

## 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 kilometres 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 throughout Australia, their geological age ranging from Precambrian to Recent. Many of the large deposits such as those at Broken Hill (N.S.W.), Mount Isa (Qld), the Kalgoorlie and Pilbara regions of W.A. and the Alligator Rivers area of N.T. are Precambrian in age. In eastern Australia the major deposits such as the Elura, Cobar, Woodlawn and Rosebery base-metal deposits and most of the black coal deposits, are Palaeozoic in age. The black coals of the Moreton district of Queensland, northeast New South Wales and Leigh Creek, S.A. are of Mesozoic age. Deposits formed in Tertiary times include the brown coal in Victoria, the bauxites of Weipa (Qld), Gove (N.T.) and the Darling Range (W.A.) and the nickeliferous laterites at Greenvale (Qld).

##### Mineral resources

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

For further details of principal Australian mineral deposits, and notes on principal mineral resources, see Year Book No. 61, pages 925-932 and the Australian Mineral Industry Quarterly and Annual Reviews.

#### 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. On 1 July 1980, executive authority with respect to mining and minerals except in relation to certain prescribed substances within the meaning of the Atomic Energy Act (principally uranium) was transferred from the Commonwealth Government to the Northern Territory Government. Private mineral rights in the Australian Capital Territory 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.

##### Mineral exploration and development

*Onshore.* Each State or Territory has its own mining Acts or Ordinances and regulations governing the prospecting for and working of mineral deposits. These Acts and regulations, although similar in principle are different in detail. They all make provision for a miner's right to prospect and for small mining leases for mineral production. The principles embodied were established many years ago when

mining operations were generally small scale and labour-intensive. Although amendments have been enacted to modernise the legislation, it is generally inadequate for the large-scale capital-intensive operations often involved with modern mineral development. For this reason a large enterprise may take the course of acquiring mining titles by negotiations with the appropriate Minister for Mines and having the agreed terms and conditions embodied in an Act of the State Parliament. This method of acquisition has been used in several cases where the leasing company undertook an obligation (such as the erection of a large treatment works) in return for leases over large areas for a long period, and has become more common in recent years (e.g. iron ore in Western Australia, coal and bauxite in Queensland, bauxite in the Northern Territory). Mining legislation enacted in recent years is simpler and more suited to modern conditions.

As a result of the introduction of large-scale modern prospecting methods (particularly airborne prospecting), small prospecting areas 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) and, if renewed for a further period, is only over an area selected from the larger area (usually 50 per cent) as a result of work done during the life of the initial agreement. It does not give the holder any rights over, or authority to prospect on, land already held under a mining title within the agreed area. Unless specifically stated in an agreement, the discovery of minerals, whether inside or outside an area covered by an authority to prospect, gives the discoverer no legal rights except the right to apply for a mining lease over the area in which the discovery was made. Suitable prospects are converted to mining tenements by making application for lease under the appropriate mining Act.

*Offshore.* Following the enactment of the *Seas and Submerged Lands Act* 1973 the High Court confirmed that the Commonwealth has sovereignty over the territorial sea and sovereign rights over the resources of the whole of Australia's continental shelf. However, in the offshore constitutional settlement between the Commonwealth and the States reached in June 1979, it was agreed that responsibility for mining within the outer boundary of the 3 mile territorial sea should lie with the States, while the Commonwealth should have responsibility for areas beyond.

*The Minerals (Submerged Lands) Act* 1981 passed by the Commonwealth Parliament in June 1981 follows the scheme of the offshore petroleum legislation amendments passed in 1980 and provides for Joint Commonwealth/State Authorities to be responsible for major matters under the legislation with the States being responsible for day-to-day administration. The legislation will be proclaimed to come into effect when complementary State legislation in respect of the 3 mile territorial sea, currently in preparation, is enacted. In the meantime administration of offshore mining is carried out under the States' onshore mining legislation on an interim basis.

The mining code under the new legislation provides for a two-stage system of titles: the exploration permit, which covers all forms of exploration, and the production licence, which covers development.

### **Petroleum exploration and development**

*Onshore.* 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:

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

*Offshore.* In the offshore constitutional settlement between the Commonwealth and the States reached in June 1979, it was agreed that, as in the case of mining for other minerals, responsibility for administering petroleum exploration and production within the outer boundary of the 3 mile territorial sea would be a State responsibility, while the Commonwealth would have responsibility for the continental shelf beyond the 3 mile territorial sea.

Amendments to the *Petroleum (Submerged Lands) Act* 1967 passed by the Commonwealth Parliament in May 1980 and proclaimed on 14 February 1983, provide for a Joint Authority for the adjacent area of each State (beyond the 3 mile territorial sea limit) consisting of the Commonwealth Minister and the State Minister. The Joint Authorities are concerned with major matters arising under the legis-

lation, and in the case of disagreement the view of the Commonwealth Minister will prevail. Day-to-day administration will continue to be in the hands of the State Minister as the Designated Authority and State officials.

The mining code applicable under 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 production. The sharing of royalty between the State and the Commonwealth Governments is to continue on a 60-40 basis, and any override royalty payments will continue to be retained by the States. The offshore constitutional settlement and the operation of Commonwealth and State offshore petroleum legislation are being reviewed by the Commonwealth Government. Decisions on the outcome of the review and details of any changes are expected to be known in 1985.

On 27 June 1984, the Minister for Resources and Energy and the Treasurer announced final details of a resource rent tax to apply to offshore 'greenfields' petroleum projects from 1 July 1984. The resource rent tax is intended to replace royalties and excise and will constitute a deduction for company tax purposes.

### Mineral royalties

The collection by governments of royalties for the production of minerals within their area of authority is an internationally-accepted practice. In Australia, the responsibility for mineral royalties is largely a State concern, and all States currently collect some form of mineral royalty payments.

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

MINERAL ROYALTY RECEIPTS: GOVERNMENTS  
(\$'000)

	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
New South Wales(a)	49,062	35,879	86,938	116,682	88,186	105,403
Victoria(b)(c)	48,446	60,111	90,554	118,611	108,782	124,861
Queensland(a)	53,651	53,638	73,473	73,274	81,382	89,703
South Australia	4,106	4,541	5,869	7,312	8,811	9,321
Western Australia	54,519	57,810	66,712	78,341	81,330	102,454
Tasmania	2,093	2,193	5,261	3,557	2,209	2,082
Northern Territory(d)	277	1,256	2,551	5,666	3,020	2,934
Commonwealth Government(c)	23,002	28,031	43,337	54,567	52,321	68,193
<b>Total</b>	<b>235,156</b>	<b>243,459</b>	<b>374,695</b>	<b>458,010</b>	<b>426,041</b>	<b>504,951</b>

(a) Includes royalties on sand and gravel from Crown lands. (b) Includes royalties on brown coal paid by State Electricity Commission. (c) Includes royalties received under the *Petroleum (Submerged Lands) (Royalty) Act 1967-68*. (d) Excludes the mining royalties paid into Aboriginal Benefits trust fund prior to 1978-79.

### Control of Exports

The Commonwealth Government has constitutional power over exports from Australia. Under the Customs (Prohibited Exports) Regulations exports of nuclear sensitive material, hydrocarbons and certain minerals and metals are prohibited unless permission is granted by the Minister for Trade or an authorised person.

Among other things, export controls are used to ensure that:

- (i) fair and reasonable market prices are achieved;
- (ii) adequate supplies are available for the domestic market;
- (iii) international and strategic obligations are met;
- (iv) the Government's nuclear safeguards and physical protection requirements on exports are met, consistent with Australia's international obligations in relation to uranium and nuclear materials; and
- (v) account is taken of environmental considerations.

Export controls are administered on coal, iron ore, bauxite, alumina, petroleum and petroleum products, uranium, monazite and materials of nuclear significance. Controls on tin are applied in respect of Australia's obligations under the International Tin Agreement.

Of the remaining minerals and metals subject to Regulations 9 and 11, automatic approval covering expected shipments over a twelve-month period is given, on application, to export ores, concentrates, matte and oxides of copper, lead, manganese, nickel, tungsten and zinc; blister and refined copper, lead bullion, and salt. Approval to export mineral sands is freely given except where the Commonwealth considers there are environmental reasons which would make such exports undesirable. Approval to export monazite and xenotime is freely given subject to the requirements of the Government's nuclear safeguards policy being first met.

Exports of copper scrap and copper alloy scrap are embargoed and quotas apply to secondary copper ingots and other basic shapes made from scrap material.

No other minerals are subject to control.

#### **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.

### **Government assistance**

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

#### **Commonwealth Government assistance**

Assistance provided by the Commonwealth Government takes the form of income taxation concessions, subsidies, bounties, and technical assistance, mainly through the work of the Bureau of Mineral Resources, Geology and Geophysics (BMR) and the Commonwealth Scientific and Industrial Research Organization (CSIRO) as well as through the National Energy Research, Development and Demonstration Program.

*Income taxation concessions as at 30 June 1984.* 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 exploration for and development of petroleum (including natural gas) are allowable to a petroleum mining enterprise engaged in these operations in Australia. Capital expenditure allowable to petroleum mining enterprises includes, broadly, the costs of exploratory surveys, drilling and well-head plant; plant for the liquefaction of natural gas; access roads; and housing and welfare. The enterprise is entitled to these special deductions against income from any source. While the special deductions for exploration expenditure are deductible immediately against the net income of the enterprise, the deductions for capital expenditure on mining are allowable over the life of the oil or gas field or over ten years, whichever is the lesser, on a straight line 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 ten years, whichever is the lesser, on a straight line basis. 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 18 per cent of the cost of certain new plant.

Special deductions are allowable for capital expenditure incurred on certain transport facilities for use in Australia primarily and principally, for the transport of raw minerals (other than petroleum or gold) 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 deductions apply to expenditure incurred on a railway, road, pipeline or similar transport facility and on certain port facilities or other facilities for ships. Allowable expenditure on transport facilities is deductible in equal annual instalments over a period of ten or twenty years at the option of the mining enterprise.

An income tax rebate of 27 cents for each dollar of share capital subscribed may be available to shareholders of petroleum mining companies exploring or mining for petroleum in Australia, including offshore areas, where those companies lodge appropriate declarations with the Commissioner of Taxation in respect of the moneys subscribed. By lodging those declarations, certifying that the capital subscriptions have been, or will be, spent on eligible outgoings within a specified period, the petroleum mining companies forgo deductions to which they might otherwise be entitled for capital expenditure.

*Payments to producers and importers of phosphate fertilizers.* The *Phosphate Fertilizers Subsidy Act 1963* provides for a subsidy to be paid on phosphatic substances produced in Australia or imported and sold for use in Australia as a fertilizer. Phosphatic substances used as a supplement to stock food are also regarded as being used as a fertilizer. Subsidy 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, subsidy 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 fertilizers (primary producers). The Act expires on 30 June 1985.

*Payments to producers and importers of nitrogenous fertilizers.* The *Nitrogenous Fertilizers Subsidy Act 1966* provides for a subsidy to be paid on inorganic nitrogenous substances produced in Australia or imported and sold for use in Australia as a fertilizer. Nitrogenous substances used as a supplement to stock food are also regarded as being used as a fertilizer. Subsidy is payable at the rate of \$20 per tonne of the nitrogen content of which the goods consist. The intention of the Act is to assist consumers of nitrogenous fertilizers (primary producers). The Act expires on 30 June 1985.

*Bureau of Mineral Resources, Geology and Geophysics.* The role of BMR is:

- (i) to develop an integrated, comprehensive, scientific understanding of the geology of the Australian continent, the Australian offshore area and the Australian Antarctic Territory, as a basis for minerals exploration; this to be done where appropriate in co-operation with State Geological Surveys and other relevant organisations and having regard to priorities for the search for minerals approved by the Minister for Resources and Energy;
- (ii) to be the primary national source of geoscience data and to publish and provide information; and
- (iii) to undertake mineral resource assessments in accordance with programs and priorities approved by the Minister for Resources and Energy with the advice of the BMR.

At 31 July 1984, 503 officers were employed at the BMR, this included 152 professional officers (geologists, geophysicists, chemists, engineers and mineral economists), 72 research scientists and seven in the Senior Executive Service.

BMR's research program is carried out by four Divisions—Geophysics, Continental Geology, Marine Geosciences and Petroleum Geology, and Petrology and Geochemistry. Mineral and petroleum resource assessments are undertaken by the Resource Assessment Division which includes Minerals and Petroleum Branches and a Uranium Resource Evaluation Unit. Other branches are Planning and Programs, Special Projects and Geoscience Services, and a Geoscience Database Branch is proposed.

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

#### **State Government assistance**

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

*New South Wales.* The primary objective of the Department of Mineral Resources is to promote the responsible development of mineral resources in New South Wales. The Department administers the various Acts (Coal, Petroleum and Mining) and grants titles to encourage and facilitate the exploration for, prospecting and development of, the State's mineral resources. The Department's staff is deployed in many diverse areas of activity to encourage and assist mining and resource development projects by the mining industry.

A wide range of services, information and advice is provided on many subjects including geological and geophysical investigations, scientific and chemical research, geological and metallogenic mapping, prospecting, mining legislation and administrative procedures. The Geological and Mining Museum, one of the States's foremost specialist museums, is maintained by the Department, as is the reference library of geology, mining and allied topics situated at the Department's head office and Bore Core Library situated at Londonderry, near Penrith.

The Department is engaged in the continuous assessment of the State's mineral resources; its coal exploration and assessment programme in particular has identified many coal deposits of high commercial promise.

*Victoria.* The Department of Minerals and Energy advises on, monitors, co-ordinates and implements energy policy. The Department conducts geological, groundwater and mineral surveys, produces geological maps, and issues scientific and technical reports thereon. Drilling operations are carried out and the results are used in sedimentary basin studies and to evaluate petroleum, mineral and groundwater potential. A comprehensive library and a geological museum are maintained, and a core library retains cores and cuttings from drilling operations. The administration of petroleum, pipeline, hazardous materials, mining and extractive industry legislation ensures that mineral and petroleum exploration and production (both onshore and offshore), mining and quarrying are regulated and controlled. Also that the manufacture, transport, storage and use of explosives and the storage and transportation of inflammable liquids and liquefied gases are carried on in a safe and effective manner. Technical assistance and limited loans and grants are available for mineral exploration and prospecting and for approved development operations. Five stamp batteries located throughout the State provide an ore-crushing service to enable test crushing 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. Information on the manufacture, handling and use of explosives, inflammable liquids and liquefied gases is also provided. 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 regulates, encourages and assists the search for and development of mineral and energy resources, including coal, petroleum and oil shale working through a system of authorities, leases and licenses issued under Acts of Parliament.

The Department provides assistance to mining by way of grants for construction and maintenance of roads in mining areas, repayable advances or subsidies for mine development, hiring of equipment, assistance to prospectors and geological services. Detailed information is collated from in-house geological studies and seismic surveys and continuous scientific appraisal of results achieved and reported by commercial exploration groups. The information effort is underpinned by a Departmental drilling program focusing on coal and mineral exploration and deep stratigraphic drilling.

The Department carries out a continuous inspection of mine safety and provides an expert technical advisory service to mining organisations. Other activities include research on mine safety and health and the administration of safety regulations on gas installations and storage of explosives. Additionally, the Department maintains an Assay Office at Cloncurry, a District Geologist's Office at Charters Towers and has Inspectors of Mines, both metalliferous and coal, stationed at various major centres throughout the State.

The Queensland Coal Board contributes to coal mining research programmes and undertakes sampling tests of Queensland coals. It can make funds available to colliery proprietors for equipment. It provides grants or loans for the provision of amenities for employees and for communities in Queensland coal mining areas. The Board also provides financial assistance for the Coal Miners' Health Scheme.

*South Australia.* The Department of Mines and Energy has as its principal functions the administration of mining and petroleum legislation including the granting of mineral leases and collection of royalties and fees; geological and geophysical investigations to ascertain the extent and nature of the State's mineral resources; drilling to test mineral deposits, petroleum reserves and underground water supplies; the testing and treatment of minerals, generally in arrangement with the Australian Mineral Development Laboratories; control of mining and rehabilitation; co-ordinating State Government activities and formulating policy advice in the discovery, assessment and development of all energy resources within the State.

*Western Australia.* The Western Australian Department of Mines operates fifteen State batteries throughout the goldfields, for the treatment of ore (principally gold) from prospectors and small mine owners, at a nominal charge. Through its Geological Survey Division, the Mines Department carries out geological investigations and surveys throughout the State. The results of this work are made available in both map and report format. The Government Chemical Laboratories Branch of the Mines Department provides analytical and research services to the mining and mineral exploration industry.

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

*Northern Territory.* The Department of Mines and Energy encourages the development of an efficient mining and processing industry. Through five divisions the Department administers relevant legislation and provides a wide range of services.

The N.T. Geological Survey Division elucidates the regional geology and geophysics of the Territory, researches new mapping, geological survey and mineral search techniques and provides technical information through its computer indexes at Darwin and Alice Springs.

Registration and orderly administration of mineral and petroleum tenure, and provision of essential drafting services fall within the ambit of the Policy and Administration Division.

Mines Division has primary responsibility for the development of policy and legislation relating to exploration and mining industries. It also provides advice to the government on special projects. The Division has regulatory responsibility in the fields of occupational hygiene, mine safety and environment protection to ensure the efficient, orderly and safe recovery and utilisation of the Territory's mineral resources. A range of services including technical and financial are also provided to prospectors.

Energy Division has primary responsibility for policy development, and advice to Government, on all energy matters. Its regulatory function in the petroleum exploration and development area is administered from Darwin and Alice Springs.

The Industrial Safety Division provides inspectorial, training and advisory safety services in the fields of construction safety, dangerous goods and machinery safety. These services are provided from the Division's offices at Darwin, Alice Springs, Tennant Creek and Katherine.

## Research

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

### **Australian Atomic Energy Commission**

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

### **The Australian Mineral Development Laboratories**

Technical consulting, contract research and process design for the mineral and associated industries is undertaken by The Australian Mineral Development Laboratories (Amdel). Operations are based in Adelaide with branch laboratories in Perth, Melbourne, Sydney and Townsville. This organisation is controlled by a council comprising representatives of the mineral industry, the South Australian Government and the Commonwealth Government. Extensive facilities are available in the fields of analytical chemistry, mineralogy, petrology, hydrocarbon fuels, chemical metallurgy and mineral engineering, process instrumentation and control, water and waste water treatment and materials technology. Both long and short term applied research is carried out and all investigations are conducted on a strictly confidential basis. Services in the field of pollution and environmental control are also available through the Amdel group, Aspect.

### **The Baas Beeking Geobiological Laboratory**

In 1965, the Baas Beeking Geobiological 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, Geology and Geophysics and the Australian Mineral Industries Research Association (*see* Research by private enterprise, below).

Subjects of current research are ore genesis and petroleum related investigations. Geological research is coordinated with the field research programs of the Bureau of Mineral Resources, Geology and Geophysics.

### **Bureau of Mineral Resources, Geology and Geophysics**

The BMR is the largest geoscience research organisation in Australia. Its role is to develop an integrated scientific understanding of the geology of the Australian continent, its Territories and offshore areas, as a basis for mineral exploration and resource assessment. BMR carries out programs in:

- Fossil Fuels: including their origin and distribution in space and time; onshore sedimentary basin analysis; geophysical investigations of the structure of onshore basins; framework studies of Australian offshore areas; and modern marine processes.
- Minerals: including the origin and distribution in space and time; metallogenic provinces; the weathered zone; and related resources; airborne geophysical mapping and interpretation; crustal geophysics; and the origin and distribution of offshore mineral deposits.
- Groundwater, and basin hydrogeology.
- Earthquake hazards.
- National and international geoscience maps.
- Overseas programs: including land geoscience in Southeast Asia; marine geosciences in the Southwest Pacific; geoscientific co-operation with China; and Antarctica.
- Petroleum and mineral resource assessment.
- National geoscience data base.

### **Commonwealth Scientific and Industrial Research Organization**

#### ***Minerals Research***

Minerals research by the Commonwealth Scientific and Industrial Research Organization (CSIRO) is undertaken within the Institute of Energy and Earth Resources. The research has the objectives of improving methods of locating, evaluating, defining and characterising Australia's mineral resources and of planning their recovery, development and effective use consistent with the minimization of environmental stresses. Divisions of the Institute engaged in mineral research are the Division of Geomechanics at Syndal (Vic.); the Division of Fossil Fuels at North Ryde (N.S.W.); the Division of Mineral Chemistry at Port Melbourne (Vic.); the Division of Mineral Engineering at Clayton (Vic.); the Division of Mineralogy and Geochemistry at Perth (W.A.), North Ryde (N.S.W.) and Canberra (A.C.T.), the Division of Mineral Physics at North Ryde (N.S.W.), Lucas Heights (N.S.W.) and Port Melbourne (Vic.), and the Physical Technology Unit at Ryde (N.S.W.).

### **Department of Resources and Energy**

The functions of the National Coal Research Advisory Committee which was established in 1964 have been incorporated into the National Energy Research, Development and Demonstration Council (NERDDC) which is administered by the Department of Resources and Energy. For details of NERDDC, which advises the Minister for Resources and Energy on matters relating to national energy policy *see* Chapter 18, Energy, and Chapter 25, Science and Technology.

### **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**

The Australian Mineral Industries Research Association Limited (AMIRA) is a non-profit organisation which was set up in 1959 by the Australian mineral industry to manage jointly sponsored research and development on behalf of the industry. There are more than 70 members of AMIRA, drawn from all parts of the mineral and petroleum industries. Membership ranges from small exploration companies to large mining houses and includes suppliers of services to the industry. The policy of the Association is determined by a Council elected by members.

AMIRA has no research facilities so organisations such as CSIRO, universities, consultants, suppliers or member companies carry out the research as contractors to AMIRA. Research contracts worth approximately \$3.0 million per annum are handled by AMIRA.



## 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. It was followed by the Second, Third, Fourth, Fifth and Sixth International Tin Agreements, which came into force on 21 February 1962, 21 March 1967, 1 July 1971, 1976 and 1982 respectively. Australia joined the Fourth, Fifth and Sixth 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. 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, and those of the Fifth in Year Book No. 66, page 376.

The objectives and provisions of the present (Sixth) Agreement are broadly similar to those of 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. The Sixth Agreement provides for a larger buffer stock than in the previous Agreements of up to 50,000 tonnes of tin metal. For the first time, financing of the buffer stock is being shared equally between producers and consumers. In the event of persistent market disequilibrium through causes beyond the control of the buffer stock mechanism, the agreement provides for the regulation of exports and stocks to stabilise the market.

The sixth International Tin Agreement is administered by the International Tin Council, which is made up of the following governments: *Producers*—Australia, Indonesia, Malaysia, Nigeria, Thailand, Zaire; *Consumers*—Belgium-Luxembourg, Canada, Denmark, Finland, France, Germany (Federal Republic of), Greece, India, Ireland (Republic of), Italy, Japan, Netherlands, Norway, Poland, Sweden, Switzerland, and the United Kingdom. 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.

### Association of Tin Producing Countries

The Association of Tin Producing Countries (ATPC) came into force on 16 August 1983. Membership is open to countries which are net exporters of tin. The current members are Bolivia, Indonesia, Malaysia, Thailand, Zaire, Nigeria and Australia. The main objective of the ATPC is to encourage greater consumption of tin through research, development and promotion.

### 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, Argentina, Australia, Austria, Belgium, Bulgaria, Canada, Czechoslovakia, Denmark, Finland, France, Germany (Federal Republic of), Hungary, India, Iran, 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.

### Association of Iron Ore Exporting Countries (APEF)

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

The objectives of the Association are to promote close co-operation among member countries with a view to safeguarding their interests in relation to the iron ore export industry; to ensure the orderly and healthy growth of export trade in iron ore; to assist member countries to secure fair and

remunerative returns from the exploitation, processing and marketing of iron ore and to provide a forum for consultations and the exchange of information on problems relating to the iron ore export industry.

The Association consists of a Conference of Ministers, which meets biennially and is the supreme authority of the Association, a Board comprising representatives of member countries which meets twice a year, and a Secretariat which is located in Geneva.

#### **Intergovernmental Council of Copper Exporting Countries (CIPEC)**

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

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

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

#### **International Bauxite Association**

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

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

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

The IBA provides members with an opportunity to discuss common problems and evolve co-operative policies to facilitate further development of their bauxite/alumina/aluminium industries. The Association's work is mostly concerned with exchanging views and information on a range of industry matters. The commercial and technical aspects of formulating minimum export prices for bauxite and alumina have received particular attention. In November 1982 the Council adopted recommendations on minimum CIF prices for bauxite and alumina sold by member countries in 1983. Australia was not included in the majority that voted for the recommendations and is not bound by them. The Association publishes a Quarterly Review.

## **MINERAL INDUSTRY STATISTICS**

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

### **Mining industry statistics**

This section contains statistics of the mining industry in Australia obtained from the annual census of mining establishments. The annual mining census is conducted throughout Australia on an integrated basis with other economic censuses, e.g. the annual census of manufacturing establishments, electricity and gas establishments and the periodic censuses of retail, wholesale trade, construction, transport and selected services establishments.

Statistics are also available for *enterprises* engaged in the mining industry. The latest statistics for mining are in respect of 1980-81 and were published in *Enterprise Statistics: Details by Industry Class, Australia, 1980-81* (8103.0). Enterprise statistics for mining are now produced annually and should be available within two years of the end of the financial year to which they relate. A description of the statistics and broad summary tables, in respect of the 1979-80 and 1980-81 censuses and surveys are given in Chapter 17.

The following table shows key items of data for establishments in Australia for 1982-83 based on the 1978 edition of the *Australian Standard Industrial Classification (ASIC)*.

### MINING ESTABLISHMENTS: SUMMARY OF OPERATIONS BY INDUSTRY CLASS, 1982-83

Industry ASIC code	Description	Establish- ments at 30 June	Average employment over whole year(a)			Wages and salaries (b)	Turnover	Stocks		Total pur- chases, transfers in and selected expenses	Fixed capital expendi- ture less Value added disposals
			Males	Females	Persons			Opening	Closing		
		No.	No.	No.	No.	\$'000	\$'000	\$'000	\$'000	\$'000	\$'000
	<b>Metallic minerals—</b>										
	<b>Ferrous metal ores—</b>										
1111	Iron ores . . . . .	23	7,071	1,051	8,122	204,924	1,622,300	207,123	261,113	782,159	894,131
1112	Iron ore pelletising . . . . .	2	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
	<b>Non-ferrous metal ores—</b>										
1121	Bauxite . . . . .	6	1,877	193	2,070	53,583	307,032	17,276	18,377	68,206	239,927
1122	Copper ores . . . . .	12	3,216	212	3,428	77,343	293,317	52,056	52,259	91,300	202,221
1123	Gold ores . . . . .	92	2,945	195	3,140	69,671	398,560	54,142	59,389	146,835	256,971
1124	Mineral sands . . . . .	12	1,239	98	1,337	27,487	143,173	52,996	64,073	74,484	79,766
1125	Nickel ores . . . . .	5	2,359	205	2,564	70,336	251,012	32,199	28,158	115,464	131,507
1126	Silver-lead-zinc ores . . . . .	15	6,958	359	7,317	171,563	644,513	94,573	135,741	194,584	491,097
1127	Tin ores . . . . .	79	1,394	120	1,514	28,705	116,814	20,689	32,382	54,492	74,015
1128	Uranium ores . . . . .	3	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
1129	Non-ferrous metal ores n.e.c. . . . .	8	788	123	911	19,818	94,235	40,777	38,035	34,708	56,784
11	<b>Total metallic minerals</b> . . . . .	257	29,172	2,676	31,848	764,586	4,374,069	699,866	853,668	1,728,958	2,798,911
	<b>Coal, oil and gas</b>										
1201	Black coal . . . . .	133	31,595	862	32,457	985,321	4,280,306	467,069	636,309	1,708,611	2,740,936
1202	Brown coal . . . . .	4	2,362	10	2,372	66,650	178,771	21,460	21,816	43,217	135,910
1300	Oil and gas . . . . .	18	2,736	521	3,257	81,092	2,138,397	47,889	73,988	180,202	1,984,294
	<b>Construction materials -</b>										
1401	Sand and gravel . . . . .	366	1,766	189	1,955	33,326	219,090	13,766	14,659	101,218	118,764
1404	Construction materials n.e.c. . . . .	448	3,740	381	4,121	76,452	425,667	43,639	48,173	203,419	226,781
14	<b>Total construction materials</b> . . . . .	814	5,506	570	6,076	109,778	644,757	57,405	62,831	304,637	345,545
	<b>Other non-metallic minerals—</b>										
1501	Limestone . . . . .	53	752	20	772	15,110	62,994	5,183	6,371	34,122	30,059
1502	Clays . . . . .	115	245	32	277	3,980	28,461	4,050	4,653	17,559	11,505
1504	Salt . . . . .	20	533	79	612	15,123	71,715	16,015	18,774	25,663	48,811
1505	Non-metallic minerals n.e.c. . . . .	128	955	130	1,085	21,485	121,615	13,738	31,715	88,952	50,640
15	<b>Total other non-metallic minerals</b> . . . . .	316	2,485	261	2,746	55,698	284,785	38,986	61,513	166,296	141,016
	<b>Total mining (excl. services to mining)</b> . . . . .	1,542	73,856	4,900	78,756	2,063,124	11,901,085	1,332,675	1,710,125	4,131,922	8,146,613

(a) Includes working proprietors.

(b) Excludes amounts drawn by working proprietors.

## Mineral production

This section contains details of the output (quantity and value) of principal 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 Resources and Energy 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 principal minerals produced and contents of principal metallic minerals produced during 1982-83 and earlier years. Further data are available relative to all minerals in the annual publication *Mineral Production, Australia* (8405.0)

## QUANTITY OF PRINCIPAL MINERALS PRODUCED

<i>Mineral</i>		<i>1980-81</i>	<i>1981-82</i>	<i>1982-83</i>
<b>METALLIC MINERALS</b>				
Bauxite . . . . .	'000 tonnes	25,450	24,690	n.p.
Copper concentrate . . . . .	"	866	905	n.p.
Copper ore . . . . .	"	21,745	23,067	15,864
Gold bullion (a) . . . . .	kg	13,806	21,008	n.p.
Iron ore . . . . .	'000 tonnes	93,754	86,786	78,969
Lead concentrate . . . . .	"	622	704	724
Lead-copper concentrate . . . . .	tonnes	22,328	31,999	24,968
Lead-zinc concentrate . . . . .	"	9,896	41,179	40,205
Manganese ore—				
Metallurgical grade . . . . .	'000 tonnes	1,485	1,198	n.p.
Mineral sands—				
Ilmenite concentrate (b) . . . . .	"	1,259	1,238	932
Rutile concentrate . . . . .	"	273	220	n.p.
Zircon concentrate . . . . .	"	461	459	404
Nickel concentrate . . . . .	"	404	423	483
Tantalite-columbite concentrate . . . . .	tonnes	235	263	149
Tin concentrate . . . . .	"	24,204	24,604	20,424
Tungsten concentrates—				
Scheelite concentrate . . . . .	"	3,800	3,364	2,307
Wolfram concentrate . . . . .	"	2,463	2,017	1,502
Uranium concentrate . . . . .	"	2,523	5,086	n.p.
Zinc concentrate . . . . .	'000 tonnes	845	1,097	1,206

## COAL

Black coal—				
Bituminous . . . . .	'000 tonnes	88,766	92,246	98,687
Sub-bituminous . . . . .	"	7,308	7,172	8,880
Brown coal—				
For briquettes . . . . .	"	2,891	2,658	1,956
Other . . . . .	"	29,212	34,904	33,042
Briquettes . . . . .	"	1,081	993	760

## OIL AND GAS

Crude oil (stabilised) . . . . .	megalitres	23,052	22,378	22,069
Natural gas . . . . .	gigalitres	10,435	11,550	11,654
Ethane . . . . .	"	140	152	169

## CONSTRUCTION MATERIALS(c)

Sand . . . . .	'000 tonnes	27,285	28,712	24,312
Gravel . . . . .	"	14,338	16,088	13,240
Crushed and broken stone . . . . .	"	53,891	58,478	50,619
Other (decomposed rock etc.) . . . . .	"	41,162	33,965	29,957

## OTHER NON-METALLIC MINERALS

Asbestos (chrysotile) . . . . .	tonnes	73,416	34,293	11,872
Brick, clay and shale . . . . .	'000 tonnes	8,146	7,882	6,198
Limestone (including shell and coral) . . . . .	"	11,894	12,790	n.p.
Salt . . . . .	"	6,799	4,985	n.p.
Silica . . . . .	"	1,828	1,895	n.p.

(a) Includes alluvial gold. (b) Includes ilmenite from which titanium dioxide is not commercially extractable and beneficiated ilmenite. (c) Excludes dimension stone.

## CONTENTS OF PRINCIPAL METALLIC MINERALS PRODUCED

<i>Contents of metallic minerals produced</i>		<i>1980-81</i>	<i>1981-82</i>	<i>1982-83</i>
Antimony . . . . .	tonnes	1,207	1,218	768
Cadmium . . . . .	"	1,676	2,083	n.p.
Cobalt . . . . .	"	3,513	3,075	2,833
Copper . . . . .	"	246,441	259,707	235,302
Gold . . . . .	kg	15,991	22,328	25,825
Iron (b) . . . . .	'000 tonnes	59,064	54,886	n.p.
Lead . . . . .	tonnes	381,377	454,776	n.p.
Manganese . . . . .	"	717,209	587,919	n.p.
Monazite . . . . .	"	12,676	10,636	10,536
Nickel . . . . .	"	73,367	81,424	82,945
Palladium . . . . .	kg	464	360	461
Platinum . . . . .	"	69	65	55
Silver . . . . .	"	759,290	887,569	n.p.
Sulphur . . . . .	tonnes	338,734	414,551	n.p.
Tantalite-columbite (Ta <sub>2</sub> O <sub>5</sub> + Nb <sub>2</sub> O <sub>5</sub> ) . . . . .	kg	91,930	129,635	78,975
Tin . . . . .	tonnes	12,690	12,750	n.p.
Titanium dioxide (TiO <sub>2</sub> ) . . . . .	"	1,008,386	940,946	n.p.
Tungstic oxide (WO <sub>3</sub> ) . . . . .	mtu(a)	451,245	384,294	n.p.
Yttrium oxide (Y <sub>2</sub> O <sub>3</sub> ) . . . . .	kg	9,187	17,152	n.p.
Zinc . . . . .	tonnes	481,887	623,904	n.p.
Zirconium dioxide (ZrO <sub>2</sub> ) . . . . .	"	306,079	299,201	266,565

(a) Metric ton unit (mtu) equals 10 kilograms. (b) Excludes iron content of iron oxide not intended for metal extraction. Includes iron contained in iron concentrate.

## Value of minerals produced

The following table shows the value of principal minerals produced during 1982-83 and earlier years. Further data are available in the annual publication *Mineral Production, Australia* (8405.0).

VALUE OF PRINCIPAL MINERALS PRODUCED  
(\$'000)

<i>Mineral</i>	<i>1980-81</i>	<i>1981-82</i>	<i>1982-83</i>
<b>METALLIC MINERALS</b>			
Bauxite . . . . .	n.p.	n.p.	n.p.
Copper concentrate . . . . .	288,768	231,952	264,144
Copper ore . . . . .	4,275	8,110	1,174
Gold bullion(a) . . . . .	184,434	200,408	n.p.
Iron ore . . . . .	1,007,307	1,131,186	n.p.
Lead concentrate . . . . .	375,018	252,136	n.p.
Lead-copper concentrate . . . . .	23,904	21,474	n.p.
Lead-zinc concentrate . . . . .	6,074	8,445	9,723
Manganese ore—			
Metallurgical grade . . . . .	59,207	46,136	n.p.
Mineral sands—			
Ilmenite concentrate(b) . . . . .	33,200	36,610	26,737
Rutile concentrate . . . . .	82,301	61,758	n.p.
Zircon concentrate . . . . .	30,180	37,526	40,892
Nickel concentrate . . . . .	n.p.	n.p.	n.p.
Tantalite-columbite concentrate . . . . .	17,594	11,091	3,971
Tin concentrate . . . . .	143,343	141,716	133,405
Tungsten concentrates—			
Scheelite concentrate . . . . .	33,739	27,612	n.p.
Wolfram concentrate . . . . .	19,606	15,607	n.p.
Uranium concentrate . . . . .	192,755	356,219	n.p.
Zinc concentrate . . . . .	188,075	n.p.	220,546
<b>COAL</b>			
Black coal—			
Bituminous . . . . .	2,276,080	2,777,212	3,303,340
Sub-bituminous . . . . .	116,380	143,903	205,531
Brown coal—			
For briquettes . . . . .	..	..	..
Other . . . . .	107,052	137,138	150,788
Briquettes . . . . .	22,230	22,754	19,808

**VALUE OF PRINCIPAL MINERALS PRODUCED**  
(S'000)

<i>Mineral</i>	<i>1980-81</i>	<i>1981-82</i>	<i>1982-83</i>
<b>OIL AND GAS</b>			
<i>Oil and Gas</i> . . . . .	<i>1,665,786</i>	<i>1,779,989</i>	<i>2,089,401</i>
<b>CONSTRUCTION MATERIALS(c)</b>			
Sand . . . . .	95,958	110,239	112,502
Gravel . . . . .	61,030	80,566	75,627
Crushed and broken stone . . . . .	263,159	325,406	320,563
Other (Decomposed rock etc.) . . . . .	80,768	90,535	92,634
<b>OTHER NON-METALLIC MINERALS</b>			
Asbestos (chrysotile) . . . . .	25,735	14,464	4,766
Brick clay and shale . . . . .	23,706	27,029	18,996
Gems . . . . .			
Opal(d) . . . . .	49,490	45,374	42,131
Sapphire . . . . .	19,783	22,675	21,566
Limestone (incl. shell and coral) . . . . .	44,153	58,785	n.p.
Salt . . . . .	66,485	52,177	n.p.
Silica . . . . .	15,858	18,494	18,357

(a) Includes alluvial gold. (b) Includes ilmenite from which titanium dioxide is not commercially extractable and beneficiated ilmenite. (c) Excludes dimension stone. (d) Partly estimated.

### Foreign participation of the mining industry in Australia

Summary information on foreign participation in the mining industry in Australia is shown in Chapter 24, Foreign Transactions. More detailed statistics are available in *Foreign Ownership and Control of the Mining Industry and Selected Mineral Processing Industries, Australia 1981-82* (5317.0) and *Foreign Control in Mineral Exploration, Australia 1975-76* (5323.0).

### Mineral exploration (other than for petroleum and oil shale)

#### 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 and oil shale* 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 Department of Mineral Resources).

#### Classification

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

(a) *Private exploration on production leases*—relates to exploration carried out on the production lease by privately-operated mines currently producing or under development for the production of minerals.

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

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

**Expenditure, metres drilled**

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

**PRIVATE MINERAL EXPLORATION (OTHER THAN FOR PETROLEUM AND OIL SHALE)**

	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Expenditure (\$'000)—						
On drilling . . . . .	50,019	50,729	72,408	126,088	141,872	89,723
Other . . . . .	108,378	131,780	213,722	344,401	433,700	348,188
<b>Australia . . . . .</b>	<b>158,397</b>	<b>182,509</b>	<b>286,130</b>	<b>470,489</b>	<b>575,572</b>	<b>437,911</b>
Metres drilled ('000)—						
Drilled-core . . . . .	557	565	862	1,156	1,201	871
Drilled-non-core . . . . .	1,772	1,763	2,055	2,808	2,824	1,882
<b>Australia . . . . .</b>	<b>2,329</b>	<b>2,328</b>	<b>2,917</b>	<b>3,965</b>	<b>4,025</b>	<b>2,752</b>

**Oil shale exploration**

Statistics of exploration for oil shale are derived from an annual exploration census conducted by the Australian Bureau of Statistics.

Exploration consists of the search for and/or appraisal of new ore occurrences and known deposits of oil shale (including extensions to deposits being worked) by geological, geophysical, geochemical and other methods (including drilling). 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 operations (including the construction of drives, shafts, winzes, etc. in underground mines, and overburden removal, for open-cut extraction).

In 1982-83 expenditure in Australia on private exploration for oil shale amounted to \$26,150,000 with 23,000 metres being drilled.

**Petroleum exploration****Source of statistics**

These statistics of expenditure on petroleum exploration have been obtained by the addition of values collected in a quarterly survey conducted by the Australian Bureau of Statistics. Other data shown were collected by the Bureau of Mineral Resources, Geology and Geophysics. Further information relating to petroleum exploration is published by the Australian Bureau of Statistics in its annual publication *Mineral Exploration, Australia* (8407.0) and by the Bureau of Mineral Resources, Geology and Geophysics in *The Petroleum Newsletter* (issued quarterly) and *The Australian Mineral Industry Annual Review*.

**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.

MINERAL INDUSTRY  
PETROLEUM EXPLORATION

		1980-81	1981-82	1982-83
<b>Expenditure—</b>				
Private sources	\$'000	368,330	803,983	927,405
Government sources	\$'000	5,351	6,797	10,188
<b>Total</b>	<b>\$'000</b>	<b>373,683</b>	<b>810,781</b>	<b>937,592</b>
<b>Wells (a)—</b>				
Drilled (i.e. those which reached final depth)—				
As oil producers	No.	14	21	36
As gas producers	No.	24	38	42
Plugged and abandoned	No.	56	99	143
<b>Total</b>	<b>No.</b>	<b>94</b>	<b>158</b>	<b>221</b>
Average final depth of wells drilled	m	1,747	1,999	2,047
Drilling still in progress at 31 December (uncompleted holes)				
	No.	11	17	14
Wells drilled or drilling over 3,000 metres	No.	24	18	31
<b>Metres drilled (a)—</b>				
Completed wells	m	180,157	296,818	426,208
Uncompleted holes	m	19,151	25,566	26,036
<b>Total</b>	<b>m</b>	<b>199,308</b>	<b>322,384</b>	<b>452,244</b>

(a) Source: Bureau of Mineral Resources, Geology and Geophysics. Data relates to years ended 31 December.

### Mineral processing and treatment

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

#### Principal products

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

#### PRODUCTION (a) OF PRINCIPAL MANUFACTURED PRODUCTS OF MINERAL ORIGIN

Commodity		1980-81	1981-82	1982-83
<b>METALS(b)</b>				
<b>Non-ferrous—</b>				
Alumina	'000 tonnes	7,235	6,651	6,701
Refined aluminium	tonnes	344,753	380,457	403,917
Blister copper(c)	"	167,778	177,344	172,163
Refined copper	"	159,437	163,052	172,456
Lead bullion (for export)(c)	"	149,027	180,675	179,462
Refined lead	"	206,127	207,242	212,176
Refined zinc	"	297,871	301,266	288,250
Refined tin	"	4,669	3,617	2,898
<b>Ferrous—</b>				
Pig iron	'000 tonnes	7,335	6,606	4,990
Steel ingots	"	7,012	6,198	5,392
<b>Precious—</b>				
Refined gold(d)	kg	12,494	17,773	25,784
Refined silver	"	315,584	325,105	303,889
<b>FUELS</b>				
<b>Coal products—</b>				
Metallurgical coke	'000 tonnes	4,676	4,198	3,338
Brown coal briquettes	"	1,081	993	760
<b>Petroleum products—</b>				
Diesel-Automotive oil	'000 tonnes	6,137	6,445	6,540
Industrial fuel and marine fuel	"	985	775	721
Fuel oil for burning	"	3,854	3,285	2,810
Automotive petrol	mil. litres	14,002	14,375	14,845



## PRODUCTION (a) OF PRINCIPAL MANUFACTURED PRODUCTS OF MINERAL ORIGIN—continued

Commodity		1980-81	1981-82	1982-83
<b>BUILDING MATERIALS</b>				
Clay bricks . . . . .	millions	2,287	2,234	1,694
Portland cement . . . . .	'000 tonnes	5,656	6,136	5,351
Plaster of paris . . . . .	"	443	480	n.p.
Plaster sheets . . . . .	'000 sq m	63,617	63,768	51,229
<b>CHEMICALS</b>				
Sulphuric acid . . . . .	'000 tonnes	1,976	2,039	1,734
Caustic soda . . . . .	tonnes	n.p.	n.p.	n.p.
Superphosphate(e) . . . . .	'000 tonnes	3,557	3,464	2,877

(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. Source: Bureau of Mineral Resources, Geology and Geophysics (non-ferrous and precious metals only). (c) Metallic content. (d) Newly-won gold of Australian origin. (e) Includes double and triple superphosphate and ammonium phosphate expressed in terms of single superphosphate, i.e. 22% P<sub>2</sub>O<sub>5</sub> equivalent.

## Overseas trade

## Exports and imports

For particulars of the quantities and values of the principal minerals and products exported from and imported into Australia during recent years. See Chapter 24. Foreign Transactions.

Considerable quantities of metallic ores, concentrates, slags, and residues are exported from Australia for refining overseas. The following table shows selected items exported during 1983 and their principal metallic content as estimated by assay.

## PRINCIPAL METALLIC CONTENTS OF SELECTED ORES AND CONCENTRATES ETC. EXPORTED FROM AUSTRALIA, 1983

<i>Metallic contents—estimated from assay</i>								
<i>Ores and concentrates, etc.</i>	<i>Copper</i>	<i>Lead</i>	<i>Zinc</i>	<i>Tin</i>	<i>Iron</i>	<i>Tungstic Oxides</i>	<i>Gold</i>	<i>Silver</i>
	tonnes	tonnes	tonnes	tonnes	'000 tonnes	tonnes	kg	kg
Copper concentrate . . . . .	64,742	4,447	4,059	—	—	—	178	52,044
Blister copper . . . . .	8,318	—	—	—	—	—	724	913
Copper matte, slags, etc.(a) . . . . .	3,648	6,135	—	—	—	—	756	6,011
Lead concentrate . . . . .	2,241	44,495	3,467	—	—	—	1,031	98,931
Lead bullion . . . . .	—	159,390	—	—	—	—	112	420,435
Lead slags and residues . . . . .	41	2,083	—	20	—	—	72	4,961
Zinc concentrate . . . . .	1,222	12,546	389,645	—	—	—	—	58,720
Zinc slags and residues . . . . .	—	—	5,048	—	—	—	—	—
Tin concentrate . . . . .	—	—	—	6,202	—	—	—	—
Iron ore—								
Pellets . . . . .	—	—	—	—	25,687	—	—	—
Fines . . . . .	—	—	—	—	1,441	—	—	—
Lump . . . . .	—	—	—	—	19,444	—	—	—
Scheelite concentrate . . . . .	—	—	—	—	—	1,620	—	—
Wolfram concentrate . . . . .	—	—	—	—	—	1,011	—	—
<b>Total metallic content . . . . .</b>	<b>80,212</b>	<b>229,096</b>	<b>402,219</b>	<b>6,222</b>	<b>46,572</b>	<b>2,631</b>	<b>2,873</b>	<b>642,015</b>

(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(a)**

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

METALS										
Period	Tin		Penang (\$Mal- kg)	Aluminium			Gold		Silver	
	Aust. (\$A— tonne)	L.M.E. (£Stg— metric ton)		Nickel U.S.A. (\$US—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)
1982 . . . . .	10,483.49	7,320.35	30.17	3.25	1,370.00	47.58	373.51	375.95	244.71	455.78
1983 . . . . .	15,960.81	8,571.10	30.20	3.25	1,587.40	68.72	471.61	424.52	411.38	753.63
1983 Highest	17,477.00	9,291.00	31.83	3.29	1,825.00	80.00	531.00	511.50	495.81	943.65
Lowest	14,222.00	7,395.00	29.15	3.20	1,370.00	47.00	410.25	374.75	295.70	575.80
Period	Copper		Lead	Zinc			Europe Prod.		U.S.A.	
	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)	(US— tonne)	(USC—lb)
1982 . . . . .	1,474.50	846.73	622.61	310.98	27.14	848.96	425.42	847.83	39.05	
1983 . . . . .	1,790.47	1,049.33	592.16	280.54	22.71	952.31	505.41	823.39	42.65	
1983 Highest	2,040.00	1,153.00	600.00	313.00	28.00	1,082.00	618.00	980.00	49.00	
Lowest	1,520.00	905.00	550.00	258.00	19.00	851.00	420.00	750.00	36.00	
ORES AND CONCENTRATES										
Period	Tin Aust. (\$A—mtu)		Wolfram Europe (£Stg—mtu)		Ilmenite Europe (\$A—metric ton)		Rutile Europe (\$A—metric ton)		Zircon Europe (\$A—metric ton)	
1982 . . . . .	114.34		102.17–106.50		26.50–28.92		253.33–265.00		110.42–115.42	
1983 . . . . .	128.53		78.66–82.50		30.00–33.83		260.00–278.33		107.91–117.08	
1983 Highest	140.08		91.00		37.00		330.00		120.00	
Lowest	118.04		71.00		27.00		230.00		115.00	

(a) Where a daily price does not actually exist for a commodity, daily prices have been imputed from price data which are available.  
NOTE: Prices data shown are those quoted in the relevant markets and are mainly derived from information collected and compiled by the Bureau of Mineral Resources. Overseas data are supplied to the Bureau of Mineral Resources by the *Metal Bulletin* and *Metals Week*.

## REVIEW OF RECENT DEVELOPMENTS IN THE AUSTRALIAN MINERAL INDUSTRY

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

Major developments in the Australian mineral industry during 1983 are reviewed briefly in subsequent parts of this section. Additional information on developments in the industry is available in *Australian Mineral Industry Annual Review 1983* 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. The *Australian Mineral Industry Quarterly*, Volume 36, Number 4, details Australia's identified mineral resources, 1983.

### General Review of 1983

The gross domestic product (GDP) of Australia in 1982–83 was \$163,442 million, of which an estimated \$10,100 million was generated by the mineral industry, excluding smelting and refining. If smelting and refining were included, an estimated \$1,700 million could be added to this figure, thus making the mineral industry the largest primary sector contributor to the GDP. Australia's export trade increased substantially in both current and constant price terms to a new record level. Japan, the UK, the USA and the EEC were the main markets for mineral commodities, the UK displacing the USA in importance for the first time since 1969.

The ex-mine value of mineral products in Australia in 1983 reached a new peak of \$10,570 million, \$660 million higher than in 1982. More than half of this increase resulted from both higher output and prices for crude oil, and a significant contribution was made by the other energy minerals, natural gas, and coal. Performance of the metallic minerals group was subdued; gains made by bauxite, copper, gold and lead were offset by a decline in output of iron ore, mineral sands, nickel, tin, zinc, and uranium, resulting in a net fall of about \$100 million. Diamonds contributed \$65 million to the value of mine output in the first year of their production.

#### *Imports—1983*

The value of imports have been dominated by crude oil in the last few years, accounting for between 80% and 90% of Australia's mineral import bill. In 1983 imports of crude oil fell by 37% or almost \$1,000 million to \$1,764 million, resulting in Australia's lowest minerals import bill since 1979. Other significant mineral imports were gem diamonds, unrefined gold, phosphate, potassium fertilisers, and elemental sulphur. Imports of mineral primary products accounted for 9.6% of the total value of merchandise imports compared with 13.1% in 1982. This contributed to a record surplus of \$7,644 million in Australia's balance of mineral trade in 1983, compared with \$4,860 million in 1982.

#### *Exports—1983*

Australia's mineral exports rose by 18% in current price terms to \$9,729 million. Most mineral exports held or improved their 1982 levels, the major exceptions being uranium, nickel, and tungsten. Minerals to show gains include alumina, black coal, copper, gold, iron ore, lead, crude oil, silver, tin and zinc. Black coal remains the largest single export earner, accounting for \$3,335 million or 34% of the total value of mineral primary products exported.

Iron ore was the second largest export earner with a value of \$1,577 million (an increase of 6%) followed by alumina which increased in value by 7% to \$1,180 million. In total, black coal, iron ore and alumina accounted for nearly 63% of the total value of exports of mineral primary products. A significant contribution was also made by gold, silver, uranium and zinc.

*Pattern of mineral trade—1983.* Australia exported metals and minerals to more than 100 countries. Japan accounted for 42.4 per cent of Australian exports by value. Principal exports of mineral primary products to Japan were black coal, iron ore, aluminium, alumina, bauxite, copper, nickel, manganese ore and mineral sands.

The proportion by value of Australian mineral exports to the EEC was 11.3 per cent (including 9.3 per cent to the UK), and to the USA 8.8 per cent. To the EEC countries, exports were mainly iron ore, black coal, lead and copper, and to the USA alumina, nickel, bauxite, manganese ore, mineral sands, iron ore, lead, and zinc.

#### **Bauxite, Alumina and Aluminium**

In 1983, production of bauxite increased by 4 percent to 24.54 million tonnes, while aluminium production increased by 26 percent to 478,190 tonnes. Australia was again the world's largest producer of bauxite and alumina.

The commissioning of the new alumina refineries at Wagerup and Worsley, W.A., commenced in February 1984. Initial rated capacities are 500,000 tonnes per year, and 1,000,000 tonnes per year respectively.

The new Tomago, N.S.W., aluminium smelter began operations in August 1983 and full production capacity is 220,000 tonnes per year.

Work on the Portland, Victoria, smelter (initial capacity to be 132,000 tonnes per year) remained at a stand-still in 1983, pending resolution of electricity charges, equity ownership, and market outlets.

Expansion of the Kurri Kurri, N.S.W., aluminium smelter was due to be completed in 1984. This will increase total capacity from 90,000 to more than 140,000 tonnes per year. Comalco's aluminium smelter at Boyne Island, near Gladstone, Qld, is supplied with alumina from the nearby Queensland Alumina Ltd (QAL) refinery. The smelter has a capacity of 206,000 tonnes per year. The rated capacities of the other two Australian aluminium smelters, at Point Henry, Vic., and Bell Bay, Tas., are 165,000 and 117,000 tonnes per year respectively. Point Henry uses Western Australian alumina while Bell Bay obtains its alumina from Queensland.

#### **Copper**

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

In 1983 mine production of copper increased to a record 264,244 tonnes. Western Mining Corporation Holdings Ltd (WMC) announced that recent exploration and development work had established within the Olympic Dam mineralised zone a probable 450 million tonnes of higher grade

ore, averaging 2.5 per cent copper 0.8kg/tonne uranium oxide ( $U_3O_8$ ), 0.6g/tonne gold and 6g/tonne silver. A study on the economic viability of the project should be completed by the end of 1984. WMC announced the discovery of economically significant secondary and primary copper mineralisation at their Nifty prospect in the Throssell Ranges, about 200 km east south-east of Marble Bar, W.A.

E Z Industries (EZI) announced plans for a feasibility study of the Scuddles copper-zinc deposit at the Golden Grove prospect near Yalgoo, W.A. EZI has been appointed operator for the underground evaluation program which is scheduled for completion in 1986.

### **Iron**

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

Production of iron ore in 1983 decreased to 71.0 million tonnes, 19.0 percent less than in 1982. Output fell in accordance with depressed domestic and export demand as well as the effects of industrial disputes. Export of iron ore and iron ore pellets was 74.3 million tonnes valued at \$1,577 million. Australia was the largest exporter and fourth largest producer.

Production at the Koolyanobbing mine in Western Australia decreased by more than 60 per cent reflecting its closure in August. The closure had been deferred since April 1982 when the Kwinana blast furnace which it mainly supplied was shut down.

Cliffs Robe River Iron Associates began deepening its shipping channel at Port Walcott (Cape Lambert) to enable ship loads to exceed a previous limit of 190,000 tonnes.

Hamersley Iron Pty Ltd upgraded port facilities at East Intercourse Island to enable entry of 250,000 dwt ore carriers which can be loaded to 200,000 tonnes.

### **Silver, lead and zinc**

Mine production of lead and zinc increased again in 1983 to new records; lead 477,000 tonnes and zinc 695,000 tonnes. A large increase in production occurred at Mount Isa and production was phased in at Elura from early in 1983.

Production of primary refined lead declined slightly in 1983 although zinc production remained at around the same levels as in previous years; lead metal production including secondary was 224,335 tonnes and zinc metal production including secondary was 303,018 tonnes.

A number of deposits underwent intensive evaluation in 1983. These included Hilton, Lady Loretta, Thalanga, Liontown, and Conjuboy, all in Queensland; Woodcutters, N.T.; Golden Grove and the Lennard Shelf in W.A.; Benambra, Victoria, and Hellyer in Tasmania.

### **Black coal**

Raw black coal production in 1983 was a record 120.5 million tonnes, 1 per cent higher than in 1982. The output of saleable coal rose by 1 per cent to the record level of 98.7 million tonnes. Domestic consumption fell slightly from 37.5 million tonnes in 1982 to 36.9 million tonnes in 1983, mainly because of a drop of 2.1 million tonnes by the iron and steel industry. Exports rose by 22 percent to 60.5 million tonnes in 1983 and the value of exports rose to \$3329 million. Of total exports 36.1 million tonnes were shipped to Japan.

Demand for steaming coal on the international market remained high. As a result Australian exports of steaming coal rose by 44 per cent to 18.3 million tonnes. At the same time, there occurred a 14 per cent growth in the exports of coking coal to 42.2 million tonnes. Several new mines commenced operation in 1983.

Papers dealing with the Australian coal industry have been published in the *Australian Mineral Industry Quarterly* Vol. 31, No. 1 and Vol. 34, No. 2.

### **Petroleum**

At the end of 1983 there were 32 fields producing stabilised crude oil. In 1983, production of crude oil rose by 12.6 per cent, the greatest level since 1979, and the production of natural gas rose by 2.8 per cent.

Total refinery input declined by 3.9 per cent although the proportion of total input from indigenous sources increased from 62 per cent in 1982 to 73 per cent in 1983. Consumption of automotive gasoline (motor spirit) decreased by 1.1 per cent. Consumption of all other major petroleum products except LPG also fell. The quantity of imported crude oil, enriched crude oil, and other refinery feedstock decreased by 27.1 per cent compared with that in 1982, and its value decreased by 32.6 per cent from \$3301 million to \$2226 million. Export of all petroleum products rose by 45.3 per cent in value to \$1605 million. In November 1983 the first export shipment of crude oil took place.

Exploration wells drilled decreased from 221 in 1982 to 202 (153 onshore, 49 offshore) in 1983, and total metres drilled for exploration decreased from 452,244 m in 1982 to 401,285 m in 1983, a decline of 11.3 per cent. Geophysical exploration also decreased during 1983. Offshore exploration resulted in

six oil, four gas and four oil and gas discoveries; on shore exploration produced eleven oil, fifteen gas, and four oil and gas discoveries. Onshore development drilling continued in: Cooper/Eromanga Basins (S.A. and Queensland) (39 wells); Barrow Island (W.A.) (6 wells); Woodada (W.A.) and Rolleston (Queensland) fields (one well each field). In the offshore, except for one well in the North Rankin Gasfield, all development drilling was restricted to the Gippsland Basin in the Snapper, West Kingfish, Cobia and Fortescue Fields.

Ten new development projects were completed in 1983. The Jackson/Moonie (Queensland) liquids pipeline was laid and field facilities were installed at the Jackson Field. In South Australia the first delivery of liquid hydrocarbons from the Cooper liquids pipeline was shipped from Port Bonython. Also in South Australia, Toolachee, Strzelecki, Della and Daralingie Fields were connected to the main Moomba plant, and the Moomba crude stabilisation plant came on-stream. Production of crude oil from the Blina Field (W.A.) and gas production from Palm Valley (N.T.) commenced during the year.

Recoverable resources (demonstrated economic plus sub-economic) of crude oil increased by 5.62 giga litres to 288.00 giga litres and recoverable resources of natural gas increased by 63.6 per cent from 905.80 billion (10<sup>9</sup>) m<sup>3</sup> to 1482 billion m<sup>3</sup>. Expenditure on petroleum exploration decreased 24 per cent to \$731.5 million in 1983.

### Nickel

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

Mine production of nickel in ore and concentrates was 79,071 tonnes in 1983. Australia was the third largest world producer after USSR and Canada. Concentrates from Kambalda, Agnew and Mount Windarra are smelted at the Kalgoorlie nickel smelter. Some of the matte produced is railed to the Kwinana nickel refinery to be refined to nickel metal and the remainder is exported. Nickel-laterite ore mined at Greenvale, Queensland, is treated at the Yabulu nickel treatment plant to produce nickel oxide sinter for export.

### Mineral sands

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

Australia is still the world's largest producer and exporter of natural rutile, ilmenite, zircon and monazite. Output of rutile, ilmenite and zircon concentrates all fell during 1983 but the production of monazite increased.

### Diamonds

Commercial production of diamonds from the alluvial deposits in the Upper Smoke creek and Limestone Creek alluvials and from the scree deposits overlying the Ak-1 Kimberlite pipe at Argyle commenced in January 1983. Production for the year was 6.2 million carats from 1.07 million tonnes of ore. The diamonds comprise approximately 10 per cent gem, 50 per cent cheap gem, and 40 per cent industrial quality. Production from the AK-1 pipe is planned to start in 1985.

### Uranium

Preliminary estimates of production of uranium in Australia in 1983 amounted to 3,786 tonnes of yellowcake (4,422 tonnes contained  $\mu$ ), 27.4 per cent greater than in 1982. Exports for 1983 were 3,273 tonnes of yellowcake (preliminary estimates only).

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