,120	(a)	(a)	(a)	(a)
Beryllium oxide (BeO) mtu(b)	678	1,386	2,123	72	..
Bismuth '000 grams	347,778	355,449	1,025,137	1,238,837	890,703
Cadmium tonnes	1,625	1,629	1,430	1,601	1,573
Cobalt "	283	310	201	1,055	2,026
Copper "	171,920	198,718	246,669	235,590	218,296
Gold '000 grams	23,253	20,002	16,271	15,061	16,901
Iron(c) '000 tonnes	39,255	47,204	57,801	60,860	58,263
Lead tonnes	420,797	385,008	370,431	416,500	396,664
Manganese(d) "	562,327	632,485	770,572	672,926	771,060
Manganese dioxide (MnO ₂)(e) "	28	4	..	..	..
Mercury kg	483	512	313	86	332
Molybdenum disulphide (MoS ₂) "	15,676	..	7,360	..	..
Monazite tonnes	4,735	4,148	3,715	3,108	4,392
Nickel "	35,559	36,104	42,247	49,106	80,953
Palladium grams	..	..	71,000	147,000	192,000
Platinum . . . . . "	..	..	17,000	62,000	79,000
Selenium tonnes	36	31	5	..	..
Silver '000 grams	700,165	670,482	674,359	709,913	721,544
Sulphur(f) tonnes	460,313	479,567	409,340	443,285	423,011
Tantalite-columbite (Ta ₂ O ₅ + Nb ₂ O ₅) '000 grams	76,217	84,744	91,108	53,734	52,160
Tin tonnes	11,070	11,754	10,599	10,168	9,685
Titanium dioxide (TiO ₂) "	752,733	711,812	679,005	839,720	889,460
Tungstic oxide (WO ₃) mtu(b)	196,372	187,601	142,776	157,562	212,422
Yttrium oxide (Y ₂ O ₃) '000 grams	3,658	4,318	4,378	4,880	4,200
Zinc tonnes	497,541	506,995	441,286	508,174	479,263
Zirconium dioxide (ZrO ₂) "	258,767	247,545	290,519	322,229	316,131

(a) Not available for publication. (b) Metric ton unit (mtu) equals 10 kilograms. (c) Excludes iron content of iron oxide not intended for metal extraction. Includes iron contained in iron concentrate. (d) Content of metallurgical grade manganese ore and zinc concentrate. (e) Content of manganese ore of other than metallurgical grade. (f) Sulphur content of pyrite and other minerals from which sulphur is recovered.

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

Value of minerals produced

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

VALUE OF MINERALS PRODUCED
(\\$'000)

<i>Mineral</i>	<i>1971-72</i>	<i>1972-73</i>	<i>1973-74</i>	<i>1974-75</i>	<i>1975-76</i>
METALLIC MINERALS					
Antimony—					
Concentrate	176	546	932	1,904	1,462
Ore	(a)	(a)	(a)	(a)	(a)
Bauxite	(a)	(a)	(a)	(a)	(a)
Beryllium ore	16	23	23	1	..
Bismuth concentrate	5,066	6,813	7,609	14,085	10,591
Copper—					
Concentrate	114,956	154,748	267,873	168,047	159,876
Ore(b)	947	701	(a)	766	305
Ore for fertiliser	6	9	5	3	..
Oxide	475	757	982	1,406	1,900
Precipitate	134	101	168	31	42
Gold—					
Bullion(c)	21,435	25,730	26,839	43,139	43,735
Ore . . . . .	..	..	3	8	10
Iron ore	372,483	395,189	427,518	613,169	674,515
Iron oxide	773	1,150	(a)	855	915
Lead concentrate	(d)69,340	(d)72,060	110,875	124,519	117,099
Lead-copper concentrate	4,444	6,089	8,799	7,609	8,363
Lead ore(e)	321	494	403	579	566
Lead-zinc middlings	1,846	2,560	2,002	2,422	2,094
Manganese ore	(a)	(a)	(a)	(a)	(a)
Mineral sands—					
Ilmenite concentrate	(f)8,071	(f)8,155	(f)7,953	(f)14,270	(f)15,835
Leucoxene concentrate	1,089	722	1,060	2,079	2,078
Monazite concentrate	608	551	542	515	774
Rutile concentrate	41,023	36,510	36,750	53,699	71,750
Xenotime concentrate	18	22	7	12	9
Zircon concentrate	12,503	11,821	16,726	58,128	60,935
Molybdenite concentrate	17	..	6	..	..
Nickel concentrate	(a)	(a)	(a)	(a)	(a)
Nickel ore . . . . .	..	(a)	..	(a)	(a)
Pyrite concentrate	2,230	139	238	441	771
Tantalite-columbite concentrate	835	670	777	942	1,256
Tin concentrate	30,406	32,282	43,448	49,138	49,060
Tin-copper concentrate	659	516	860	390	435
Tungsten ores and concentrates	7,979	5,550	5,292	11,385	15,497
Zinc concentrate	63,393	61,820	97,122	138,385	133,340
Zinc ore . . . . .	..	..	1,551	2,439	1,600
Other metallic minerals . . . . .	..	..	..	84	2,928
Total metallic minerals	921,642	995,416	1,281,782	1,572,746	1,676,273
COAL					
Black coal	330,504	390,980	449,855	874,879	1,211,199
Brown coal (lignite)(g)	21,768	24,716	27,251	40,556	48,346
Brown coal briquettes	11,280	9,173	11,011	11,391	11,974
Total coal	363,553	424,869	488,116	926,827	1,271,519
PETROLEUM(h)					
Petroleum	271,981	311,903	378,750	446,298	513,155

For footnotes see next page.

VALUE OF MINERALS PRODUCED—*continued*
(\$'000)

<i>Mineral</i>	<i>1971-72</i>	<i>1972-73</i>	<i>1973-74</i>	<i>1974-75</i>	<i>1975-76</i>
CONSTRUCTION MATERIALS(i)					
<i>Construction materials</i>	<i>159,031</i>	<i>170,484</i>	<i>196,611</i>	<i>238,044</i>	<i>253,845</i>
OTHER NON-METALLIC MINERALS					
Asbestos	(j)453	3,256	4,140	7,960	18,406
Barite	202	208	98	303	(a)
Carbon dioxide	38	47	52	45	56
Clay—					
Brick clay and shale	8,408	9,355	11,153	10,241	12,634
Other clays	2,385	2,682	(a)	(a)	4,335
Diatomite	17	43	70	45	60
Dolomite	844	888	1,087	991	1,262
Felspar (including cornish stone)	38	35	48	87	97
Fluorspar	22	79	49	..	..
Garnet concentrate	8	2	2	..	..
Gems	27,262	40,911	47,262	37,032	41,972
Gypsum	2,819	2,826	3,665	3,176	3,069
Limestone (including shell and coral)	15,135	16,932	20,794	24,221	26,087
Lithium ores	30	11	..	..	..
Magnesite, crude	236	318	291	722	(a)
Mineral pigments—red ochre	..	10	6	..	15
Peat(k)	87	(a)	143	146	(a)
Pebbles—for grinding	38	36	43	27	38
Perlite	3	18	11	32	12
Phosphate rock	10	6	6	894	1,508
Pyrophyllite	58	112	103	156	200
Salt	11,804	12,655	16,410	21,951	29,394
Silica	3,555	4,484	5,353	6,301	6,559
Sillimanite	17	17	19	22	18
Talc (including steatite and chlorite)	782	(a)	1,363	1,348	(a)
Vermiculite	1	35	(a)	(a)	..
<i>Total other non-metallic minerals</i>	<i>74,253</i>	<i>95,943</i>	<i>116,062</i>	<i>120,097</i>	<i>149,398</i>
TOTAL					
Total, all minerals and construction materials	1,790,460	1,998,615	2,461,320	3,304,012	3,864,189

(a) Not available for publication. (b) Includes value of copper slag. (c) Includes alluvial gold. (d) Excludes value of Western Australian production. (e) Includes value of silver-lead ore, silver-lead slimes and lead slag. (f) Includes beneficiated ilmenite. (g) Excludes value of coal used in making briquettes. (h) 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. (i) Incomplete owing to difficulties of coverage in some States. (j) Excludes Western Australian production. (k) Comprises peat for fertiliser and peat moss.

Foreign participation in the mining industry in Australia

Summary information on foreign ownership and control of the mining industry in Australia is shown in Chapter 24. More detailed statistics are available in *Foreign Ownership and Control of the Mining Industry* (5317.0) and *Foreign Ownership in Mineral Exploration* (5230.0).

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:

- (i) State Mines Departments and business undertakings operated by State and local government authorities.
- (ii) the Commonwealth Government (Bureau of Mineral Resources, Geology and Geophysics, The Joint Coal Board, The Atomic Energy Commission and The Mines Branch of the Department of the Northern Territory).

Expenditure, metres drilled

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

MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM)

	1971-72	1972-73	1973-74	1974-75	1975-76
Expenditure (\$'000)—					
On drilling	32,864	29,039	28,824	36,172	35,104
Other	91,611	79,088	83,714	88,029	82,033
Australia	124,475	108,127	112,539	124,200	117,137
Metres drilled ('000)—					
Drilled-core	794	769	657	733	530
Drilled-non-core	2,514	2,181	1,854	1,775	1,589
Australia	3,308	2,949	2,511	2,509	2,119

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 bulletin, *Petroleum Exploration* (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

		1971	1972	1973	1974	1975
Expenditure—						
Private sources	\$'000	78,883	103,626	93,240	89,534	59,990
Government sources	\$'000	4,371	4,548	4,880	4,468	4,941
Total	\$'000	83,254	108,174	98,120	94,002	64,931
Wells—						
Drilled (i.e. those which reached final depth)—						
As oil producers	No.	1	3	1	1	..
As gas producers	No.	12	17	8	4	3
As oil and gas producers(a)	No.	..	..	2	3	1
Plugged and abandoned	No.	62	82	49	43	21
Total	No.	75	102	60	51	25
Average final depth of wells drilled	m	2,274	2,213	2,441	2,321	1,953
Drilling still in progress at 31 December (uncompleted holes)	No.	8	9	7	2	1
Wells drilled or drilling over 3,000 metres	No.	23	20	22	16	5
Metres drilled—						
Completed wells	m	153,344	204,836	127,978	118,256	47,617
Uncompleted holes	m	15,199	19,595	12,860	3,028	620
Total	m	168,543	224,431	140,838	121,284	48,237

(a) This breakdown not available prior to 1973.

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).

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	1971-72	1972-73	1973-74	1974-75(a)	1975-76(a)
METALS(b)					
Non-ferrous—					
Alumina '000 tonnes	2,826	3,527	4,516	5,073	5,618
Refined aluminium . . . tonnes	212,461	207,531	208,756	222,876	220,027
Blister copper(c) "	144,791	149,512	184,952	189,257	174,187
Refined copper "	130,827	136,792	149,300	178,451	164,279
Lead bullion (for export)(c) . . . "	141,582	138,798	149,257	149,876	152,256
Refined lead "	190,638	173,561	201,025	170,508	168,183
Refined zinc "	274,245	302,536	281,586	243,209	204,534
Refined tin "	6,391	7,301	6,509	5,973	5,386
Ferrous—					
Pig iron(d) '000 tonnes	6,006	7,021	7,444	7,598	7,519
Steel ingots(d) "	6,480	7,209	7,504	8,063	7,937
Precious—					
Refined gold(e) '000 grams	16,394	14,689	11,106	10,744	12,829
Refined silver "	273,142	247,933	259,221	272,855	226,209
FUELS					
Coal products—					
Metallurgical coke . . . '000 tonnes	4,136	4,926	4,921	5,103	5,253
Brown coal briquettes . . . "	1,329	1,221	1,164	1,092	946
Petroleum products—					
Motor spirit mil. litres	10,609	11,157	12,200	12,508	12,501
Furnace fuel '000 tonnes	5,015	5,042	5,265	4,656	4,340
Automotive distillate "	3,426	3,707	4,265	4,682	5,003
Industrial diesel fuel "	1,112	1,055	1,276	1,110	1,216
BUILDING MATERIALS					
Clay bricks millions	1,744	1,881	2,050	1,722	1,820
Portland cement '000 tonnes	4,884	5,097	5,412	5,273	5,100
Plaster of paris "	315	342	361	339	355
Plaster sheets '000 sq m	34,315	39,151	44,105	42,372	44,794
CHEMICALS					
Sulphuric acid '000 tonnes	1,756	2,266	2,434	1,770	1,295
Caustic soda tonnes	127,857	123,219	140,578	141,430	139,535
Superphosphate(f) '000 tonnes	3,508	4,962	5,288	3,092	2,278

(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 mineral 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
AUSTRALIA

Commodity(a)	Quantity			Value (\$'000 f.o.b.)		
	1973-74	1974-75	1975-76	1973-74	1974-75	1975-76
EXPORTS(b)						
Non-ferrous—						
Copper—						
Concentrate	tonnes	175,510	146,744	158,891	57,755	44,145
Blister	"	10,426	15,196	9,497	21,856	20,853
Refined	"	50,678	93,862	85,843	76,850	93,800
Matte, slags, etc.	"	8,392	23,496	30,548	2,440	3,859
Lead—						
Concentrate	"	77,678	42,192	84,507	19,445	13,223
Bullion	"	147,820	152,754	151,652	73,059	82,265
Refined	"	134,231	124,766	153,675	43,671	47,436
Slags and residues	"	44,825	25,406	19,340	2,644	2,261
Zinc—						
Concentrate	"	426,272	398,622	424,582	45,560	58,311
Refined	"	164,404	140,429	124,068	69,331	78,526
Slags and residues	"	6,758	5,454	5,304	1,647	1,799
Tin—						
Concentrate	"	7,982	13,700	7,339	13,530	25,623
Refined	"	2,409	2,394	2,351	7,641	11,044
Aluminium—						
Alumina	'000 tonnes	3,951	4,472	5,265	196,078	297,873
Refined	tonnes	45,834	64,064	69,119	20,727	37,536
Ferrous and alloy—						
Iron ore—						
Pellets	'000 tonnes	9,519	7,747	9,040	89,905	101,746
Fines	"	31,874	36,196	34,810	154,078	237,477
Lump	"	36,871	41,404	35,076	248,098	365,783
Tungsten—						
Scheelite concentrate	tonnes	1,658	1,924	2,286	3,419	8,686
Wolfram concentrate	"	382	469	533	792	2,106
Pig iron	"	957,805	558,507	593,051	60,081	62,012
Steel ingots, blooms	"	747,572	1,132,954	1,527,951	64,059	149,322
Mineral sands—						
Ilmenite concentrate	'000 tonnes	711	628	628	8,136	7,658
Rutile concentrate	"	359	338	339	45,324	56,780
Zircon concentrate	"	402	389	286	18,616	56,972
Precious—						
Gold, refined	'000 grams	4,344	2,940	7,659	13,660	10,973
Silver, refined	"	112,894	143,301	89,982	8,212	14,119
Coal, black	'000 tonnes	27,755	32,652	30,260	347,992	660,511
Crude oil(c)	'000 cu m	288	234	243	8,520	14,388

IMPORTS

Tin, refined	tonnes	67	26	34	337	138	181
Nickel (pigs, anodes, etc.)	"	2,687	1,050	992	5,474	3,410	3,761
Ferro-alloys	"	46,335	43,287	25,348	12,570	21,210	11,895
Gold—							
Unrefined bullion(d)	'000 grams	2,697	2,809	3,051	7,265	8,744	9,187
Refined	"	7	24	13	21	108	49
Crude oil(e)	'000 cu m	10,139	9,552	9,569	244,062	475,080	516,361
Asbestos	tonnes	56,839	51,194	56,241	8,216	11,195	17,853
Diamonds—							
Industrial	metric carats	1,084,883	928,558	743,841	3,717	3,420	2,818
Gemstone	"	90,196	69,091	86,721	14,734	14,307	17,268
Phosphate rock	'000 tonnes	3,104	2,639	1,482	35,232	74,059	53,212
Potassium fertilisers	tonnes	190,596	211,108	110,190	5,220	9,523	7,257
Sulphur	"	608,010	925,747	156,495	8,329	14,899	4,986

(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.

Considerable quantities of metallic ores, concentrates, slags, and residues are exported from Australia for refining overseas. The following table shows selected items exported during 1975-76 and their principal metallic content as estimated by assay.

**PRINCIPAL METALLIC CONTENTS OF SELECTED ORES AND CONCENTRATES
ETC., EXPORTED FROM AUSTRALIA, 1975-76**

Ores and concentrates, etc.	Metallic contents—estimated from assay							
	Copper	Lead	Zinc	Tin	Iron	Tungstic oxides	Gold	Silver
	tonnes	tonnes	tonnes	tonnes	'000 tonnes	tonnes	'000 grams	'000 grams
Copper concentrate	46,718	..	..	..	..	..	1,032	11,105
Blister copper	9,757	..	..	..	..	..	1,563	1,804
Copper matte, slags, etc.(a)	2,560	4,223	1,803	..	..	..	1,264	16,853
Lead concentrate	3,222	50,469	5,992	..	..	..	1,328	87,384
Lead bullion	11	150,731	..	..	..	..	..	370,575
Lead slags and residues	348	7,375	26	..	..	..	49	15,400
Zinc concentrate . . . . .	..	2,755	219,682	..	..	..	..	41,028
Zinc slags and residues . . . . .	..	..	4,324	..	..	..	..	..
Tin concentrate	1	..	..	3,309	..	..	..	..
Iron ore—								
Pellets . . . . .	..	..	..	..	6,185	..	..	..
Fines . . . . .	..	..	..	..	23,462	..	..	..
Lump . . . . .	..	..	..	..	24,852	..	..	..
Scheelite concentrate . . . . .	..	..	..	..	..	157,786	..	..
Wolfram concentrate . . . . .	..	..	..	..	..	37,745	..	..
Total metallic content	62,617	215,553	231,827	3,309	54,499	195,531	5,236	544,149

(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)

Period	METALS(a)									
	Tin		Aluminium				Gold		Silver	
	Aust. (\$A— tonne)	L.M.E. (\$Stg— metric ton)	Straits (\$Mal- picul)	Nickel U.S.A. (\$U.S.—lb)	Aust. (\$A— tonne)	U.S.A. (USC—lb)	Premium markets (\$A—f. oz) Australia and Overseas	U.K. (\$US—f. oz)	Aust. (\$A—kg)	U.K. (Stg new pence— f. oz)
1973-74	4,774.1	2,882.8	957.0	1.59	585.0	28.2	88.47	130.76	82.5	162.8
1974-75	5,715.8	3,246.7	1,022.3	1.93	671.0	38.1	121.54	167.86	104.9	187.9
1975-76	5,698.3	3,402.7	1,014.9	2.17	751.7	41.1	110.40	139.32	112.4	221.9
1975-76										
Highest	6,840.0	4,577.5	1,197.1	2.20	787.0	44.0	127.20	168.4	126.6	271.3
Lowest	5,174.0	3,003.0	923.0	2.01	707.0	39.0	102.13	124.6	103.0	189.1

Period	Copper		Lead		Zinc		Zinc		Zinc	
	Aust. (\$A— tonne)	L.M.E. (\$Stg— metric ton)	Aust. (\$A— tonne)	L.M.E. (\$Stg— metric ton)	U.S.A. (USC—lb)	Aust. (\$A— tonne)	L.M.E. (\$Stg— metric ton)	Prod. (\$Stg— ton)	U.S.A. (USC—lb)	
1973-74	1,428.8	980.7	358.4	237.4	18.48	454.2	582.0	282.4	27.45	
1974-75	1,050.5	598.3	366.6	216.5	23.95	612.8	359.1	353.6	38.55	
1975-76	1,017.9	655.3	300.8	194.9	20.32	628.7	364.3	(b)795.0	37.99	
1975-76										
Highest	1,260.0	908.5	355.0	283.0	23.00	651.0	449.5	(b)795.0	41.00	
Lowest	900.0	537.5	290.0	156.8	19.00	603.0	318.9	(b)795.0	37.00	

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)
1973-74	.	42.43	15.70-45.50	9.35-11.32	127.00-240.00	45.00-240.00
1974-75	.	48.58	37.00-50.25	13.00-18.00	200.00-330.00	170.00-330.00
1975-76	.	47.89	36.75-64.00	15.00-18.00	290.00-330.00	140.00-330.00
1975-76—						
Highest	.	56.77	64.00	18.00	330.00	330.00
Lowest	.	44.03	36.75	15.00	290.00	140.00

(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.

Details on monthly prices, and price specifications relating to each commodity in the table are contained in each issue of the bulletin, *Minerals and Mineral Products* (8404.0).

REVIEW OF RECENT DEVELOPMENTS IN THE
AUSTRALIAN MINERAL INDUSTRY

Major developments in the Australian mineral industry, particularly during the last year, are reviewed briefly in subsequent parts of this section. Additional information on developments in the industry is available in *Australian Mineral Industry 1975 Review* published by the Bureau of Mineral Resources, Geology and Geophysics. That publication contains comprehensive reviews of mineral commodities of importance to the Australian economy, as well as a general review of the industry's performance during the year.

General Review of 1975 and 1976

In 1975, the major factors affecting the world mining industry were lack of demand and large increases in costs. Depletion of stocks by consumers resulted in reduced demand for mineral products, and inventories held by producers rose to record levels. Mine, smelter and refinery production continued to be curtailed, and capital expenditure on new projects and expansion programs was either deferred or reduced.

A significant overall growth in the world mining industry occurred in 1976, but this masked the rather disappointing performance of the OECD nations, particularly in Europe. The revival that occurred in the United States terminated late in the year and the western developed economies stagnated in recession. The Communist nations continued their steady increase in output, but the highest growth rates occurred in the developing countries of Asia, mainly in oil and gas production where output in 1975 had been temporarily reduced as a result of OPEC policies. The rapid expansion of the Australian mining industry that had characterised the previous decade came to an end.

In Australia in 1975 the principal economic indicators showed a continuous expansion of the Australian mineral industry but, in general, at a slightly lower rate than the average for the previous two years. In 1976, with the exception of pig iron and steel, they showed a further expansion of the industry. However, black coal production increased by 13 per cent in 1976 (6 per cent in 1975 and 4 per cent in 1974) and the index of exports at constant prices increased by 9 per cent (2 per cent in 1975 and 7 per cent in 1974).

The slackening of the rate of growth of the industry in 1975 resulted mainly from the increase in domestic costs and falling domestic and overseas demand. This fall in the rate of growth was masked somewhat by revenue increases arising from renegotiations of export contracts, and the effects of the September 1974 revaluation of the Australian dollar.

The 1976 record ex-mine value of mineral production of \$4,255 million was an increase of 22 per cent compared with 1975. However, this hid the fact that production of base metals fell and producer stocks of these and some other metals rose because of a serious recession in demand during 1976.

Bauxite and Alumina

The history of the aluminium industry and recent significant developments in the industry were reviewed in previous issues of the Year Book (No. 51, page 1168 and No. 52 page 1048).

In 1976, bauxite production capacity at Weipa, Queensland, was 11.2 million tonnes per annum following completion of a further stage in the development of the mine and associated township, and of ore treatment and loading facilities. Approximately 4 million tonnes from Weipa were used by the Gladstone, Queensland, alumina refinery in 1976; the remaining production is available for export.

A decision has been made to proceed with the bauxite/alumina project in Western Australia to mine bauxite from the Mount Saddleback area and build an aluminium refinery at Worsley. A refinery will also be built at Wagerup by the early 1980's, with an initial capacity of 1 million tonnes of alumina per annum. A study is in progress concerning the limited development of the Mitchell Plateau bauxite deposits for use in refractories and for other special purposes.

The rated annual capacities of the existing alumina plants are now: Gladstone, Queensland, 2,000,000 tonnes; Gove, Northern Territory, 1,000,000 tonnes; Kwinana, Western Australia, 1,400,000 tonnes; and Pinjarra, Western Australia, 2,000,000 tonnes. Bauxite supplies for the Kwinana refinery are obtained from deposits 50 km away at Jarrahdale, the reserves of which are assessed as at least 500 million tonnes, while supplies for the plant at Pinjarra are obtained from Del Park and Huntly.

Copper

Mine production of copper at Mount Isa increased to 141,000 tonnes in 1976. New discoveries include copper-zinc mineralisation at Teutonic Bore, 80 km southwest of Agnew, W.A., and copper-uranium mineralisation at Roxley Downs, S.A. The Kanmantoo, S.A. and Mammoth (Gunpowder), Qld, mines have been placed on care and maintenance. The scale of operations at the Mount Lyell mine, Tasmania, was reduced in 1976 because of lower copper prices. The Commonwealth Government is providing financial assistance to enable the mine to operate at least until June 1978. The Mount Morgan mine, Qld, was still operating in late 1977 but at a reduced scale. Production schedules at Cobarr, N.S.W., have been restricted to alleviate the adverse effects of high production costs and low prices.

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.

The major development of recent years has been the establishment in Australia of a large-scale iron ore export industry based principally on steelmaking requirements in Japan. Exports of iron ore and iron ore pellets in 1976 to Japan and elsewhere were 81.0 million tonnes valued at \$828 million.

Annual production and shipment capacity for iron ore was increased in 1976 to 40 million tonnes by the Mount Newman Joint Venturers, who plan to expand capacity to 45 million tonnes per annum. Hamersley 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.

Silver, lead and zinc

Production of lead and zinc metal in 1976 was 398,300 tonnes and 464,300 tonnes respectively.

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 is expected to begin in late 1978. Operation commenced in 1977 of a 50 tonne per day pilot plant as part of a feasibility study at McArthur River, N.T.. It will operate for 12 months after which progress will be reviewed. Construction of a vertical development shaft to explore the Que River Prospect, Tasmania, commenced in 1977. A test shaft to obtain bulk samples for metallurgical testing of ore at the Elura Prospect, N.S.W., was completed in late 1977.

Black coal

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

The expansion of the export trade has been of major significance. In 1955 exports were about 200,000 tonnes valued at about \$1.7 million; in 1976 exports were 31.2 million tonnes valued at \$1,111 million. These increased exports have been largely to Japan for use in the iron and steel industry and to Europe as steaming coal. 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, particularly in Queensland.

Petroleum

At the end of 1976, there were nine oil fields in production: Moonie, Alton and Bennett in Queensland; Barrow Island, Yardarino and Dongara in Western Australia; and Barracouta, Halibut and Kingfish offshore from Victoria in Bass Strait. The production of crude oil (excluding condensate and LPG) in 1976 amounted to 24,030,000 cubic metres representing 70 per cent of the year's total input to Australian refineries. The average daily production of 65,800 cubic metres in 1976 was one per cent higher than in 1975. Natural gas production in 1976 amounted to 6,100 million cubic metres, 15 per cent more than in 1975. About 10 per cent of this was used in the field and processing plants and the balance was sold, mainly as fuel, to markets in Victoria, South Australia, Western Australia and Queensland. Supplies to the New South Wales market from the Cooper Basin, S.A., commenced in late 1976.

Discoveries in 1976 included one of gas and condensate (non-commercial) at Barolka No. 1 (Cooper Basin in Queensland), and three gas discoveries (all currently non-commercial) at Spar No. 1, (Northwest Shelf, offshore from Western Australia), Perentie No. 1 (Barrow Island, Western Australia) and Namur No. 1, (Cooper Basin, South Australia).

The provisional figure for metres drilled in petroleum exploration and development in Australia in 1976 was 74,826 metres, 28 per cent more than that drilled in 1975; 47,129 metres were in exploration drilling, including 27,697 metres offshore. Of the thirty-four wells completed in 1976, nineteen were exploration wells, including three offshore. Compared with 1975, there was a decline of six in the number of exploration wells and an increase of eleven in the number of development wells drilled. There was also a decline of sixteen in the number of offshore exploration wells. Six exploration and thirteen developmental wells were completed as potential gas producers.

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 increased to about 82,500 tonnes in 1976, about 11 per cent of world mine production. Production is expected to commence at Agnew, W.A., in late 1978, with the concentrates being toll-smeltered at the Kalgoorlie smelter, the capacity of which will consequently be increased. Australia's major nickel producer, Western Mining Corporation Ltd, cut back production in late 1977 because of excess world nickel supplies and the very large nickel stockpiles held by major producers.

Mineral sands

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

Phosphate

Capacity for producing direct-shipping grade rock at Duchess, Qld, was increased to one million tonnes per annum with the commissioning of a new crushing, washing and screening plant in late 1976. A rock drier was commissioned in Townsville in 1977. Production in late 1977 was running below capacity because of marketing problems.

Uranium

The Mary Kathleen, Qld uranium mine and mill re-commenced production in early 1976 and produced 329 tonnes of uranium in yellowcake during the year.

Plans for further development of Australia's uranium resources were held in abeyance during 1976 and much of 1977 pending a Government decision which was made after consideration of the reports of the Ranger Uranium Environmental Inquiry. The Government announced a new uranium Safeguards Policy on 24 May 1977 and announced its decision to allow the mining and export of uranium on 25 August 1977.

Substantial additions to in-place ore reserves at the Jabiluka deposits, N.T. and to uranium resource estimates at new deposits in Queensland (Maureen), South Australia (Honeymoon), and Western Australia (Lake Raeside, Lakeway and Thatchers Soak) were announced in 1976. Significant new uranium discoveries were announced by the Australian Atomic Energy Commission in the Northern Territory, and by Western Mining Corporation Ltd in South Australia at Roxby Downs. The latter is copper-uranium mineralisation which shows promise of developing into a very large low-grade deposit. This discovery is a new type of mineralisation to Australia and opens up the possibility of a major new uranium province.

REFERENCES

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