BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1988/ 20

AUSTRALIA:

MINERAL RESOURCE DEVELOPMENTS

1985-1987

by

MINERAL COMMODITIES BRANCH

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Prepared by the Mineral Commodities Branch with contributions from other divisions and branches of BMR, the policy divisions of the Department of Primary Industries and Energy, and the Australian Bureau of Agricultural and Resource Economics, February 1988.

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INTRODUCTION

Triennial reviews of mineral resources development activities in the ESCAP region have been prepared and presented at those sessions of the Committee on Natural Resources for which mineral resources development constituted the main theme of the session. The triennial review is based on information and data provided by countries of the ESCAP region supplemented with data from other sources as appropriate. The next triennial review, covering the period 1985-1987, is to be presented at the fifteenth session of the Committee in Bangkok. This paper constitutes Australia's contribution to the review.

The paper summarises the main developments in the Australian mineral industry over the period 1985 to 1987; outlines the current status of appraisal and development of Australia's mineral resources; describes in some detail developments in the more important minerals; and deals with some of the scientific and administrative aspects of the industry such as factors hampering its development, regional co-operation, government policy and legislative action, and future prospects and plans for the industry.

World prices of most metals remained depressed in the first two years of the period under review, but the effect of this on the Australian mineral industry was relieved to some extent by the fall in the value of the Australian currency in the first part of the triennium. Nevertheless, the average profitability of the mining, smelting and refining sectors remained low.

Despite the unfavourable conditions, the ex-mine value of Australian mineral production (Table 1) excluding petroleum, increased from $12 011 million in 1985 to an estimated $14 435 million in 1987. The estimated value of petroleum production fell markedly in the same period, from $10 098 million to $7 448 million, because of the large decrease in the petroleum price in late 1985 and early 1986. Exports of mineral primary products (Table 3) (excluding crude oil and LPG) rose from $13 127 million to $15 068 million, and imports (Table 3) rose from $524 million to an estimated $656 million. Exports of petroleum fell from $2 136 million to $1 242 million in the period, and imports (which make up most of Australia's mineral imports) fell from $1 504 million to $1 249 million, largely because of lower crude oil prices.

Coal, iron ore and petroleum were the main contributors to mine production, and together with aluminium, were the main commodities exported. Gold became increasingly important over the triennium, both production and exports doubling in value. Production of black coal continued to increase, despite the low profitability of the industry, and bauxite output increased with the opening of new mines. Commencement of mining of the primary deposit at Argyle quadrupled diamond production, and Australia became the leading diamond producer, accounting for 36% of the world's output in 1987. Alumina and aluminium production increased with the commissioning of new plants. Mine production of nickel and copper decreased from 1985 to 1987 with closure of some mines because of low prices or exhaustion of reserves. Although mine production of tin increased over the triennium, smelter production fell because of concentrate shortages after mine closures.

Private expenditure on exploration for minerals other than petroleum (Table 4) increased during the period, from $437.3 million in 1984-85 to $556.8 million in 1986-87. Gold attracted the most interest; expenditure on gold exploration increased from 40% of total mineral (excluding petroleum) exploration expenditure in 1984-85 to 64% in 1986-87. Expenditure on base metals, by far the main target in the early 1980s, fell from 30% of the total in 1984-85 to 14% in 1986-87.

Petroleum exploration (Table 4) and development activity decreased markedly in 1986 from the record levels achieved in 1984 and 1985, due mainly to the worldwide decline in crude oil prices. In 1987, exploration expenditure was less than half that of 1985. A total of 282 wells was drilled in 1987 compared with the record total of 373 wells in 1984, and 176 in 1986. The number of kilometres of seismic surveying was 41 097 km in 1987, less than half the 1985 total. In 1987 exploration was concentrated mainly in low-risk areas onshore with ready access to markets. Onshore exploration resulted in a record 58 new petroleum discoveries compared with 3 discoveries offshore. Despite the generally higher level of activity in 1987, crude oil discoveries were relatively small in size. Economic demonstrated resources of crude oil increased primarily because of adjustments to estimates of resources for some fields and to a lesser extent because of discoveries during the period. However there has been a large increase in the gas and condensate resources due to re-evaluation of data from the Browse and Amadeus Basins, reclassification of some gas resources in the Bonaparte Basin and further appraisal drilling on the North West Shelf.

1. CURRENT STATUS OF APPRAISAL AND DEVELOPMENT OF MINERAL RESOURCES

In Australia, petroleum and mineral exploration and exploitation is undertaken by private industry under Government regulation and controls. Onshore, the jurisdiction is by the State Governments, and offshore the Commonwealth Government has jurisdiction which it exercises by arrangements with State Governments.

The principal Commonwealth organisation concerned with economic research into the minerals and energy sectors of the Australian economy is the Australian Bureau of Agricultural and Resource Economics (ABARE).

ABARE was established in 1987 when the Bureau of Agricultural Economics and the Bureau of Resource Economics which formerly operated as a Division of the Department of Resources and Energy were amalgamated.

Functions of the new Bureau include:

- the development of an integrated approach to assessing prospects for the entire Australian resources sector; and
- the provision of independent, objective and professional economic analysis of issues affecting Australian minerals and energy industries.

Geoscience and geotechnical activities are undertaken by Government organisations (both Commonwealth and State), private industry and universities.

Commonwealth Government Organisations

The Commonwealth's principal geoscience organisation is the Bureau of Mineral Resources, Geology and Geophysics (BMR). BMR is a research bureau attached to the Department of Primary Industries & Energy. It provides basic information for mineral exploration by industry and for mineral resources policy formulation by the Commonwealth Government.

BMR's principal objective is to provide 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 mineral exploration. It also undertakes petroleum and mineral resource assessments and mineral industry studies which provide the scientific and technical background to the formulation and administration

of the Government's policies. It is the primary national source of geoscience data, and makes appropriate scientific and technical data readily available to Government and industry.

In undertaking its work BMR maintains a complementary relationship with other geoscience organisations and collaborates with them wherever possible. BMR employs 566 staff, nearly all of whom are based in Canberra. Its annual budget is funded directly by the Commonwealth Government.

Between 1985 and 1988 BMR has continued to concentrate strategic research on developing as a basis for exploration the fullest understanding of the geology of the Australian continent and Australian Antarctic Territory and particularly the distribution, abundance, age and genesis of its petroleum and mineral resources in the context of the three-dimensional structure, composition and evolution of the Earth's crust.

Priority is given to energy-related research under the Fossil Fuels program.

In February 1985 the Division of Marine Geosciences & Petroleum Geology commenced a major research program - the Continental Margins program - using a chartered research vessel "Rig Seismic" to study the offshore continental margins of Australia and adjacent territories. Its main purpose is to provide a geological framework for petroleum and mineral resource exploration and assessment with the underlying objective of ensuring a high level of oil self-sufficiency in the long term.

Sixteen cruises have been undertaken, resulting in the discovery of new sedimentary basins with possible petroleum potential on the Kerguelen and Queensland Plateaux. Elsewhere, results of the associated geophysical surveys, geological sampling and heatflow studies have contributed significantly to a better understanding of the nature and formation of Australia's offshore areas.

Onshore, continued geophysical research now under the Division of Petrology & Geochemistry involves studies of the deep structures by seismic refraction and reflection techniques. The Division also continues research on selected ore deposits and the major Australian metallogenic provinces.

The Division of Continental Geology emphasises research into sedimentary basins and systems which may host fossil fuels and groundwater. A major study is being made of the Amadeus Basin. One of the highlights of 1985 was the discovery of "live oil" in the McArthur Basin. This oil is about 1500 million years old and is probably the oldest oil show yet discovered anywhere in the world.

An Intergraph interactive computer graphics workstation was installed in 1985, mainly to facilitate map productions under the Division's Palaeogeographic Maps project. Limited financial support for the project is provided by the Australian Mineral Industry Research Association.

The Division of Geophysics' main mineral resource concern is to undertake airborne magnetic and radiometric surveys and research on the geomagnetic field as an aid to mineral exploration.

In addition to improving the information base on Australia's identified resources, much of the Resource Assessment Division's work is concerned with reviewing and assessing the petroleum and mineral resources of Australia and its territories. The Division also undertakes research

relating to the characterisation and assessment of petroleum and mineral resources, including undiscovered resources.

The BMR Geoscience Computing & Database Branch was established in 1986 to coordinate geoscience database activities within BMR and among Government geoscience organisations in Australia, and to liaise with appropriate national and international organisations. A directory of all Government geoscience databases in Australia was published in 1985 and will be updated at regular intervals.

The Special Projects & Geoscience Services Branch continues to undertake national and international map projects and manage the BMR library, cartographic and publication services.

Two volumes, on "Coal Basins in Australia" and "The Tectonics of the Tasman Fold Belt" are being produced as an Australian Bicentenary project.

In October 1985 the BMR Advisory Council, comprising members from BMR, the Department of Primary Industries & Energy, industry, States and academia, was established. Its main function is to advise the Minister for Resources and the Director, BMR, on the objectives and priorities of BMR's research programs.

Geoscientific research and development is also undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) through its Institute of Minerals, Energy and Construction (IMEC). CSIRO is responsible to the Minister for Industry, Technology and Commerce. The objective of the Institute is to conduct and foster research that will contribute to the better definition, utilisation and management of Australia's mineral, energy and groundwater resources with due recognition of the environmental consequences of these activities.

Within IMEC the main geoscientific research is undertaken by the Divisions of Exploration Geosciences, Geomechanics, and Water Resource Research. Research in other divisions is focused on engineering aspects of mining, energy and chemical and mineral processing.

The geoscience divisions of IMEC employ around 420 staff, mainly located in laboratories in Melbourne, Sydney and Perth. Its annual budget includes direct funding from private industry for tactical research on specific industry problems or applications.

The Commonwealth administers the National Energy Research, Development and Demonstration program, through which funding is provided for research into various aspects on the exploration for and utilisation of the energy minerals.

State Government Organisations

Each State Government has a Geological Survey as part of a department responsible for the development, regulation and control of the State's mineral industry.

The activities of Geological Surveys relate to four main objectives, namely: energy, minerals, water and the environment. Systematic geological mapping of the State is one of the major responsibilities of the Geological Surveys. Each Survey is an important resource centre for earth science information relating to its particular State or Territory. The Geological Surveys also undertake engineering geology and environmental studies associated with development projects and land-use planning.

Universities

Most universities in Australia have departments which undertake teaching and research in the geosciences. The Australian National University (ANU) has special arrangements in that it also has departments exclusively for post-graduate studies and research. For example, the ANU Research School of Earth Sciences is a centre of excellence in geoscience and has a record of notable achievements in its studies of the composition, structure and evolution of the crust and deep interior of the Earth.

In 1985 the National Centre for Petroleum Geology and Geophysics was established at the University of Adelaide as a joint venture by three South Australian tertiary institutions to conduct specialised research on basin analysis related to the distribution and configuration of potential petroleum reservoirs. It receives active technical and financial assistance from the petroleum industry and the State and Commonwealth Governments

In 1985 the Centre for Petroleum Engineering was established, attached to the University of New South Wales, with the main purpose of training petroleum engineers and conducting research relevant to the petroleum industry. It is governed by an Advisory Board comprising representatives from government, academia and over fifteen private companies. Financial support comes mainly from industry, with subordinate contributions from Commonwealth grants.

Industry

Industry employs over 2,500 geoscientists, of whom about half are directly involved in exploration. A number of companies such as the Broken Hill Proprietary Co Ltd, CRA Ltd, CSR Ltd, MIM Holdings Ltd, and Western Mining Corporation Holdings Ltd employ significant resources on geoscientific research.

The Australian Mineral Industry Research Association (AMIRA) provides a forum for industry interests in geoscience research and provides funds for selected research projects.

The Australian Coal Industry Research Laboratories Ltd is a non-profit organisation whose primary object is research concerned with the exploration for and mining, beneficiation and utilisation of coal. Its services are available to individual companies on a contract basis.

Joint Government/Industry Organisations

The Australian Mineral Development Laboratories (AMDEL), which are located in all the capital cities of Australia, were established to undertake contract research and development for companies associated with the exploration and exploitation of minerals. The financial security of AMDEL was underwritten by work supply guarantees from the South Australian State Government, the Commonwealth Government and AMIRA which together comprised the governing council of AMDEL until 1987, when the organisation was declared an unlisted public company, AMDEL Ltd, under the administration of its own board of directors. This comprises the former governing council, together with general industry representatives.

The Australian Mineral Foundation (AMF) was established to provide for the specialised training and information requirements of all organisations associated with the mining and petroleum industries. Its courses are short and intensive (one to two weeks) and are conducted by experts on contract, often from overseas. Its governing council includes representatives from the professional institutes and societies, together

with the Government Department of Primary Industries & Energy, CSIRO, universities and colleges of advanced education, and the petroleum and mineral industries.

Australian Geoscience Council

The Australian Geoscience Council (AGC) was formed to bring together the widest possible range of knowledge and affiliations from geoscientists in industry, government and academia to promote the best interests of earth science organisations and their contribution to the Australian nation. Seven major professional institutes are members of AGC. Additionally, a number of Government organisations and research institutions are included as Associate Members or Observers. These include BMR, CSIRO, AMF and the Australian Academy of Science.

Mineral Resources

Until the early 1970s, national resource assessment work was largely qualitative. In 1975 BMR adopted, with minor changes, the McKelvey resource classification system used by the US Bureau of Mines and US Geological Survey. The BMR classification system was reviewed in 1983 in the light of experience. The principles, which had been found suitable for BMR's needs, were retained, but some changes in detail were made to overcome problems in the practical application of the classification system.

BMR classifies known (identified) mineral resources according to two parameters: degree of assurance of occurrence (degree of geological assurance) and degree of economic feasibility of exploitation. The former takes account of information on quantity (tonnage) and chemical composition (grade); the latter takes account of changing economic factors such as commodity prices, operating costs, capital costs, and discount rates.

Resources are classified in accordance with circumstances at the time of classification. Resources which are not available for development at the time of classification because of legal and/or land-use factors are classified without regard to such factors; however, the amount of resource thus affected will, wherever possible, be stated for each classification category.

The classification framework is designed to accommodate all naturally-occurring metals, non-metals, and fossil fuels, and to provide a means of comparing data on different resources which may have a similar end use (e.g. petroleum, coal and uranium as energy sources).

The BMR classification is intended to be used for classifying aggregate resources of a commodity at the national or regional scale. Resources in individual deposits normally are classified using guidelines in a report issued in 1982 by a Joint Committee of the Australasian Insitutue of Mining and Metallurgy and the Australian Mining Industry Council.

Resources in major Australian mineral deposits which are being mined, being developed, or are likely to be developed in the next 10 years are shown in Table 7. Total Australian resources of a number of mineral commodities are shown in Table 8.

2. THE CURRENT STATUS OF THE MINING INDUSTRY

Energy Minerals

Crude Oil

Total Australian production of crude oil and condensate in fiscal year 1986-1987 was about 29.5 GL and 2.2 GL respectively. The Bass Strait fields contributed 80% of the total crude oil production and about 36% of total condensate production. Western Australian fields accounted for about 12% of total crude oil production and Queensland for about 6%.

From 1985 to the end of 1987, development drilling continued in the Cobia, Flounder, Fortescue and Snapper fields in the offshore Gippsland Basin in Bass Strait. The Bream oil and gas production platform jacket was installed during 1987 and the first oil is scheduled to be produced in 1988. Other fields in the area are being evaluated for new development, and plans were announced for three small oil fields to be developed at a cost of $238 million. Production from these and possibly other small fields will help offset declining production in the early 1990s. Exports of crude oil continued during 1987 from the Gippsland Basin, from the Jabiru field in the Timor Sea, and from Port Bonython on the Spencer Gulf, which processes liquids from the Moomba area fields. In Western Australia, the offshore Harriet oil field near Barrow Island commenced production. Development drilling was underway at North Herald and South Pepper oil fields south of Barrow Island; it is planned to bring these fields on stream with five wells utilising one sub-sea completion and two small steel platforms to support the well heads. Recoverable oil reserves are 4 to 6 million barrels in each field and the complex is expected to produce oil at a rate of about 8 000 barrels/day. Plans were announced to develop the Saladin oil field, also near Barrow Island. The project will consist of four small platforms with production fed to nearby onshore facilities. Estimates suggest recoverable oil reserves of about 20 million barrels and a predicted peak production rate of more than 30 000 barrels/day over at least six years. The Challis oil field, south of the Jabiru field in the Timor Sea, is also to be developed. Production is expected to start in late 1989, at a rate of 24 000 barrels/day, from well heads on the sea bed, a moored production/storage barge and a vessel with production and processing facilities accommodated on deck.

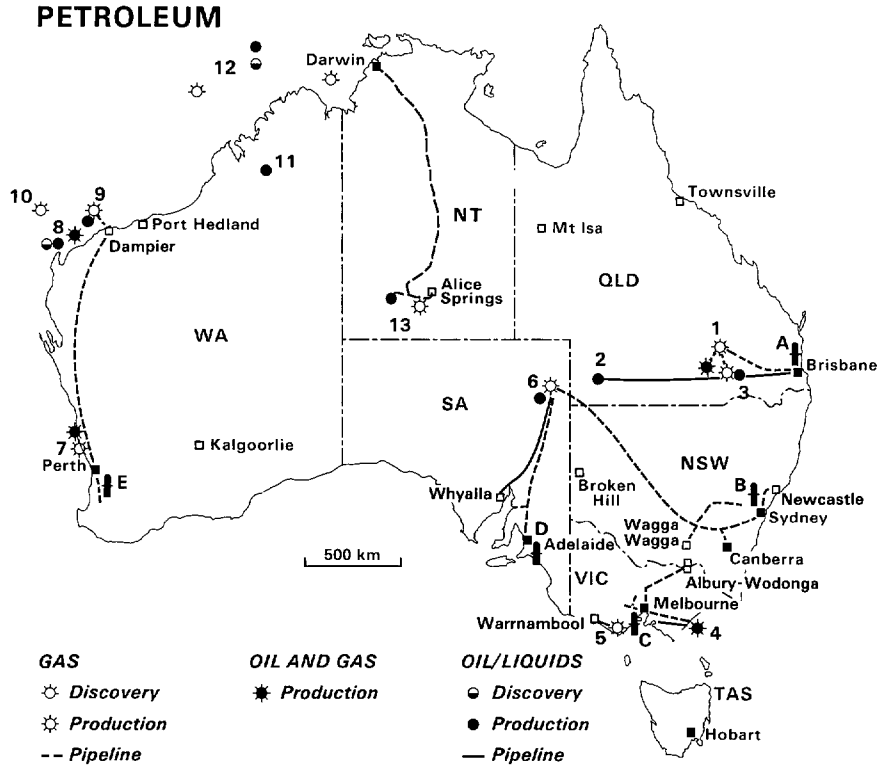
In central Australia the crude oil pipeline linking the Mereenie oil field and Alice Springs was completed in 1985.

In South Australia, an enhanced oil recovery project will double the oil produced from several oil fields in the Moomba area.

During the period under review significant offshore oil discoveries were made in the Snapper, Leatherjacket, Angelfish, Whiptail, Whiting, Remora and Kipper fields in Bass Strait, and in the Saladin and Skua fields in Western Australia. These discoveries further confirmed the oil-bearing potential of these areas.

Onshore crude oil discoveries were generally in relatively small fields; most discoveries were in the Cooper/Eromanga and Bowen/Surat Basins of South Australia and Queensland. Intensive drilling along the eastern edge of the Cooper/Eromanga Basins resulted in the discovery of a number of small oil fields which confirmed the region about the town of Eromanga as a new petroleum province. In the South Australian part of the Cooper Basin, drilling was largely concentrated in areas near previous discoveries or producing fields; the discovery of oil in the Patchawarra Formation of the Daralingie field has led to further oil and condensate

PETROLEUM



FIELD LOCATIONS

1 Roma area (gas) 2 Jackson area (oil) 3 Moonie area (oil) 4 Gippsland Basin area (oil & gas) 5 Otway Basin area (gas) 6 Moomba area (gas, oil/liquids) 7 Dongara area (oil & gas) 8 Barrow Island area (oil & gas) 9 Rankin area (gas & oil) 10 Exmouth Plateau (gas) 11 Blina area (oil) 12 Browse & Bonaparte Basins area (oil & gas) 13 Amadeus Basin (oil & gas)

PIPELINES

Roma (Wallumbilla) to Brisbane (gas), Moonie to Brisbane (oil), Gippsland Basin to Longford (oil & gas), Longford to Melbourne (gas), Longford to Western Port (oil & gas liquids), Melbourne to Wodonga (gas), Melbourne to Ballarat (gas), Moomba to Sydney/Wollongong (gas), Sydney to Newcastle (gas), Moomba to Adelaide (gas), Dongara area to Perth, Kwinana, Pinjarra (gas), Dalton to Canberra (gas), Young to Wagga Wagga (gas), Young to Lithgow (gas), Moomba to Port Bonython (oil/liquids), Dampier to Perth/Pinjarra (gas), North Rankin to Dampier (gas), Palm Valley to Alice Springs (gas) and Mereenie to Alice Springs (oil), Amadeus Basin to Darwin (gas)

REFINERY LOCATIONS

A Brisbane area (Bulwer Island & Lytton) B Sydney area (Kurnell, Clyde) C Melbourne area (Altona, Geelong) D Adelaide (Hallets Cove) E Perth (Kwinana)

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discoveries in known gas fields elsewhere. A 42 well exploration and development drilling program was completed at Barrow Island.

Natural Gas

The main areas currently producing gas are in the Cooper Basin of South Australia, the North West Shelf offshore from Dampier, Western Australia, and Victoria's offshore Gippsland Basin. By the end of 1987, Sydney, Canberra, Melbourne, Adelaide, Perth, Darwin and Brisbane and a number of other cities and towns throughout Australia were being supplied with natural gas. Construction of a natural gas pipeline to supply some other country centres in New South Wales with gas is underway.

Since 1985 numerous onshore gas discoveries have been made in the Bowen/Surat, Cooper/Eromanga, Gunnedah, Otway and Sydney Basins.

Offshore, significant discoveries have been made in fields and pools in the Bass Basin, Tasmania; Carnarvon Basin, Western Australia; and in the Gippsland Basin, Victoria.

Following the completion of the first phase of the North West Shelf gas project to supply natural gas to the Perth market in 1984, full scale construction is underway for the second phase of the project, to supply liquified natural gas (LNG) to Japan. The first shipment is planned for October 1989. The LNG phase will cost approximately $9 800 million, and a further approximately $5 000 million will be spent on the construction of 7 LNG tankers and LNG handling facilities in Japan. LNG production will peak at 6.0 Mt/year in 1995 and supply gas at least until 2009. A second offshore production platform on the North West Shelf is to be installed on the Goodwyn field to supplement production from the North Rankin 'A' platform. Testing and appraisal drilling at the North Rankin and Goodwyn fields indicated a potential condensate reserve of about 55.5 $x10^6 m^3$.

In the Northern Territory gas started flowing to Darwin from the Palm Valley and Mereenie fields in late 1986. The gas is servicing power stations at Tennant Creek and Katherine, as well as a new power station at Darwin. A gas separation plant to be built at Darwin by the end of 1988 will produce liquified petroleum gas, natural gas and provide Australia's only source of helium . Negotiations with overseas clients for the supply of LNG from the Bonaparte Gulf fields are continuing.

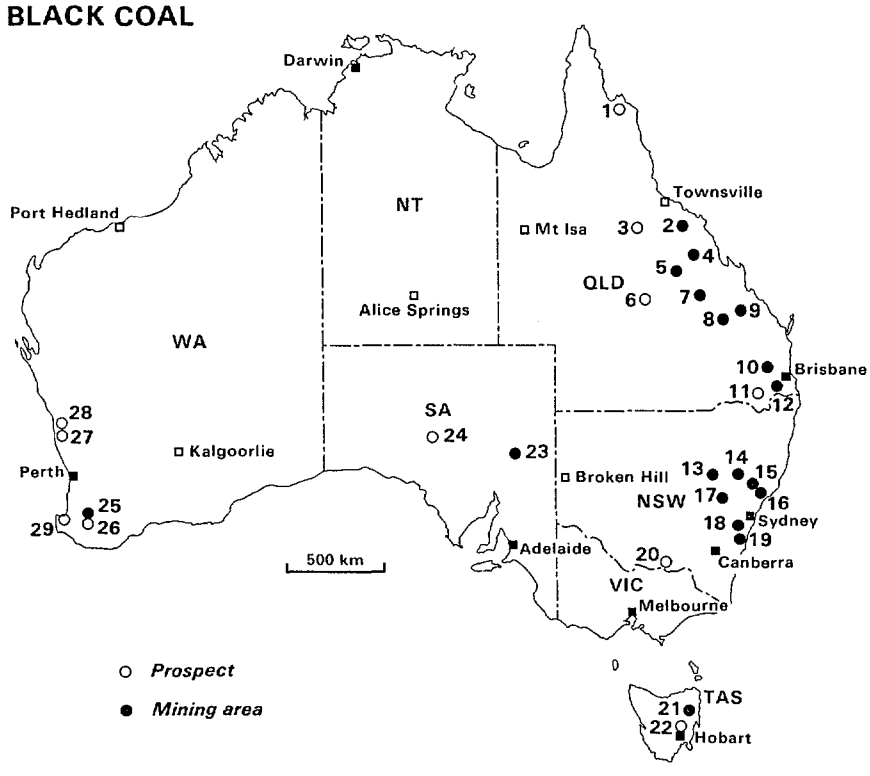
In Queensland, the Wallimbilla LPG processing plant was completed in 1985 and is producing about 35 000 t/year of LPG. A smaller LPG processing plant was completed at Kincora with production running at about 13 000 t/year. An ammonium nitrate plant near Blackall in Central Queensland is expected to be operational by 1989. Gas will be supplied by a 140 km pipeline from the Gilmore field and the plant will produce about 80 000 t/year of ammonium nitrate as well as ammonia and nitric acid. Construction is about to begin of a gas pipeline to link the Denison Trough gas fields to a major industrial client at Gladstone. A second phase of the project will link the Denison Trough fields to the Surat Basin gas fields and the Roma-Brisbane natural gas pipeline.

Black Coal

Production, consumption and exports all reached record levels in 1987.

Raw black coal production continued to grow from 1985 to 1987 but at a reduced rate. Saleable coal output increased in line with the increase in raw coal production. Queensland and New South Wales dominate production, accounting for over 96% of total Australian raw coal output. Production in Tasmania, South Australia and Western Australia increased by small

BLACK COAL



1 Laura Basin 2 Bowen District 3 Pentland 4 Mackay District 5 Blair Athol 6 Alpha 7 Blackwater District 8 Kianga-Moura District 9 Callide 10 Tarong 11 Millmerran 12 West Moreton District 13 Ulan 14 Singleton-North West District 15 South Maitland District 16 Newcastle District 17 Western District 18 Burragorang Valley District 19 South Coast District 20 Oaklands 21 Fingal 22 Woodbury 23 Leigh Creek 24 Arckaringa Basin 25 Collie 26 Wilga Basin 27 Hill River 28 Eneabba 29 Vasse Shelf

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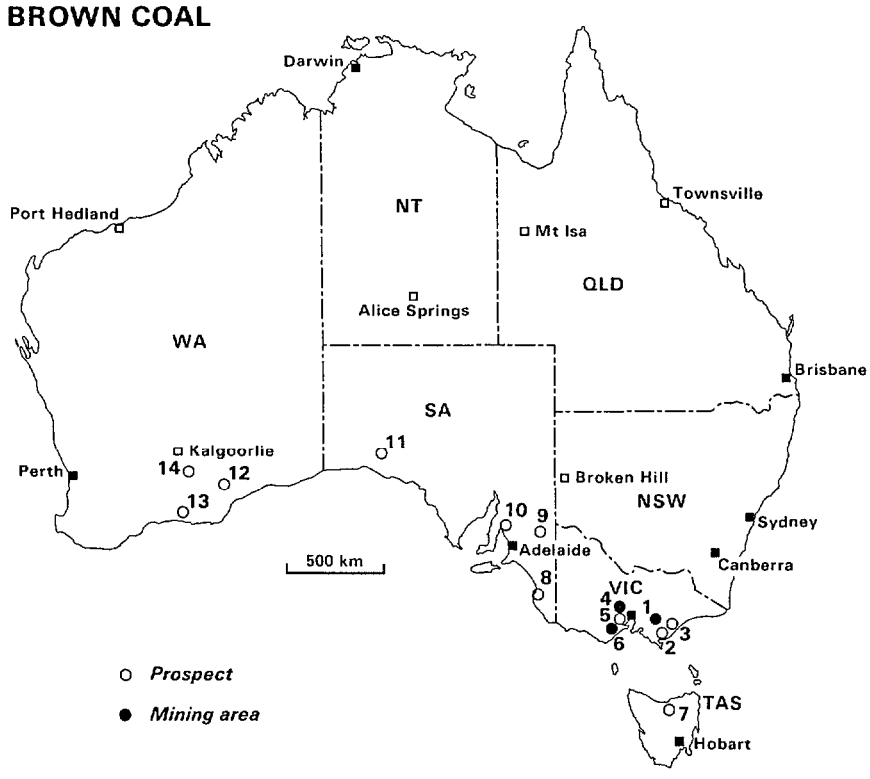
BROWN COAL



1 Latrobe Valley 2 Gelliondale 3 Stradbroke 4 Bacchus Marsh 5 Altona 6 Anglesea
7 Rosevale 8 Kingston 9 Mannum 10 St Vincents Basin 11 Pidinga 12 Balladonia
13 Esperance 14 Norseman

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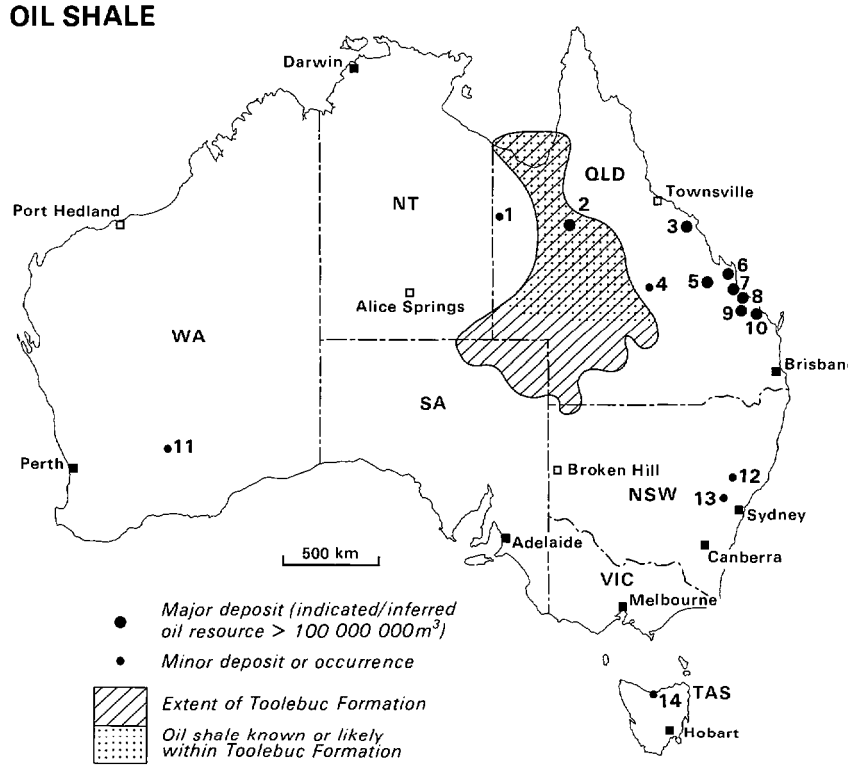
OIL SHALE



1 Camooweal 2 Julia Creek 3 Condor 4 Alpha 5 Duaringa 6 Yaamba
7 Rundle 8 Stuart 9 Nagoorin 10 Lowmead 11 Coolgardie 12 Baerami
13 Genowlan, Newnes, Glen Davis 14 'Tasmanite'

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amounts over the period. No black coal is produced in the Northern Territory or Victoria.

Consumption within Australia rose slowly to over 44Mt in 1987. Approximately 75% of all coal consumed is used in the generation of electricity. The other main consumer is the iron and steel industry which accounts for about 15% of annual consumption.

Australia was the world's leading exporter of coal over the period 1985-1987 with total exports rising to 101 Mt in 1987. Most of the growth can be attributed to increased shipments of thermal coal which now make up approximately half the overseas sales of Australian coal. Queensland was the major exporting state with an estimated 58 Mt of coal shipped in 1987 while New South Wales shipped an estimated 43 Mt.

The record Australian performance in 1987 was achieved despite the closure of 14 mines in New South Wales and Queensland. In addition staffing at many other mines was substantially reduced. Mine closures and retrenchments in New South Wales largely stemmed from depressed prices on the world coal market. In Queensland many closures occurred as the result of a restructuring of the State's electricity generating capacity which has led to the phasing out of a major power station near Brisbane.

Australia has sufficient mine and infrastructure capacity to substantially increase exports should demand increase. Port capacity is sufficient to allow the export of almost 140Mt/year if required.

Brown Coal

Victoria is the only State in Australia which produces brown coal. The major deposits are in the Latrobe Valley where the State Electricity Commission mines over 95% of the State's total output. The remaining 5% is won from private mines at Anglesea and Bacchus Marsh. All brown coal produced is used for domestic purposes.

Over 2Mt/year of coal is used in the production of brown coal briquettes. These are used primarily for industrial purposes within Australia but increasing markets are being found in overseas countries. The Coal Corporation of Victoria has made a concerted effort to develop the export market for brown coal briquettes.

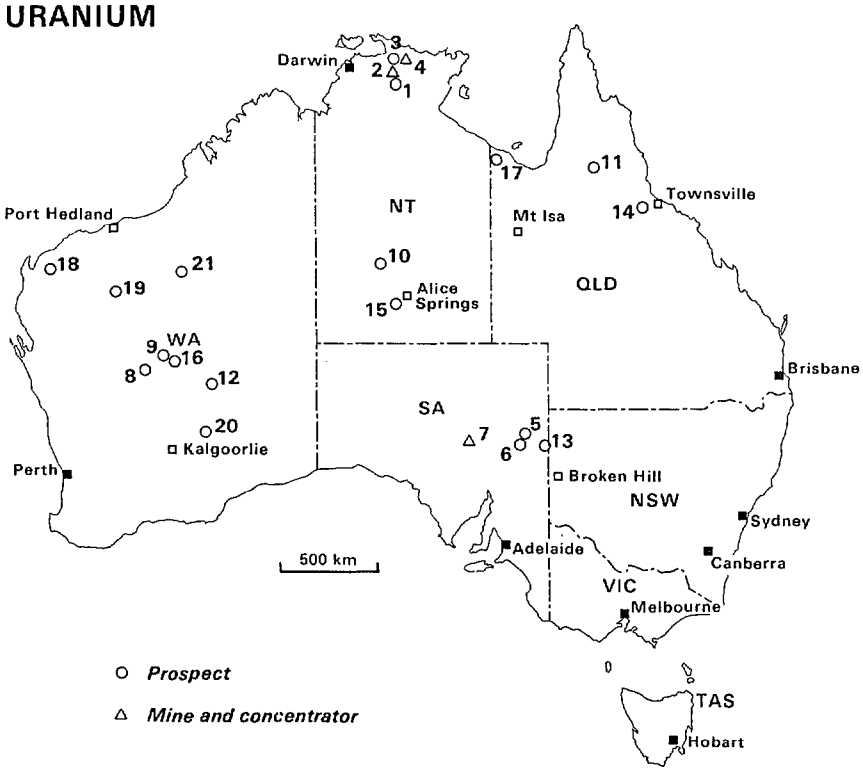
Production of brown coal rose in 1987 to the record level of just under 45Mt. This growth is due largely to the increased contribution from the new open-cut operation at Loy Yang, adjacent to the Loy Yang Power Station in the Latrobe Valley.

Exploration over the period has little changed the resources of brown coal in Tasmania, South Australia and Western Australia. Of these States, a mine is most likely to be developed in South Australia where the Electricity Trust of South Australia is considering the development of a new coal fired powerstation.

Oil Shale

Development studies at all major Australian oil shale deposits continued throughout the period 1985-87. No decision has been taken to develop commercial operations at any deposit. Prospects for such development were reduced by the large reduction in crude oil prices and the only partial recovery of those prices to former levels.

URANIUM



1 Koongarra 2 Ranger 3 Jabiluka 4 Nabarlek 5 Beverley 6 Mount Painter 7 Olympic Dam (Roxby Downs) (being developed) 8 Yeelirrie 9 Lake Way 10 Ngalia Basin 11 Maureen 12 Thatchers Soak 13 Honeymoon 14 Ben Lomond 15 Angela 16 Lake Maitland 17 Westmoreland 18 Manyingee 19 Turee Creek 20 Mulga Rock 21 Kintyre

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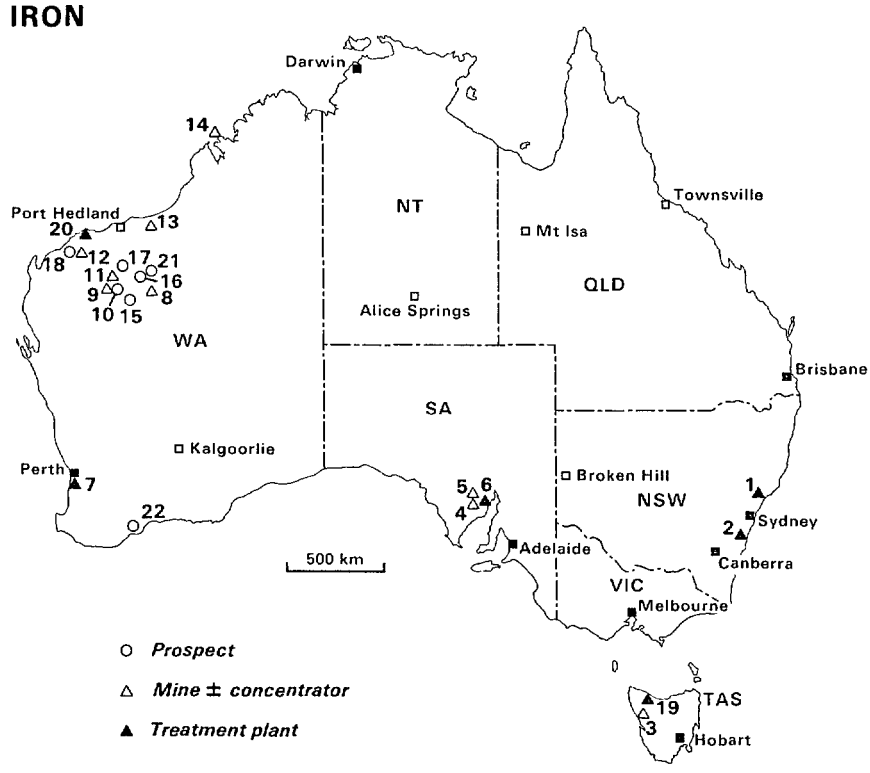
IRON



1 Newcastle (ironmaking, steelmaking) 2 Port Kembla (ironmaking, steelmaking) 3 Savage River 4 Iron Baron, Iron Prince, Iron Queen, Cavalier 5 Iron Monarch, Iron Knob 6 Whyalla (ironmaking, steelmaking, pellet plant) 7 Kwinana (ironmaking—not operating) 8 Mount Whaleback 9 Paraburdoo 10 Channar 11 Mount Tom Price 12 East Deepdale (Pannawonica) 13 Shay Gap, Sunrise Hill 14 Yampi Sound (Cockatoo Island, Koolan Island) 15 West Angela 16 Area C 17 Marandoo 18 Deepdale 19 Port Latta (pellet plant) 20 Dampier (pellet plant—not operating) 21 Yandicoogina 22 Southdown

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Uranium

During the period under review two uranium mines operated: Ranger and Nabarlek. Australia's share of world production is about 10%.

Energy Resources of Australia Ltd expects that sales contracts will require plant expansion at the Ranger mine to 4 500t/year by 1989 with a further increase to 6 000t/year by 1991-92. Nabarlek continued treating stockpiled ore, which is almost exhausted.

Construction at Olympic Dam commenced in March 1986. Annual production is expected to be 2 000t U_3O_8, 30 000t copper and 2 800kg gold. Uranium production is scheduled to commence in the third quarter of 1988.

CRA Exploration Pty Ltd announced the discovery of the Kintyre uranium deposit in the Rudall River area, Western Australia. Based on the evaluation drilling completed to September 1987, the company estimated that the deposit has probable resources of 15 000t contained U_3O_8 and an additional 15 000t contained U_3O_8 in the possible category. The average grade of the resource was not reported; however, the company stated that grade intersections range from 1.5 to 4kg/t U_3O_8.

Iron Ore and Ores for Ferroalloys

Iron and steel

Australian iron ore output rose in 1985, fell in 1986 then rose to a record 100 Mt in 1987 after measures to improve efficiency and production rates took effect at some mines. A number of developments for new mines or for expansion of mine capacity were announced during the period.

The production rate at the East Deepdale (Pannawonica) mine was increased from 16 Mt/year to more than 18 Mt/year and new equipment at Mount Newman, including an in-pit waste crushing and conveying system, increased ore and waste production from 88 to 105 Mt/year. Mount Newman Mining Co will also expand the capacity of its Orebody 29 mine from 1.5-2 Mt/year to 5 Mt/year.

Goldsworthy Mining Ltd began a project to prolong its operations by 20 years by extracting a further 100 Mt of iron ore in the Shay Gap area; the project will enable mining to continue at Shay Gap and Sunrise Hill and begin at nearby Nimingarra and, later, at Kennedy Gap and Yarrie. A beneficiation plant is to be constructed at Port Hedland to treat low grade ore.

An agreement between Mount Newman Mining Co. and Hancock Mining Ltd provides for limited mining of scree deposits to begin at McCamey's Monster, 35 km southeast of Newman, at a rate of 750 000 t/year; for Mount Newman to supply and to service Hancock Mining's contracts with Romania from 1988; and for further study into the feasibility of establishing a more permanent 5 Mt/year mine at McCameys Monster.

Hamersley Iron Pty Ltd and the China Metallurgical Import and Export Corporation will develop an iron ore mine at Channar, 20 km east of Paraburdoo . Production, which is to be blended with output from Hamersley Iron's other mines, is to begin in 1990 at a rate of 3 Mt/year, and will be increased progressively to 10 Mt/year as required.

Iron ore exports reached a record level in 1985 but decreased in the following 2 years as requirements by the major markets, Japan and Europe, fell, although exports to the Peoples Republic of China, Taiwan Province, Republic of Korea and Pakistan continued to increase. Shipments to Romania

will begin in 1988 and potential for expanding exports to Eastern Europe is promising.

Port works by Mount Newman at Port Hedland enabled vessels of 270 000 dwt to enter the port on favourable tides and 220 000 dwt vessels to load to capacity on the average high tide. Goldsworthy Mining Ltd expanded its port facilities at Port Hedland in 1987 to permit entry of 170 000 dwt vessels.

Australian iron and steel output increased in 1985 and 1986. Industrial disputes and the commissioning of new plant adversly affected production in 1986 and 1987 and caused output to fall in 1987.

Iron and steel exports rose in 1985 and shipments of semi-finished steel products to Pacific Basin markets were at a high level. In the following 2 years, production was required for the domestic market, consequently exports declined. Higher domestic requirements caused steel imports to increase in 1987.

During the period under review further major investment projects aimed at improving Australian steelmaking and rolling mill facilities were announced or commissioned. Most of these projects were part of a steel industry plan announced in August 1983 aimed at restoring the Australian steel industry's competitive position internationally. Cumulative expenditure under the plan since 1983 totalled $1227 million at the end of June 1987. Almost 57% of this expenditure has been at Port Kembla.

Works to increase productivity were completed at Newcastle and a 130 000 t/year capacity merchant mill producing reinforcing bars and specialised rods from billets supplied from other Australian steelworks was commissioned by BHP Brisbane.

Commonwealth Steel Company Ltd completed a major modernisation program at its alloy steelworks at Waratah, NSW, which increased production capacity from 108 000 t to 130 000 t/year.

Humes Smorgon Steel Pty Ltd completed an expansion program to expand billet and merchant mill product capacity at its Melbourne works from 210 000 t to 310 000 t/year.

Manganese

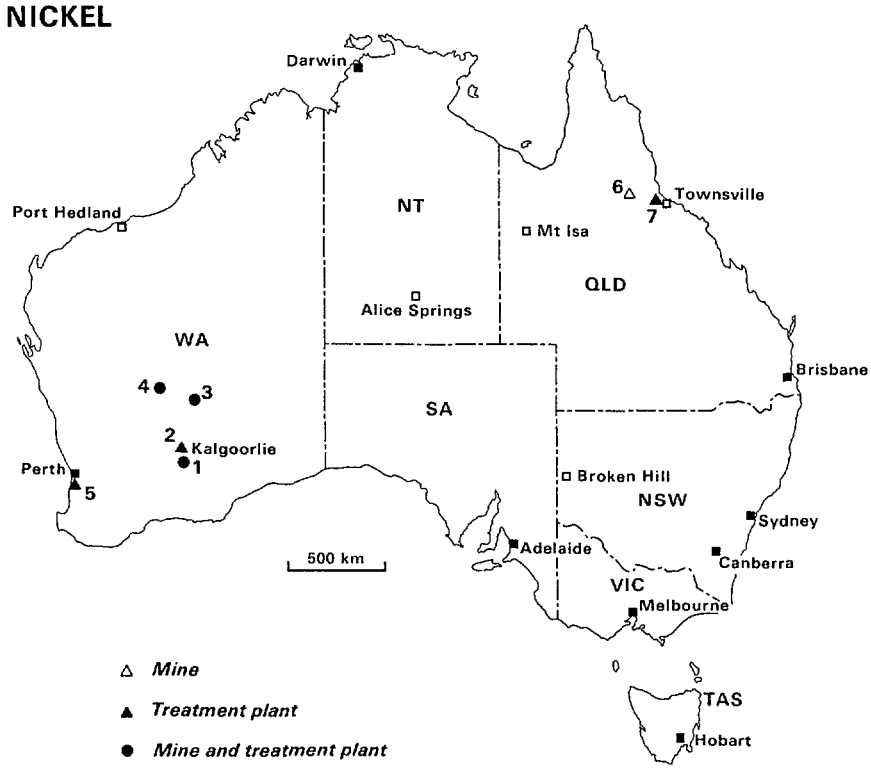
International demand for manganese ore eased in the latter half of 1985 and decreased in the following 2 years. Australian manganese ore production and exports fell in 1986 but recovered in the latter part of 1987. Production capacity for both manganese ore and manganese alloys was increased in 1987 after completion of improvement programs carried out during the period.

Although exports to the major markets, Japan and Europe, fell, important new markets in China were expanded substantially, with sales averaging 170 000 t/year.

An improvement program at the Groote Eylandt concentrator increased ore treatment capacity from 750 to 1000 t/hour and production capacity for concentrate from 2.3 to 2.4 Mt/year; production capacity for manganese ferroalloys at the Bell Bay smelter, which treats manganese ore from Groote Eylandt, was increased from 135 000 to 200 000 t/year.

BHP-Utah Minerals International will build a plant at Newcastle to produce electrolytic manganese dioxide for manufacturing dry cell batteries. The plant, which will have a capacity of 15 000 t/year of manganese dioxide

NICKEL



1 Kambalda field (mines & mill) 2 Kalgoorlie (smelter) 3 Mount Windarra (mine & mill)
4 Agnew (mine & mill), (on care-and-maintenance) 5 Kwinana (refinery) 6 Greenvale
7 Yabulu (refinery)

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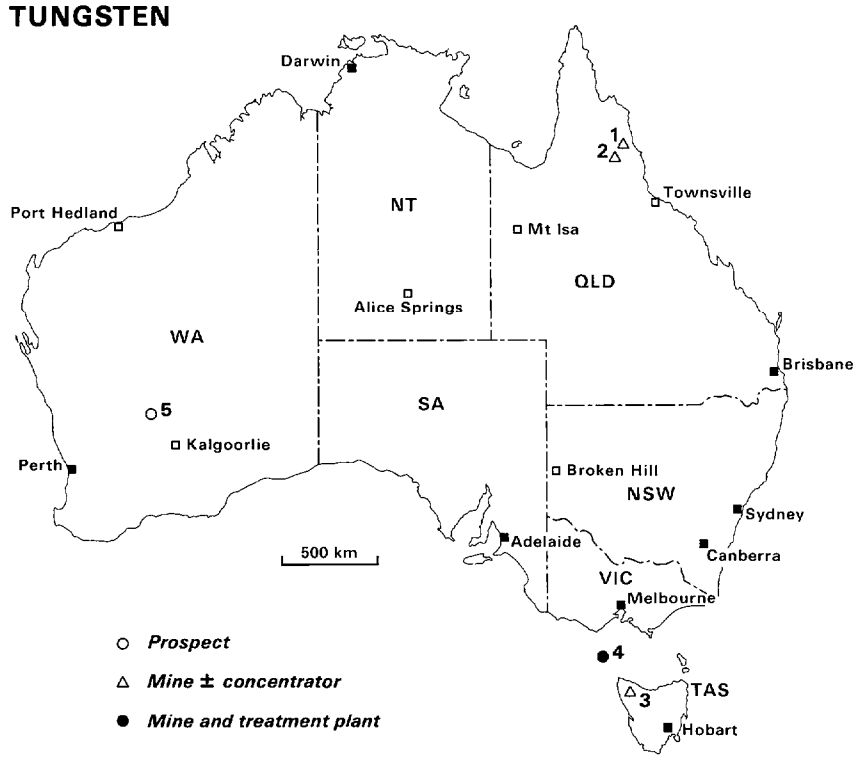
TUNGSTEN



1 Mount Carbine 2 Wolfram Camp 3 Kara 4 King Island (mine, concentrator, and artificial scheelite plant) 5 Mount Mulgine

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will process ore from the company's Groote Eylandt mine and is scheduled to be commissioned in 1990.

Nickel

The period under review was one of rationalisation for the Australian nickel industry. Operations were suspended at eight mines in Western Australia, in most instances mainly because of depressed nickel prices.

In April 1986, Western Mining Corporation Ltd (WMC) suspended operations at the South Windarra open cut and at five of its higher-cost mines in the Kambalda field (McMahon, Hunt, Jan, Mount Edwards, and Wannaway). Later that year Agnew Mining Co. Pty. Ltd stopped mine production at Agnew; the mine was put on care-and-maintenance and will reopen when market conditions permit. In May 1987 the Nepean mine, which reopened in September 1985, closed because accessible ore reserves had been exhausted.

As a consequence of these mine closures, Australia's mine production of nickel decreased from 85 757 t in 1985 to an estimated 73 000 t in 1987. The closure of Agnew accounted for most of this fall; WMC's loss of production from closed mines was compensated by increased production from some of its other mines, notably the Long, and by the start of production from the Lanfranchi mine early in 1986.

Australia's only other nickel mine, Queensland Nickel Pty Ltd's Greenvale mine, operated at full capacity during the period. Reserves at the mine are expected to be exhausted in 1992. Studies are well advanced for the use of imported laterite ore as feed for Queensland Nickel's Yabulu refinery. Australia imported 41 082 t of laterite nickel ore from New Caledonia in 1986; the ore was used in trials at the refinery to test its suitability as feedstock.

Australia continues to be the world's second largest exporter of primary nickel, and the world's third and fourth largest mine and refinery producer respectively.

Tungsten

Australia is one of the Western world's largest tungsten producers but because of reduced world demand for tungsten in recent years its production fell from around 3 600 t W in 1982 to around 1 600 t in 1987.

The largest producer is King Island Scheelite Pty Ltd which has two mines and an artificial scheelite plant on King Island in Bass Strait. Optimum production is around 2 000 t/year W but in recent years only one of the mines has been operating, and that at a reduced rate.

Australia's other major tungsten producer, Queensland Wolfram Pty Ltd, placed its 1 000 t/year W mine at Mount Carbine on care and maintenance in 1986, pending an improvement in the tungsten market.

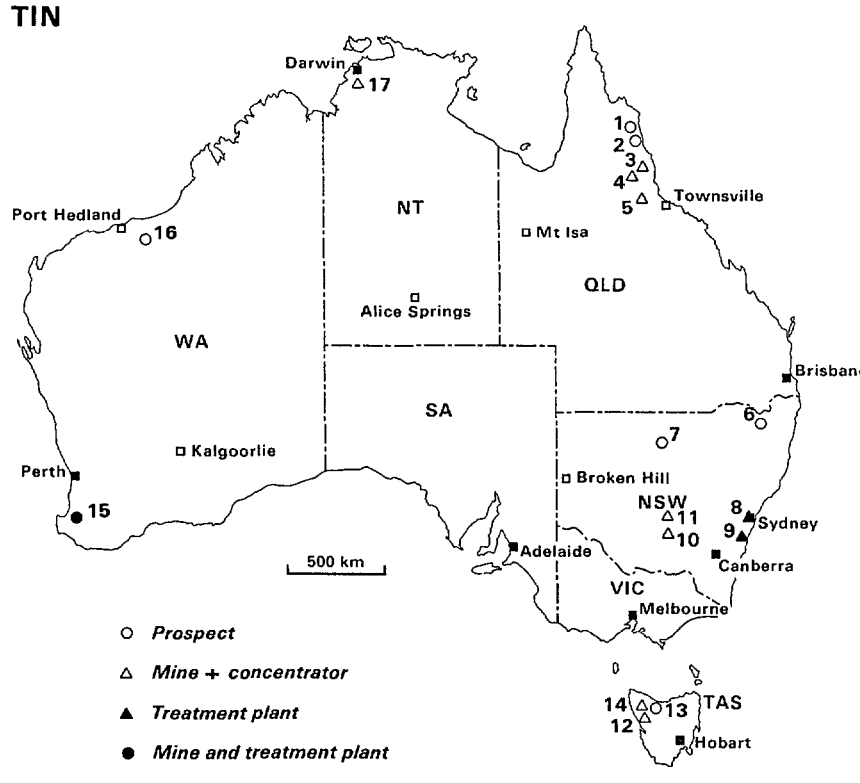
All of the smaller tungsten producers have closed down with the exception of Kara which produces scheelite and magnetite.

Non-ferrous Ores

Tin

Although tin output has fluctuated considerably in the last three years, the 1987 mine output was similar to the 1984 level of 7900t tin-in-concentrate; however the smelter output fell by two-thirds to around 1000t. The 40% fall in the tin price following the October 1985

TIN



1 Kings Plains 2 Collingwood 3 Herberton–Mareeba district 4 Mount Garnet district 5 Dinner Creek 6 Emmaville district 7 Doradilla 8 Sydney (refinery) 9 Unanderra (secondary refinery) 10 Ardlethan 11 Gibsonvale 12 Renison 13 Mount Bischoff 14 Cleveland 15 Greenbushes (mine & refinery) 16 Moolyella 17 Bynoe Harbour district

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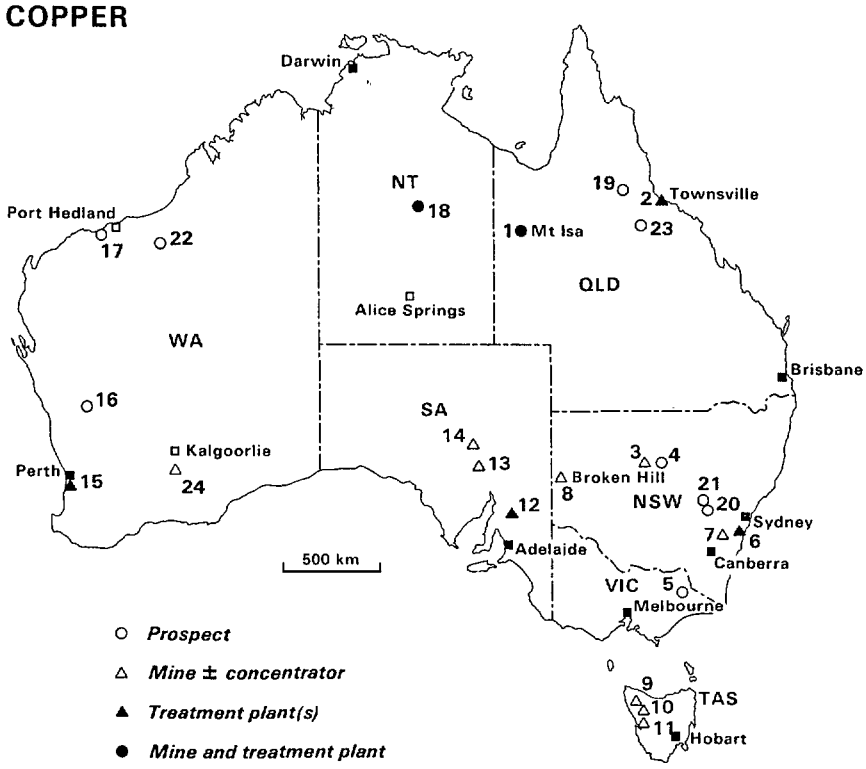
COPPER



1 Mount Isa (mine & smelter) 2 Townsville (refinery) 3 CSA (Cobar) 4 Chesney, Gladstone 5 Benambra 6 Port Kembla (smelter & refinery) 7 Woodlawn 8 Broken Hill area (by-product Cu from Zn-Pb-Ag mining) 9 Cleveland (by-product Cu from Sn mining) 10 Rosebery, Hercules, Que River (by-product Cu from Zn-Pb-Ag mining) 11 Mount Lyell 12 Burra (copper oxide) 13 Mount Gunson 14 Olympic Dam (Roxby Downs) (being developed) 15 Kwinana (by-product Cu from Ni refining) 16 Golden Grove 17 Mons Cupri 18 Tennant Creek (mine & closed smelter) 19 Balcooma 20 Cadia 21 Goonumbla (Parkes) 22 Nifty 23 Thalanga 24 Kambalda (by-product Cu from Ni mining)

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tin market collapse has led to changes in the industry. During 1986 the Ardlethan and Cleveland mines closed; together they previously accounted for around 20% of tin-in-concentrate production. Most of the numerous small-scale alluvial and lode miners of north Queensland, who accounted for 10-15% of national production, have ceased tin mining and have changed to small gold mining operations. The larger alluvial producers have also curtailed or stopped production. In contrast, the major lode mine, Renison, increased production to its capacity level after the expiry of International Tin Council export quotas in early 1986; all of its output is exported as concentrate. Australia's two tin smelters, at Sydney and Greenbushes, have curtailed operations because of a shortage of concentrates and in mid 1986 Australian consumers commenced importing tin in substantial quantities. Exploration and evaluation of undeveloped tin deposits has virtually ceased and existing mines have raised their production cutoff grades.

Estimated consumption of refined tin has remained static through the three year period, at a level slightly higher than in the previous period. The major destination of concentrate exports and source of metal imports was Malaysia.

Copper

In the period under review production of copper declined from around 260 000t in 1985 to an estimated 221 000 t in 1987, largely because production ceased at Teutonic Bore in 1985 and at Mount Gunson in 1986 because of exhaustion of reserves.

The tonnage of copper exported, measured in terms of the estimated copper content of ores, concentrates, blister and refinery shapes, fell over the period because of declining mine production. Blister copper exports ceased in 1985 as all blister is now processed to the refined stage in Australia.

The open pit operation at Woodlawn finished in May 1987 and underground mining commenced. The mining rate will fall to around 500 000 t/year from the open-cut rate of 1 Mt/year and copper output will decline.

Renison Goldfields Consolidated Ltd announced that, because of higher copper prices and cost savings, major underground work would be carried out at Mount Lyell that would allow mining operations to continue beyond the proposed mine closure date of June 1989.

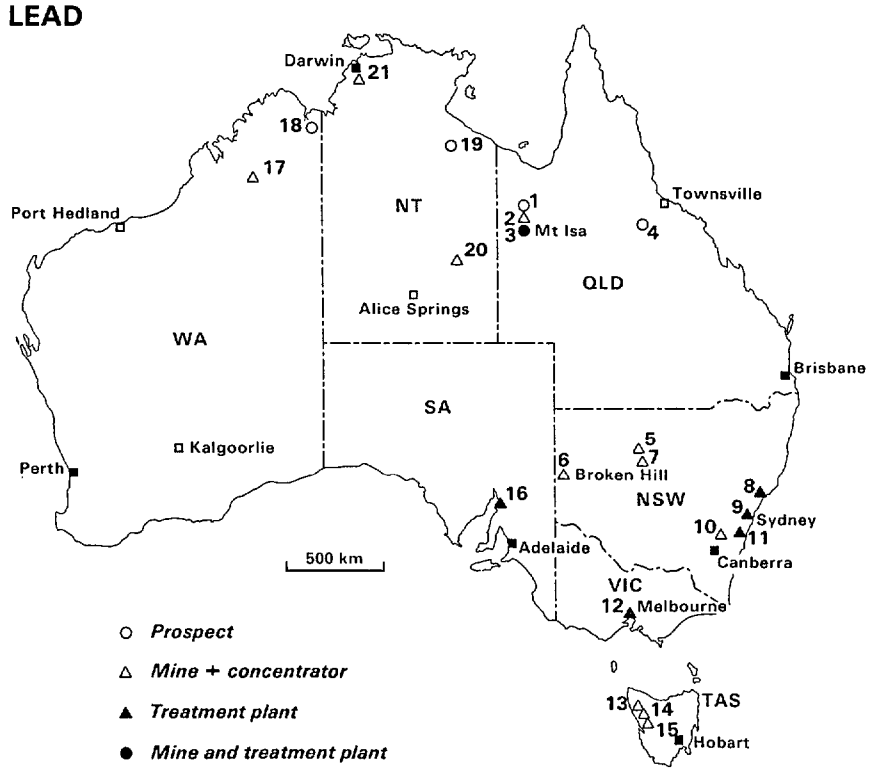
Construction at the Olympic Dam mine at Roxby Downs began in March 1986; production is to commence in mid 1988 at the annual rate of 30 000 t of refined copper, 2 000 t of U_3O_8 and about 2 800 kg of gold. Copper output could possibly increase to 55 000 t/year by the early 1990s.

The Starra deposit in north Queensland and the Horseshoe Lights deposit in Western Australia are to begin production in early 1988 at annual rates of 10 000 t and 16 000 t of contained copper in concentrate respectively.

A feasibility study of the Parkes porphyry copper deposits at the end of 1986 concluded the project was unecomonic. Further work by Peko Wallsend Ltd following withdrawal of the other joint venturer has shown that there is considerable gold content in a number of the oxidized caps of the deposits and a further feasibility study, to be completed in mid 1988, is taking this into consideration.

Exploration and evaluation of a number of other prospects, including Golden Grove, Thalanga, and Nifty, continued.

LEAD



1 Lady Loretta 2 Hilton (being developed), Hilton North 3 Mount Isa (mine & smelter) 4 Thalanga 5 Elura 6 Broken Hill (several mines) 7 Cobar 8 Cockle Creek (smelter) 9 Sydney (secondary refineries) 10 Woodlawn 11 Port Kembla (secondary refinery) 12 Melbourne (secondary refinery) 13 Hellyer 14 Que River (mine only) 15 Rosebery, Hercules 16 Port Pirie (refinery) 17 Cadjebut 18 Sorby Hills 19 McArthur River 20 Attutra (on care-and-maintenance) 21 Woodcutters

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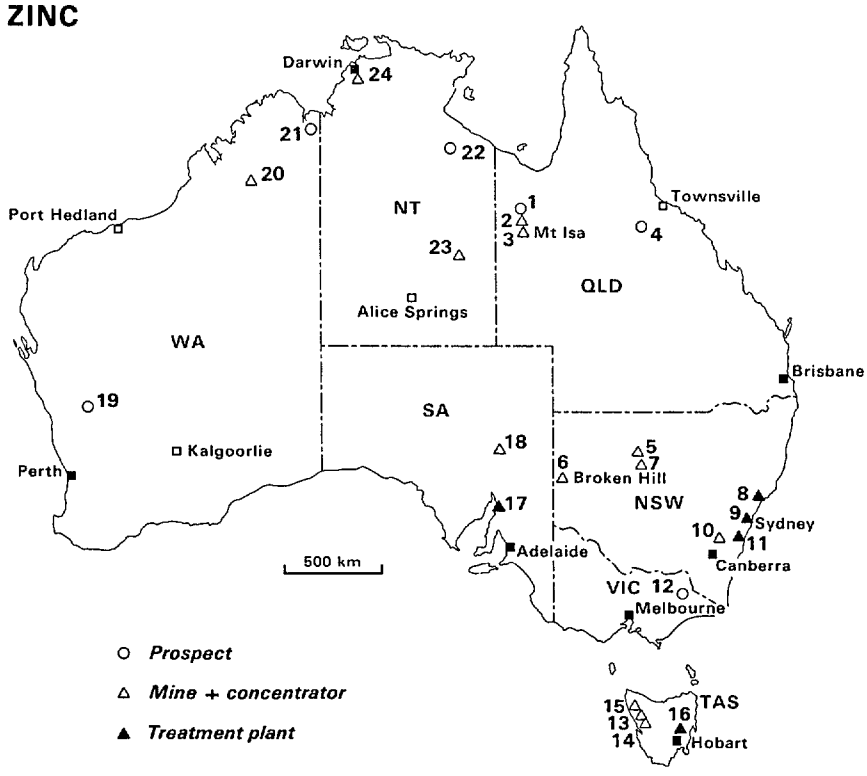
ZINC



1 Lady Loretta 2 Hilton (being developed), Hilton North 3 Mount Isa 4 Thalanga 5 Elura 6 Broken Hill (several mines) 7 Cobar 8 Cockle Creek (refinery) 9 Sydney (secondary refinery) 10 Woodlawn 11 Port Kembla (secondary refinery) 12 Benambra 13 Que River (mine only) 14 Rosebery, Hercules 15 Hellyer 16 Risdon (refinery) 17 Port Pirie (refinery) 18 Beltana 19 Golden Grove 20 Cadjebut 21 Sorby Hills 22 McArthur River 23 Attutra (on care-and-maintenance) 24 Woodcutters

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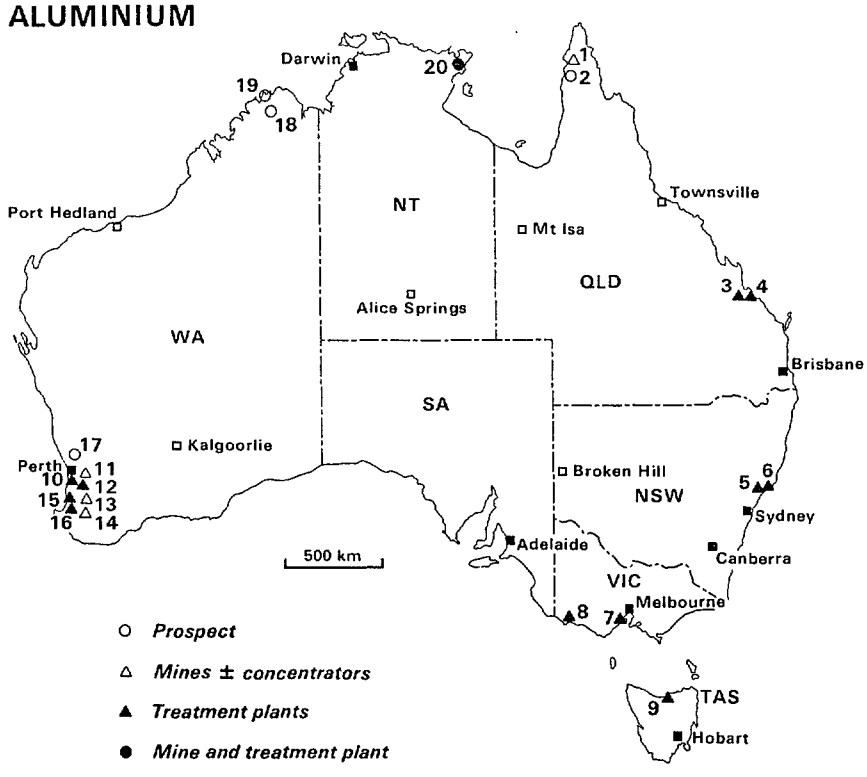
ALUMINIUM



1 Weipa 2 Aurukun 3 Gladstone (refinery) 4 Boyne Island (smelter) 5 Kurri Kurri (smelter) 6 Tomago (smelter) 7 Point Henry (smelter) 8 Portland (smelter) 9 Bell Bay (smelter) 10 Kwinana (refinery) 11 Jarrahdale, Huntly, Del Park 12 Pinjarra (refinery) 13 Mount Saddleback 14 Willowdale 15 Wagerup (refinery) 16 Worsley (refinery) 17 Chittering 18 Mitchell Plateau 19 Cape Bougainville 20 Gove (mine & refinery)

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Lead

Several new base metal mines began production in the period under review. These are at Hellyer (annual production rate 12 000t), Woodcutters (11 000 t) and Cadjebut (75 000 t).

Lead processing technology for long-term smelting and refining at Port Pirie has been under study by Broken Hill Associated Smelters Pty Ltd for some years and a major program of works to address environmental issues at its plant at Port Pirie was approved in mid 1987. Expenditure totalling around $53 million will be incurred over a four year period commencing in 1988. This will guarantee continued operations for the foreseeable future at a production level of 200 000 t/year. The current production capacity is 230 000 t/year. Output from the three secondary refined lead plants constitutes about 25 percent of Australia's consumption of about 65 000 t/year.

Most of the lead bullion produced at Mount Isa and at Cockle Creek is exported.

Australia is the largest exporter of lead, accounting for about 20 percent of total world exports of lead ores and concentrates, lead bullion and metal.

Zinc

All zinc produced is a coproduct of lead with the exception of Teutonic Bore, WA, which closed in 1985 because of exhaustion of reserves. Three new zinc rich mines started production in the triennium: Woodcutters (annual production rate 23 000 t), Cadjebut (40 600 t), and Hellyer (28 100 t); trial production commenced at Hilton near Mount Isa. Production at the Woodlawn and Woodcutters mines changed from open-pit to underground mining in 1987.

Evaluation continued of the Lady Loretta and Benambra zinc-lead prospects and the Scuddles zinc-copper prospect.

The Electrolytic Zinc Company of Australia commissioned a feasibility study early in 1987 into expanding the capacity at the Risdon refinery by up to 50% to 320 000 t/year.

Australia is the world's second-largest exporter of zinc and accounts for about 19% of Western world trade of primary zinc products, other than in manufactured form. Whereas 80% of lead concentrate produced is processed in Australia, less than half the zinc concentrate produced is processed locally.

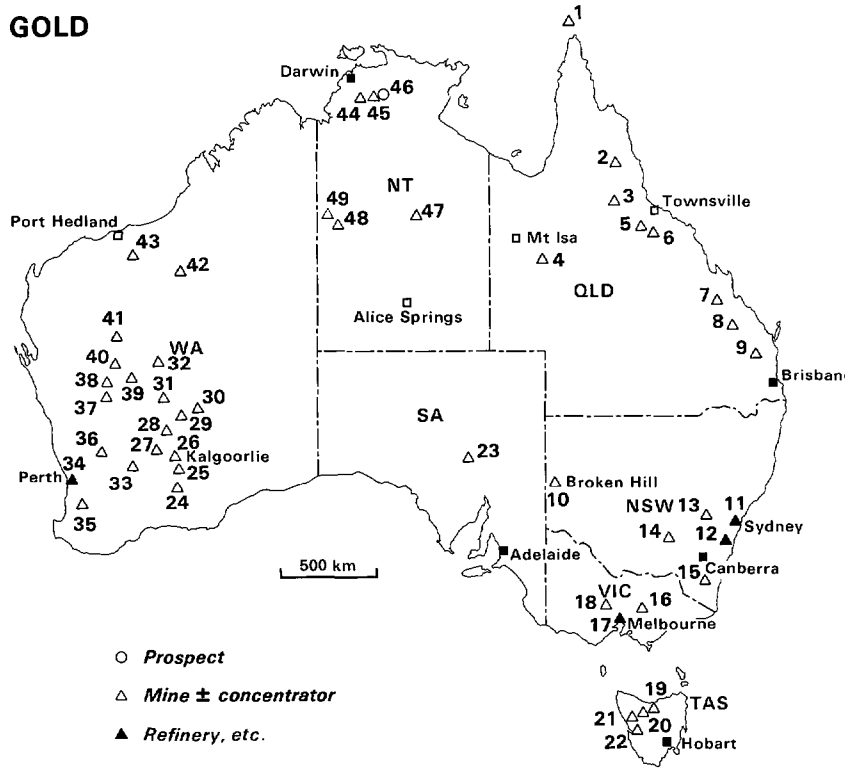
Ores of Light Metals

Aluminium

Bauxite production was about 25% higher than in previous years in the period under review because of the opening of two new bauxite mines at Mount Saddleback and Willowdale in the Darling Ranges, and because of slight increases in the demand for aluminium. Australia remained the world's largest bauxite producer.

Production of alumina also increased; Australia is the world's largest producer and exporter of alumina; the addition of two new refineries, at Wagerup and Worsley, and an expansion at the refinery at Gladstone has increased Australia's rated refining capacity to 9.5 Mt/year, although actual production capacity exceeded this amount.

GOLD



1 Horn Is.* 2 Red Dome 3 Kidston 4 Starra* 5 Mount Leyshon 6 Pajingo 7 Mount Morgan (tailings) 8 Cracow 9 Agricola* 10 Broken Hill (by-product) 11 Sydney (refinery) 12 Port Kembla (refinery) 13 Orange area 14 Temora 15 Cowarra 16 Gaffneys Creek 17 Melbourne (refinery) 18 Stawell 19 Beaconsfield* 20 Que River (by-product), Hellyer (by-product)* 21 Rosebery (by-product) 22 Mount Lyell (by-product) 23 Olympic Dam* 24 Norseman area 25 Kambalda area 26 Kalgoorlie area 27 Davyhurst 28 Menzies area* 29 Leonora area 30 Laverton area 31 Agnew area 32 Wiluna area 33 Southern Cross area 34 Perth (mint) 35 Boddington 36 Mount Gibson 37 Mount Magnet area 38 Cue area 39 Youanmi area 40 Meekatharra area 41 Horseshoe Lights 42 Telfer 43 Blue Spec 44 Cosmo Howley 45 Pine Creek 46 Coronation Hill 47 Tennant Creek area 48 The Granites 49 Tanami

* being developed at Dec 1987

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Annual production of primary aluminium increased by almost one-fifth in the three year period because of the commissioning of new capacity and increased operating rates at most existing smelters. Australia remains the Western world's third major producer and exporter of aluminium.

Lithium

Production of lithium concentrates from the Greenbushes pegmatite body in the southwest of Western Australia began early in 1983. Following the recent development of a high ore grade open pit, the operators, Lithium Australia Ltd, commenced production of a 4.5% Li_2O glass grade spodumene concentrate in addition to their existing 7.5% Li_2O high grade spodumene concentrate. Production in 1987 was about double the 11 000-12 000t level of 1985 and 1986.

Precious Metals and Gemstones

Gold

The upsurge in gold production of the early 1980s continued and from 1985 to 1987, gold output more than doubled, reaching an estimated 108 000 kg in 1987, the highest total since 1906. In 1987, Australia was the fifth ranked gold producer in the world and was an important exporter also.

Forty-one new gold mines were commissioned in the three years and plans are in hand to bring at least another fifteen more prospects to production during the next three years. The Kidston mine, which commenced operation in February 1985, was Australia's major producer during the period. However, expansion of the treatment plant at Telfer to an estimated annual recovery rate of 8000 kg gold, and the commissioning of a mine at the large laterite-hosted gold deposit at Boddington will provide competition for the position of leading producer in the future.

Western Australia remains the leading gold producing State and in 1987 accounted for an estimated 70% of the national output. Production increased in all states except South Australia from 1985 to 1987.

The Perth Mint produces the bulk of refined gold in Australia from Australian and overseas crude bullion. The mint plans to substantially increase refining capacity to meet future demands by the expanding gold mining industry, including mines in parts of the Pacific Rim region.

In April 1987 a set of four bullion gold coins, known as the Nugget Series, was released by the Perth Mint for public sale.

Because of its favourable price compared with most other mineral commodities and its tax-free status, gold attracted an increasing percentage of the Australian private sector expenditure on mineral exploration. In 1987 the proportion of mineral exploration expenditure allocated to the search for gold was estimated to be more than half of the total.

Silver

The general level of mine production of silver over the three year period was about 5% higher than in the 1982-84 period. The 1985 production, at 1 085 933 kg, was an Australian record. Australian mine production of silver is as a co-product of lead, zinc and, less commonly, copper, gold and other metals. A small amount is a by-product of nickel refining in Western Australia. The amount of silver produced each year is therefore directly dependent on the output of other metals, particularly lead.

By far the leading producer of silver is the Mount Isa mine; other important producers are the Broken Hill mines, the mines on the west coast of Tasmania, and the Elura mine, NSW. Australia is the world's fifth largest silver producer, and the third largest exporter .

About a third of the mine production is converted to refined silver. The remainder is exported, mainly in base metal concentrates and partly refined base metals.

Gemstones

After depletion of the alluvial and eluvial diamond deposits at Argyle, mining of the AK-1 lamproite pipe commenced in December 1985 and output in 1986, the first year of full scale production, was 29.2 million carats of diamonds, which surpassed the planned annual production of 25 million carats. Argyle's production exceeded that of any other diamond mine in the world and accounted for about a third of the world's production of natural diamonds in 1986. Diamonds produced from the AK-1 pipe comprise about 6% gem, 39% cheap gem and 55% industrial grades.

The Bow River Joint Venture, which is developing alluvial mines in the Bow River and Limestone Creek areas near Argyle, plans to commence mining in early 1988.

Australia produces over 90% of the world's opal. Most is mined in South Australia in three fields: Andamooka, Coober Pedy and Mintabie, the last now being the major field. Lightning Ridge in New South Wales accounts for a small percentage of total Australian production but produces almost the entire world output of the valuable black opal. A small quantity of opal, mostly boulder opal, is produced from numerous small mines within a broad, roughly north-trending zone in western Queensland.

Australia remained the leading exporter of uncut sapphires and is estimated to have accounted for about 70% of the world's trade. Sapphires are produced almost exclusively from the Inverell-Glen Innes district, and the Anakie Field. Investigations into the occurrence and distribution of sapphires have indicated that extensive areas in New South Wales may be prospective.

Nephrite from the Cowell area, SA, chrysoprase mainly from the Rockhampton district of Qld, rhodonite from the Armidale district of NSW, and an assortment of gemstones such as topaz, zircon, jaspilite, aquamarine, beryl, amethyst and chalcedony are also produced. Australia is estimated to have about 80% of the world's nephrite resources.

Mineral Sands

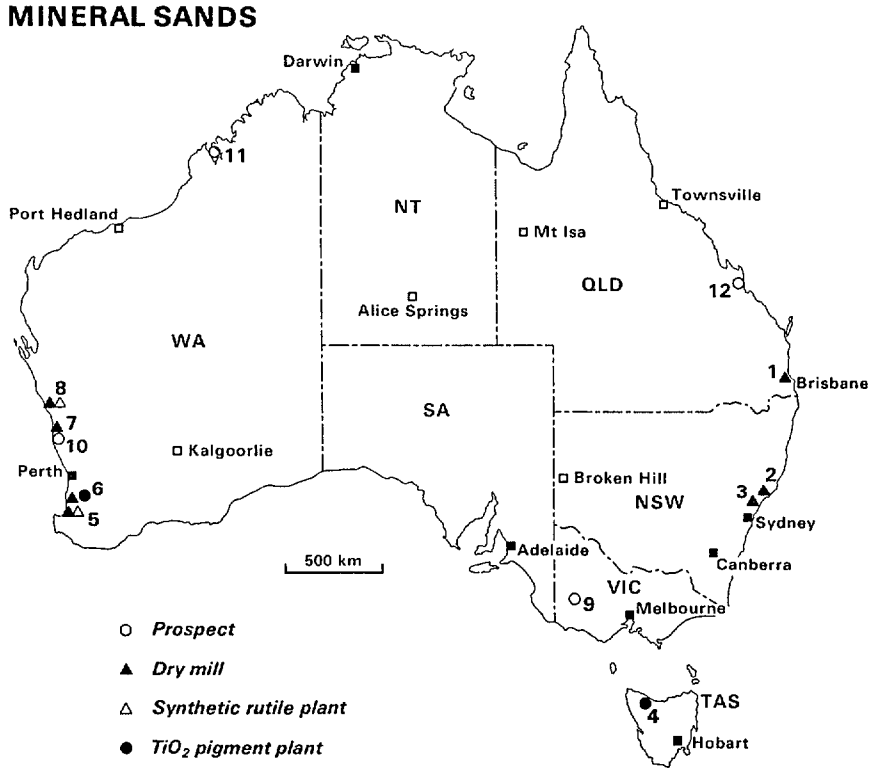
In the period 1985 to 1987, the mineral sands industry benefitted from strong demand for its products, low stockpiles of raw materials, and, as a consequence, increased prices. The bulk of mineral sands output comes from Western Australia; the east coast, however, is still the main source of rutile.

Australia continued to lead the world in production of titanium and zirconium mineral sands minerals.

A number of heavy mineral sands projects are presently undergoing feasibility studies. These include deposits at Jurien Bay and Cooljarloo in Western Australia, at Byfield, Qld, and at Horsham, Vic.

Although Australia is a major exporter of mineral sands, it is now exporting increasing quantities of processed products. Two new synthetic

MINERAL SANDS



1 Meeandah 2 Hawkes Nest 3 Tomago 4 Burnie 5 Capel 6 Bunbury 7 Eneabba
8 Geraldton 9 Horsham 10 Cooljarloo 11 King Sound 12 Bayfield

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rutile plants, both in WA, were commissioned in 1987, increasing Australia's synthetic rutile capacity fourfold to 272 500 t/year. A new zirconia plant (capacity 450 t/year of high purity zirconia powders and 250 t/year of zirconium chemicals) is expected to be operational by late 1988.

Industrial Minerals

Clays

Two export-oriented kaolin plants were commissioned in Australia in the triennium: a 100 000 t/year plant at Weipa, Qld, by Comalco Ltd and a 25 000 t/year plant at Tallawang, NSW, by Australian China Clays.

Fertilisers

Queensland Phosphate Ltd's phosphate mine at Phosphate Hill, Qld, generally remained on care-and-maintenance, although the company sold small quantities of rock at various times (about 17 000 t in 1985 and about 28 000 t in 1986) either from stocks or from 'campaign operations' to meet particular, intermittent, orders. The company, in conjunction with Mount Isa Mines Ltd, is studying the feasibility of a project that envisages production of about 1 Mt/year of phosphate rock and recovery of about 450 000 t/year of acid from smelter emissions at Mount Isa to produce about 210 000 t/year of high analysis phosphatic fertiliser and 170 000 t/year of phosphoric acid, the latter for conversion to ammonium phosphate. The outcome of the study is likely to be announced early in 1988.

Work to date on the Mount Weld carbonatite-type deposit, WA, indicates that the deposit contains about 200 Mt of residually-concentrated apatite ore grading about 18% P_2O_5, from which could be recovered 80 Mt of beneficiated concentrate grading 38% P_2O_5. CSBP and Farmers Ltd, which has sole rights to the apatite content of the deposit, is testing the material in its various fertiliser plants.The deposit also contains other elements of economic interest such as niobium and various rare earths.

An ammonia/urea complex, using natural gas as the feedstock, is to be constructed at Kwinana, WA. Plant capacities are reported as 500 000 t/year for ammonia and 43 000 t/year for urea. About two-thirds of production is destined for export.

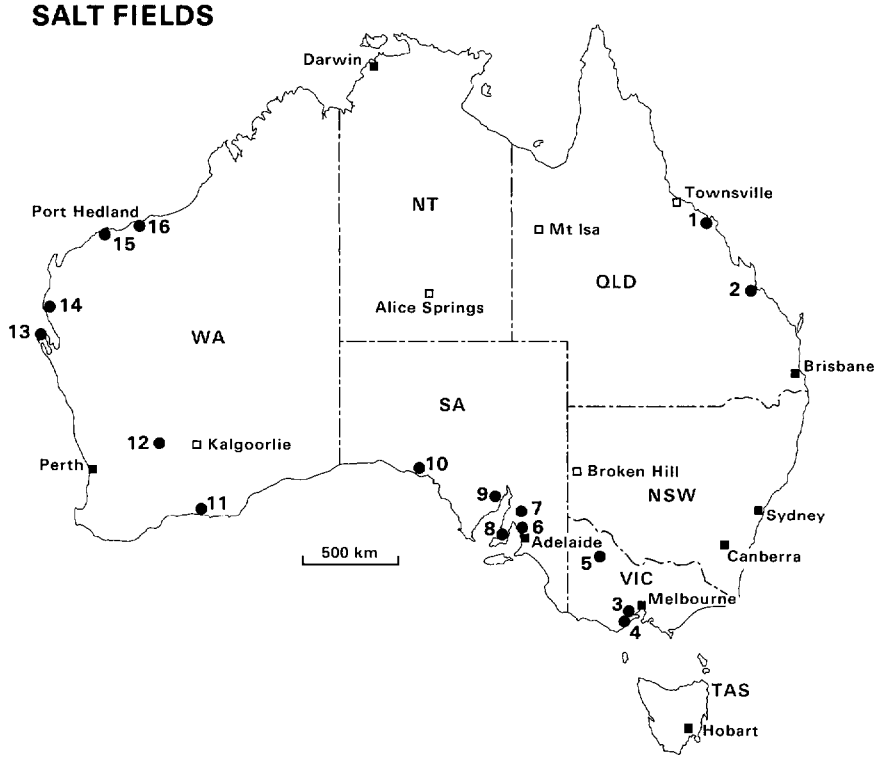
A nitrogenous fertiliser complex, also using natural gas, (capacity 1650 t/day ammonia, 1000 t/day urea) is proposed for Port Kembla, NSW. Output is destined for export.

Following the Australian government decision to stop giving financial assistance to its Phosphate Mining Corporation of Christmas Island, the operation closed on 31 December 1987.

Magnesite

Queensland Metals Corporation NL announced in November 1985 the discovery of a very large magnesite deposit near Kunwarara, Qld, Work to date has established an in-situ indicated resource of 550 Mt of ore containing about 260 Mt of low iron, nodular, cryptocrystalline magnesite. In February 1987, the company established a joint venture to develop portion of the deposit to produce magnesia products (proposed nominal plant capacities 150 000 t/year dead-burned magnesia, 50 000 t/year caustic calcined magnesia) for world markets. The development strategy envisages eventual production also of electrofused magnesia, production of raw

SALT FIELDS



1 Bowen 2 Bajool 3 Port Phillip Bay 4 Corio Bay 5 Lake Tyrrell 6 Dry Creek
7 Lake Bumbunga 8 Price 9 Whyalla 10 Lake MacDonnell 11 Pink Lake
12 Lake Deborah 13 Shark Bay 14 Lake MacLeod 15 Dampier 16 Port Hedland

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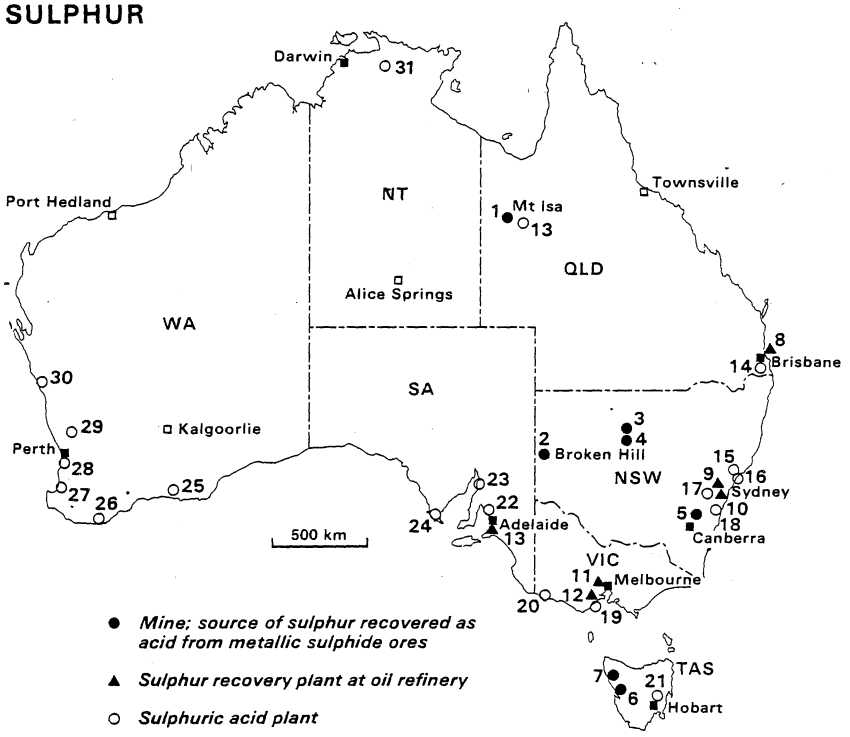
SULPHUR



MINES

1 Mount Isa 2 Broken Hill 3 Elura 4 Cobar 5 Woodlawn 6 Rosebery, Hercules 7 Que River

PLANTS AT OIL REFINERIES

8 Bulwer Island 9 Clyde 10 Kurnell 11 Altona 12 Geelong 13 Halletts Cove

SULPHURIC ACID PLANTS

14 Pinkenba 15 Cockle Creek 16 Kooragang Island 17 Chester Hill 18 Port Kembla (on care-and-maintenance) 19 Geelong 20 Portland 21 Risdon 22 Port Adelaide 23 Port Pirie 24 Port Lincoln 25 Esperance 26 Albany 27 Bunbury (2 plants) 28 Kwinana 29 Bayswater 30 Geraldton 31 Jabiru (Ranger)

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and/or partially beneficiated magnesite for export as primary feedstock for magnesium metal production, and production of magnesium metal in Australia.

Salt

About 85% of salt production, almost all from Western Australia, is exported, mainly to Japan. Australian consumption, presently about 800 000 t/year, is met mainly by producers in the eastern States. About 75% of consumption is used for producing sodium carbonate and sodium hydroxide.

A joint venture is to build a 16 000 t/year chlorine and 18 000 t/year caustic soda chlor-alkali plant at Bunbury. Most of the chlorine and some of the caustic soda will be sold to SCM Chemicals Ltd which is presently manufacturing titanium dioxide pigment via the sulphate process, but is changing to the chlorine process.

Petrochemical Industries Co. Ltd will build a $850 million petrochemical complex at Kwinana, which would include a 200 000 t/year caustic soda plant.

Silica and Silicon

Australia's first silicon plant was commissioned at Snug (Electrona), Tas., in mid 1987. The 9 000 t/year silicon plant is operated by Pioneer Concrete Services Ltd and Pechiney SA.

The West Australian Silicon Trust was formed in 1987 to build a 23 000 t/year silicon plant at Wundowie, WA. Later in the year the whole project was sold to Barrack Mines Ltd which were reported to have said that construction could begin in 1988 but not necessarily at Wundowie.

A high-purity silica fine-grinding plant will be commissioned at Burnie, Tas.,in March 1988.

Sulphur and Sulphuric Acid

Australia has no known deposits of elemental sulphur and its requirements, which are mostly for making sulphuric acid, are met mainly by imported brimstone (380 000 t in 1986), by sulphuric acid recovered at domestic smelters processing indigenous metallic sulphides (533 000 mono-tonnes of acid in 1986), and by small amounts of sulphur recovered at oil refineries (10 285 t in 1986).

Total Australian acid production capacity is about 3.2 million mono-tonnes/ year of which about 20% is based on indigenous raw materials (lead/zinc sulphides) but in 1986 production represented a capacity utilisation of only 55%. In 1986 the fertiliser industry accounted for about 60% of total consumption of 1.46 million mono-tonnes.

Production

The ex-mine value of minerals produced (Table 3) decreased from $22 108 million in 1985 to an estimated $21 883 million in 1987.

3. TRADE IN MINERAL COMMODITIES

Australia is an important exporter of mineral commodities, and a large part of the production of many commodities is exported.

Mineral exports (Table 3) rose in value by 7% from 1985 to 1987 to $16 310 million. The increase was a result of increased exports of many commodities and depreciation of the Australian dollar, particularly against the US dollar, Black coal remained the largest export earner, accounting for 31% of total mineral exports in 1987, and iron ore remained the second largest earner, with 10% of exports. Petroleum remained by far the major import (Table 3). Nearly two-thirds of the exports went to Asia; most imports were from the Middle East (Table 5).

4. THE MAIN FACTORS FAVOURING OR HAMPERING THE DEVELOPMENT OF MINERAL RESOURCES AND THE MINING INDUSTRY IN AUSTRALIA

The development of Australia's mineral industry has been largely dependent on overseas markets. International commodity markets are naturally characterized by instability, but during the 1980s unusually sustained low prices coupled with adverse developments in world trading relationships have imposed substantial adjustment pressure on the Australian industry.

The diversity, size and quality of Australia's mineral resource endowment and the availability of relatively low cost energy in many parts of the continent are strong natural advantages. During the recent climate of largely oversupplied international markets and depressed prices the Australian industry has undertaken major restructuring and has improved its efficiency and production performance.

The Government has sought to facilitate domestic cost containment and other improvements in competitiveness through a mix of macro and microeconomic policies.

International Market Impediments

Australia is a major international mineral trader in many key industrial minerals and fuels. Australia therefore has an interest in maintaining liberal conditions for international trade. Growth in trade protection in some industrialised nations, including in the higher value added mineral commodity products, has restricted both the volume and value of Australia's mineral exports. Protectionism not only increases prices to mineral consumers in the home country but also can create a burden on their taxpayers. Australia believes firmly that it is in the widest interest for economic activity to be located as far as possible where resource use can be most efficient. Distortion of the efficient international allocation of resources through a range of trade barriers and protectionist devices has contributed to a situation where, despite some progress, especially in the aluminium sector, Australia still undertakes less downstream processing than might be expected of a nation with such good access to skilled manpower, capital, energy and high grade resources.

Limitations on Australia's exports of processed minerals have resulted in part from the unwillingness of some nations to forgo old and inefficient subsidized capacity even when the costs of such industry include pollution and environmental degradation.

Despite substantial falls in the metals intensity of developed economies, which appear to be permanent, by the end of the 1985-87 period low commodity prices had led to reductions in production and stock levels sufficient to improve the prices of a number of mineral commodities. In light of this, and of the major realignment of currencies that has occurred during the period, opportunities are opening for a range of new and replacement investment in mineral processing capacity.

Domestic Competitiveness

The Australian industry's competitiveness and ability to expand production and exports depend on a wide range of both economic and non-economic factors. These include:

- characteristics of ore deposits, eg location, grade, and ease of ore treatment. Resource limitations are not expected to be a significant constraint on levels of output in Australia for such minerals as coal, iron ore, and bauxite in the foreseeable future;
- mining and processing technology;
- the level of labour-related costs (both wage costs and on-costs), reflecting wage rates and labour productivity;
- the level of Government taxes and charges, including, in addition to income taxation, royalities, export levies, infrastructure charges, and other resource-related charges. An over-extensive Government "take" or an inefficient method of charging can inhibit efficient minerals development;
- infrastructure availability and arrangements for raising loans to finance infrastructure;
- interest rates;
- contruction costs and lead times;
- access to overseas markets;
- energy costs and the cost of other inputs;
- transport costs, both national and international - these can be crucial, as the competitiveness of goods is measured at the market destination;
- the level of the exchange rate;
- conditions governing access to land for exploration and development, including environmental considerations and the rights of landholders (eg Aboriginals and farmers);
- regulatory requirements and the time taken to obtain necessary approvals;
- industry perceptions of the stability of the policy environment within which it is required to operate; and
- the extent to which there is effective co-ordination and consultation between governments, industry and employees on policies relating to the minerals industry and the economy generally.

The Australian minerals industry has always been export oriented and has become increasingly capital and technology intensive as conditions in world markets have put pressure on miners everywhere to raise their productive efficiency and cut costs.

During 1985-87 both the industry and Government have been forced to focus on both economic and non-economic issues bearing on the industry's ability to remain a competitive supplier of minerals to domestic and world markets. Issues of access to land, the extent of government

regulation, and the level of taxes and charges imposed on the industry have been important; policy and legislative matters arising are discussed in section 8 below.

5. FOREIGN INVESTMENT IN THE RESOURCES SECTOR

Foreign ownership of the Australian resources sector has shown a significant decline during the three year period under review. A survey of foreign ownership in 1984-85 showed that the proportion of Australian ownership had risen since the 1982-83 survey by the following measures:

. in value added - from 49.6% to 55.3%

. in persons employed - from 58.3% to 63.5%

. in turnover - from 50.8% to 57.1%

. in fixed capital expenditure less disposals - from 48.1% to 59.3%.

The increase in Australian ownership has resulted from purchases in the iron ore and black coal industries and increased Australian equity in the subsidiary of one major international mining house.

In terms of value added. the countries with the largest foreign control over the Australian resources sector continue to be the USA, the UK and to a lesser extent Japan. However over the two years to 1984-85 the level declined from 24% to 21.7% for the USA, from 16.1% to 13.3% for the UK, and from 3.5% to 3.2% for Japan.

Of all sectors of the economy assessed in 1984-85, the resources sector had the highest level of foreign owned value added (44.7%) compared to life insurance (40.3%), manufacturing (32.9%), transport (5%) and agriculture (1.8%).

Mining categories with the highest foreign ownership of value added were salt (76.6%), bauxite (62.3%), iron ore (59.5%), oil and gas (53.0%), copper ore (51.4%) and tin ore (51.7%).

The annual inflow of investment into the Australian mining industry declined from a peak of $2.7 billion in 1982-83 to a net outflow in 1985-86 of $1.4 billion. However, a small net foreign investment inflow of $28 million was recorded in 1986-87.

The outflow of foreign investment in 1985-86 was attributed to the limited number of resource projects underway, lower exploration expenditure, the refinancing onshore of some major loans, the buyout of foreign resource companies by Australian firms and a high rate of remittances by foreign owned companies. The total level of foreign investment peaked in 1984-85 at $13.0 billion after increasing by over 5 times from the level of 1979-80 ($2.4 billion). The level in 1985-86 and 1986-87 has remained at around $11-12 billion.

Foreign investment in the mineral and petroleum exploration industries has fallen over the nine years from 1975-76 to 1984-85. Foreign investment's share of total private expenditure on exploration has fallen during this period from 63% to 36% for mineral exploration, and 82% to 37% for petroleum exploration.

Expenditure continued to be primarily sourced from USA-owned and UK-owned companies, with the USA remaining the largest source, and with an increased share. In the 1984-85 survey the USA accounted for 60% of

total foreign exploration expenditure (against 41% in 1975-76) and the UK 21% (37%).

6-7. REGIONAL COOPERATION AND PARTICIPATION IN UNITED NATIONS AND OTHER INTERNATIONAL ORGANISATIONS

Regional Cooperation

Regional cooperation has taken place by means of contributions to Australia's foreign aid commitments, channelled through the Australian Government's Australian International Development Assistance Bureau (AIDAB). Most of the projects originate from the United Nations Development Program (UNDP), the Economic and Social Commission for Asia and the Pacific (ESCAP), the Colombo Plan, and from bilateral agreements between Australia and Papua New Guinea, and Australia and Indonesia.

Under the auspices of the ASEAN/Australia Economic Cooperation Program, Australia administers a Trade and Investment Promotion Program (TIPP). Under the TIPP, ASEAN countries are assisted in the promotion of their exports to Australia and in the attraction of Australian investment.

Indonesia has requested that Australian Government assistance in attracting Australian investment to Indonesia should concentrate on the mining sector - through interesting Australian firms in participating in the exploitation of identified mineral deposits, by equity participation on a joint venture basis and by the provision of expertise and technology on a commercial basis.

Government Geologists' Conference

The Government Geologists' Conference comprises the heads of the Geological Surveys of each of the States of Australia and of the Bureau of Mineral Resources (BMR), plus observers from Papua New Guinea Geological Survey and the New Zealand Geological Survey. The Conference meets annually to discuss matters of mutual concern. It also encourages regular meetings of specialist groups including the Chief Draftsmans Conference, a regular meeting of Chief Geophysicists of the Geological Surveys and specialist groups such as Engineering Geology and ADP and information specialists.

Regional Research

Petroleum and minerals oriented research in the southwest Pacific region under the auspices of CCOP/SOPAC and funded by AIDAB continued under the Tripartite Program. This project is conducted by Australia, USA and New Zealand and is organised as two phases: Phase I - six cruises in 1981; and Phase II - four cruises in 1984, and five cruises in 1985-87. A third phase mainly concerned with finalising results of these cruises is under consideration.

Results of this research, which covered areas of offshore Tonga, Fiji, Vanuatu, Solomon Islands and Papua-New Guinea have either been published or are in the last stages of preparation for publication. A final phase of data review and presentation to island countries with potential for petroleum exploration will be undertaken in 1988-89.

Research related to offshore minerals has continued under the auspices of the Tripartite Program in 1985-1987. This work has concentrated on defining the areal extent and economic potential of cobalt-rich manganese crusts, manganese nodules and hydrothermal metals. Results have either been published or are expected to be published in 1988.

Planning by the Tripartite partners for a compilation of SEA MARC II imagery and bathymetry from the region has commenced. Areas to be covered include the Manus, Woodlark and North Fiji Basins.

International Cooperation

Papua New Guinea

Historically, Australia has strong links with Papua New Guinea stemming from days prior to self-government when Australia provided general and specialist geoscience staff and services.

BMR continues to provide expert services to Papua New Guinea when requested in such areas as the cooperative investigation of volcanic hazards and of the petrology and geochemistry of volcanic rocks, and advice on petroleum drilling technology.

BMR has also been involved in multi-nation projects investigating active seafloor spreading ridges in the younger small ocean basins of PNG, including those of the Tripartite program.

A small number of BMR staff continue to serve on secondment within the Geological Survey of PNG.

Indonesia

BMR is currently engaged in a major 10-year geological and geophysical mapping project in Indonesia on behalf of AIDAB. The present approved contribution by Australia is about $13.75 million. The project is due to be completed in 1988-89.

The prime objective of the program is to assist Indonesia to strengthen institutional long-term capacity to undertake systematic and comprehensive geological and geophysical surveys and to produce appropriate high quality maps and reports. The project also involves Australian scientists in training Indonesian personnel to utilise advanced geological and geophysical surveying techniques in very difficult terrain using modern scientific methods and much helicopter support. The project also provides the Indonesian Government with information necessary for planning the management and utilisation of earth resources. The systematic mapping will identify and outline areas of potential for mineral and energy resources including petroleum, coal and hydro-electric power.

Field operations were terminated in October 1986 with the completion of geological mapping and gravity surveys of the West Kalimantan region. Australia's assistance will now be directed towards synthesising the results of the fieldwork and preparing the related maps and reports.

In January 1987 a 1:1 000 000 multicolour geological map of Irian Jaya with gravity contours was published. All the preliminary 1:250 000 geology and gravity maps for Irian Jaya have been issued, and work is proceeding on the multicolour editions.

Training of Indonesian geoscientists is continuing through degree courses at Australian universities, and by attachments to geological surveys in Australia.

China

Links with China were strengthened by the expansion of geoscientific cooperative research under the Memorandum of Understanding (MOU) with the Ministry of Geology and Mineral Resources which was signed in 1983 and

extended in 1986, and by the signing in July 1986 of a MOU between BMR and the Chinese National Non-ferrous Metals Industry Corporation (CNNC).

Under the MOU with the Ministry, programs have been identified in the following fields: specialist studies of petroleum-bearing sedimentary basins; geology and mineral resources; structural geology; Antarctica; and resource assessment and management in the mineral industry. Cooperative exchanges will be initiated in 1988. In addition, a feasibility study was carried out in June 1987 on an area of the Xinjiang Autonomous Region, northwest China, in relation to a proposed comprehensive geological survey of the region.

The proposed cooperative research program with CNNC includes: geological basis for exploration for stratabound copper-lead-zinc deposits, Palaeozoic volcanic hosted massive sulphide deposits, and tin-tungsten deposits in fold belts; multidisciplinary studies of mineral provinces; applications of geophysical techniques; and information technology. Cooperative exchange visits took place in late 1987 under the tin-tungsten and information technology programs. Further exchanges are proposed in these and other programs.

In October 1984 Australia and China signed a Memorandum of Understanding (MOU) on scientific and technical cooperation on coal production, handling and utilization. Areas of cooperation identified under the MOU included coal resource assessment; mine design, development and management; coal preparation, processing and utilization; computer applications in coal mines and preparation plants; and coal storage handling and transport. The MOU provides for training of personnel, exchanges by technical and management experts and collaboration on symposia, etc.

Other Programs

International Collaboration on Offshore Research

In addition to the surveys by BMR's RV Rig Seismic, collaboration on associated offshore research is undertaken with other international geoscience organisations in the USA, France, the Federal Republic of Germany and Japan using research vessels from these countries.

Hydrogeology

Groundwater studies are important for small coral islands which commonly lack surface waters. Collected rainwater might be insufficient for the people's needs. A BMR team has recently undertaken an investigation of the groundwater resources of Nauru, on behalf of the government of that island nation. The main purpose was to evaluate the groundwater potential for future water supplies when the shipment of fresh water as return loading for phosphate cargos ceases on depletion of the island's phosphate reserves. The investigation included detailed geophysical and hydrogeological studies, and the results form an input to the Nauru government's enquiry into the proposed rehabilitation of mined-out phosphate lands on the island.

A BMR specialist in island hydrology was involved in organising and lecturing at a training workshop on Water Resources of Small Islands, held in Fiji under the auspices of the Commonwealth Science Council.

International Maps

Publication of geological, tectonic and geophysical maps is an important means of collating and making public regional geoscientific data. Such maps are of fundamental importance in exploration and resource assessment

but may be beyond the scope of resources and expertise of developing nations.

Australia's commitment to, and participation in, international geoscience map-making is chiefly carried out by BMR. Currently, BMR's map compilation section is involved in projects of the Commission for the Geological Map of the World (CGMW), the Circum-Pacific Map Project (CPMP) and the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).

CGMW is a commission of the International Union of Geological Sciences and is based in Paris. BMR has published, and will continue to prepare geological, metamorphic, tectonic and metallogenic maps, mostly at 1:5 million scale, as part of CGMW programs.

In 1987 BMR contributed a first-draft compilation of a geological map of Australia at 1:25 million for the proposed Geological Map of the World, and consolidated local comments on a 1:10 million Plate Tectonic Map of the World. Ongoing activities include the proposed 1:10 million World Minerals Atlas and the Australian section of the proposed 1:15 million Tectonic Map of the World.

CPMP is an activity of the Circum-Pacific Council for Energy and Mineral Resources, an international section of the American Association of Petroleum Geologists, Tulsa. CPMP maps are interrelated sets of themes - geography, geology, plate tectonics, tectonics, geodynamics, mineral resources and energy resources. Five 1:10 million sheets cover the Pacific region for each theme; some themes are summarised for the whole region on one sheet at 1:17 million. All geography and plate tectonic sheets have been published, and the rest are advanced to varying degrees. The Southwest Quadrant 1:10 million sheet area covers Australia and Oceania (and also much of Southeast Asia, but this area is the responsibility of the Northwest Quadrant Panel).

BMR continued with the compilation of the 1:10 million geological map, which was printed in late 1987, and the preparation of 1:10 million Mineral Resources Map and Energy Resources Map, both due for publication in 1988.

ESCAP's Mineral Resources Development Series Atlas of Stratigraphy (IGCP Project 32) comprises correlations within and between sedimentary basins in the ESCAP region.

In 1985 BMR supplied a map on the Murray Basin. A contribution on the Darling Basin by BMR, the Geological Survey of New South Wales and Macquarie University is in progress.

In November 1987, BMR participated in the Fifth Working Group Meeting on the Triassic Subproject of the Atlas of Stratigraphy. The expertise gained from BMR's Australian Palaeogeographic Map Project is relevant to the Subproject and could contribute to a better understanding of the Triassic sedimentation and related potential of the ESCAP region. BMR has contributed 5 stratotype sections for the Trassic together with explanatory text.

Support for the Petroleum and Mineral Industries

Under various agreements Australia provides advice to several of our neighbouring countries in relation to exploration for and development of petroleum both onshore and offshore.

Australian inspectors are provided for the Fijian Government as required, and a tentative arrangement has been agreed upon with the Kingdom of Tonga should petroleum exploration proceed in that country.

Advice is also given as required on matters relating to the mineral industry; for example, in 1986 a BMR official visited the Kingdom of Tonga to advise on the drafting of mining regulations.

Potential

Australian geoscientists have had considerable experience in foreign assignments over the years, whether as scientists involved in aid programs or as consultants to UN agencies or the recipient countries themselves and there is a reservoir of comprehensive geoscientific expertise, in government research organisations and in academic institutions and industry.

Participation in International Organisations

Australia is a member of several international commodity organisations. These include:

- International Bauxite Association;
- Association of Iron Ore Exporting Countries (APEF);
- International Lead and Zinc Study Group;
- Association of Tin Producing Countries;
- International Tin Council;
- UNCTAD Committee on Tungsten.

Australia withdrew from the Intergovernmental Council of Copper Exporting Countries at the end of 1987. In November 1987 it announced its intention to join the proposed International Nickel Study Group.

8 GOVERNMENT POLICY AND LEGISLATIVE ACTIONS

Government economic policy has concentrated on improving economic efficiency through reduction of regulatory controls on business and measures designed to facilitate structural adjustment. In the first and second terms (1983-87) of the current government, major initiatives were taken in the macroeconomic area. Reforms have included floating of the Australian dollar, deregulation of the Australian financial system including interest rates, entry of foreign banks, easing of foreign investment guidelines, major restructuring and improvement of the efficiency of the taxation system, including making most dividends tax-free in the hands of shareholders, and co-operation with the trade union movement in development of a wages policy responsive to the changing circumstances of the Australian economy as well as of individual industries.

The minerals and energy sector has benefited from these reforms through higher Australian dollar returns on contracts written in international currencies, greater diversity and competitiveness of financial services available, improved ability to attract foreign capital on advantageous terms as well as to raise capital on the domestic market, and a lower incidence of industrial disputes. Export controls on a wide range of minerals have been progressively relaxed and in some cases abolished. From 1 January 1988 the only minerals still subject to control (other than those associated with the nuclear industry) are bauxite and alumina, iron ore, mineral sands, monazite and xenotime concentrates, copper scrap and copper alloy scrap and basic shapes cast from copper scrap or copper alloy scrap, salt, coal, liquefied natural gas and liquid petroleum gas.

The Government also has progressively relaxed foreign investment policy. Following the latest liberalisations in 1987 and January 1988, new mining or resource processing projects smaller than $10m investment, and all oil and gas projects irrespective of size, may proceed without examination. Proposals for acquisitions of existing mines (excluding petroleum) need to demonstrate net economic benefits, but new mining projects over $10 million may proceed if not contrary to the national interest and if they provide for 50% Australian equity and joint control; nevertheless the equity and control guideline is applied flexibly. Resource processing projects over $10m will be approved unless contrary to the national interest. The benefits for foreign companies flowing from the naturalisation provisions of the policy have also been improved.

The Government has also developed industry strategies to improve the technical and economic competitiveness of various industry sectors such as steel and other basic metals through phased structural adjustment programs. The lowering of protection measures and stimulation of productivity improvements have been a principal characteristic of these measures.

In the third term of the current Government, emphasis has been placed on microeconomic reforms mainly to reduce impediments to trade competitiveness in sectors that support export industries, for example in transport costs. Also general economic efficiency is being improved by making a substantial component of future wage increases for the work force directly dependent upon identified productivity gains in the particular labour sector or enterprise.

The Government is currently addressing company taxation arrangements with a view to reducing the tax rate to a more internationally competitive level.

Taxation of the mining industry has been recognised as requiring special treatment because of the high risk that discovery and development of mineral deposits entails. Commonwealth Government policy has been to move royalty taxation for minerals and energy commodities away from existing ad valorem assessment systems to profit related structures. Progress toward this objective depends heavily on the States, which have resource taxing powers over onshore minerals. The Australian Government has introduced a resource rent tax regime for offshore "greenfield" petroleum projects that did not have a production licence at 1 July 1984. For these projects no excise or royalty applies. The resource rent tax is related to achieved profits and is only payable by those projects earning a minimum rate of return on outlays before company tax. This protects the viability of projects and encourages the development of ventures that might otherwise be uneconomic.

In 1985 the Western Australian Government introduced a resource rent royalty for onshore petroleum along the lines of the Commonwealth resource rent tax. The Northern Territory has had a similar profits based royalty system for all new mineral projects since 1982 and made some amendments in 1987. Other States have moved towards profit-related taxation in certain areas.

A major policy approach of the current Government has been the pursuit of consensus and cooperation between interest groups on industrial relations issues. In 1984 the Western Australian Iron Ore Industry Consultative Council was established in response to the perception by major customers that unsatisfactory industrial relations in the Pilbara iron ore mines were affecting Australia's reputation as a reliable supplier to the world steel industry. The Council brings together representatives of management, labour and Commonwealth and State Governments to discuss

industrial issues, the state of the industry, and strategic questions of research, technology and marketing. Since the Council's inception the level of working days lost has fallen by about two thirds.

In the coal industry problems have been discussed in the similarly constituted Australian Coal Consultative Council established in 1983. In 1987 this forum has been used to help develop a restructuring package for the black coal export industry. The package was directed at the New South Wales coal industry with financial support being provided by both the Commonwealth and State Governments. Other issues addressed by the Council include industry development, international trade, employment and industrial relations.

In parallel with the Commonwealth's review of the extent of its own regulation of industry, the States have also been addressing their own requirements with a view to reducing procedures, costs and time taken to obtain project approvals. Fast tracking and 'one stop shopping' (ie a single government contact for approvals) are available in some States.

Access to land for mineral exploration and development has become an increasingly difficult issue for both the industry and governments in recent years, as claims under Aboriginal land rights and environment and heritage conservation have grown, and the surface rights of landholders in some States have been in contention.

During 1987 the Commonwealth amended the Aboriginal Land Rights (Northern Territory) Act in an attempt to "break the log jam" in processing applications from miners for access to Aboriginal land in the Territory. Legislative and administrative measures have been taken in several States with a view to striking a more workable political balance between the rights of Aboriginal communities and miners. The Commonwealth has acted to protect parts of Tasmania and Queensland with world heritage values from logging, and action is being taken to maintain a basis for some access for exploration and mining. At the same time the Commonwealth is seeking to simplify procedures for granting mining access to land owned by the Commonwealth.

Complementary Commonwealth and State/NT legislation providing the basis for offshore exploration and mining of seabed minerals, following the model of the existing offshore petroleum legislation, is expected to be implemented during 1988 or 1989.

9. FUTURE PROSPECTS, PLANS AND PROGRAMS

Short term

Prior to the slump in world share markets in October 1987, strong recovery had occurred for a range of base metal prices, particularly aluminium, copper, lead, and nickel. Factors contributing to this recovery included the declining value of the US dollar, short term supply disruptions, and stock rebuilding against anticipated and actual increases in industrial production.

Unless there is a significant downturn in world industrial activity following the share market developments, the outlook for base metals should remain sound. As stocks are rebuilt the main factor determining prices in the medium term is likely to be the level of economic activity, although short term supply disruptions may continue to have an impact for some metals.

Longer term

On the basis of a report on the outlook for the Australian resource sector to the year 2000 prepared by the Australian Bureau of Agricultural and Resource Economics (ABARE), continued real growth in real resource exports is expected. This analysis assumed that Australia maintained about its current shares of world markets and concluded that prospects for some commodities are bullish, while others have a relatively static outlook.

On a commodity specific basis, the key growth areas over the medium and longer term were projected to be in alumina/aluminium, liquefied natural gas (LNG) and steaming coal. Mineral sands and uranium were projected to exhibit relatively strong growth but from a lower current revenue base. Gold provides very strong growth over the next few years, but (on the basis of information available when the projections were made) was projected to peak in the late 1980s and early 1990s; this may well prove to be conservative as the supply situation is changing rapidly. Offsetting these positive developments were projected declines in crude oil production - and consequently its co-product liquefied petroleum gas (LPG), and nickel production.

In the base case, the real value of Australia's mineral resource exports is expected to grow at an average rate of 3.4%/year between 1986 and 2000; this rate is higher than projected growth in gross domestic product. When net imports of crude oil and petroleum products are included, the base case real value of exports is projected to grow at an average 1.8%/year. With world economic growth higher than in the base case, strong growth in mineral resource exports is projected. Even at world economic growth rates 1 per cent a year lower than in the base case, which would represent extremely low growth by historical standards, the value of mineral resource exports is expected to be maintained in real terms at 1986 levels.

One of the dominant influences on these trends is the reversal of petroleum's contribution to the sector. Petroleum (including crude oil and petroleum products) moved from being a net import of some $3.7 billion in 1982 to a net export of almost $1 billion in 1985 (in 1986 dollars). Through the 1990s petroleum (excluding LNG) was projected to return to a net import position of around $4-5 billion by 2000.

Capital expenditure

Private new capital expenditure (PNCE) in the resources sector peaked in 1982-83 at $4.8 billion following strong growth in investment in energy resources and energy industries (for example, aluminium). Resource sector investment declined until 1985-86 when a resurgence in investment occurred. Resource sector PNCE grew by 28% in 1986-87 to $4.8 billion, or by about 15% in real terms. This reflected strong performance by the mining industry where expenditure was up 30%, or about 17% in real terms. These results are the outcome of buoyant investment activity in gold, and to a lesser extent, in base metal mining, and ongoing expenditure on the North West Shelf LNG project. Expenditure in the mineral processing subgroup of industries grew by 20%, or about 8% in real terms. However, in this subgroup major investments in aluminium and steel processing are almost complete.

Reflecting some overall uncertainty in the sector and the winding down of the investment phases of several major projects, private new capital expenditure in the resource sector is expected to fall in nominal terms in 1987-88 to about $4.8 billion representing a real decline of about 8%. Estimates of capital expenditure intentions in the mining industry, collected in January-February 1988, indicate a slight deterioration since

the October 1987 share market decline. A real fall in private new capital expenditure in mining of about 7% in 1987-88 and a further fall of 6% in 1988-89 are indicated by these estimates.

The fall in resource sector investment is due mainly to completion of the Olympic Dam copper, uranium and gold mine and the Portland aluminium smelter this year. For oil and gas, investment in the $350 Bream field is nearing completion, but Esso and BHP have recently announced further investment of about $238 in the Tarwhine, Seahorse and Whiting fields. There is also continuing expenditure on the North-West Shelf gas project.

Any sustained improvement in resource commodity prices could see further investment in capacity, particularly in those industries with shorter investment lead times. The possible construction of an aluminium smelter in Western Australia in the early 1990s could add considerably to capital expenditure in the sector over that period.

Planned investment in the resources sector includes expenditure on new iron ore projects such as the Channar mine ($250 million) and extensions to Mount Newman's Marra Mamba ore body ($40 million). In the steel industry poor financial results have delayed plans to rebuild BHP's number 4 blast furnace at Port Kembla. A $15 million relining program will, however, be carried out.

Ongoing and new capital expenditure continues to be attracted to the gold industry, with Western Mining Corporation announcing intentions to spend $150 million to $250 million on further developments. Intentions to proceed have been announced for new gold operations such as the Big Bell open cut ($145 million), the Hedge's project ($50 million), the Kalgoorlie tailings project ($30 million), a gold refining plant at Leonora ($21 million), and the Horn Island gold mine ($12.5 million). Committed gold mine expansions included the Kalgoorlie Golden Mile 'Big Pit' development ($104 million), Boddington ($15 million) and the Jubilee mine ($7 million), which was one of a number of smaller upgrades. Precious metal investment will be augmented as a result of a commitment to build a gold and silver refinery, to treat scrap metal, in Sydney ($15 million).

Strong investment is also occurring in the mineral sands and rare earths industry, including the Wundowie zirconia plant ($70 million), and the Pinjarra rare earth and gallium plants ($120 million).
Base metal capacity will be boosted by the next phase of the Hellyer lead and zinc mine ($112 million) and the Cadjebut lead and zinc mine ($28 million). Capital investment on lead and zinc production received a boost when Broken Hill Associated Smelters announced a $58 million 'environmental and economic improvement plan' for their Port Pirie refinery.

A $100 million modernisation program at the Risdon zinc refinery of Electrolytic Zinc is at an advanced stage and should save $20 million in annual operating costs. In March 1987 EZ announced a feasibility study with expansion of capacity from 220 000 t/year to 320 000 t/year at a cost of $150 million.

Petroleum sector expenditure benefitted from the decision to bring the Whiting Field in Bass Strait on stream ($150 million) and to commence development of the Challis Field in the Timor Sea ($150 million to $200 million). Investment is also planned at the Kwinana LPG plant ($100 million). Several investment commitments have been made in upstream petroleum sector projects. In the Cooper Basin an initial $20 million will be invested in enhanced oil recovery. Further downstream, Southern Cross Refineries announced a commitment to construct a second oil refinery in South Australia ($350 million). On a larger scale, two projects involving

the construction of petrochemical plants utilising locally available hydrocarbons were announced. One, in Western Australia, involves the building of an ethylene dichloride plant ($850 million) which will tap North West Shelf gas. The other project, in Queensland, is known as the Blackall Chemical Complex. The initial plans will involve construction of an ammonium nitrate plant ($40 million) and a caustic soda and chlorine production unit ($25 million).

In the coal industry, a commitment to proceed with the initial stage of development of the Gordonstone deposit has been made ($15 million) and Coal Resources of Queensland will expand the Cook colliery ($40 million).

In addition, the North West Shelf project continues to contribute about 20% of resource sector PNCE investment.

Employment

Employment in Australia's mineral resource sector was about 164 100 persons in 1986-87 or about 2% of total employment. This included about 74 800 persons in the mining industry, about 12 400 in exploration and about 76 900 persons in minerals processing.

Employment has fallen in the mining industry (down by about 5% during 1986-87) due largely to industry restructuring, especially in the coal industry, and employment is not expected to grow substantially over the years to come. Exploration employment also fell in 1986-87, by about 5 per cent. An expected upturn in exploration expenditure in 1987-88 could see rises in exploration employment. However, employment in minerals processing grew by almost 2% in 1986-87.

Individual Commodities

Aluminium

Production of bauxite and alumina in Australia is likely to continue to grow at a modest rate over the next decade. Production of primary aluminium will increase over the next few years as the Portland smelter in Victoria expands to its planned capacity. This expansion will bring Australia's nominal capacity to 1 Mt/year of aluminium. Exports of aluminium should continue to grow over the next decade. Projected growth in demand for alumina suggests expansion from the current nominal capacity of 10 Mt/year will be required; no commitment to expand capacity has yet been made. Bauxite production capacity is adequate for the short term, and any longer term requirement for increased capacity will probably be met by expansion of existing operations.

Black Coal

The existing world overcapacity for coal is likely to continue for several years although it is declining as mines shut and demand grows. This will continue to constrain price increases on international markets. Any change to this situation will depend partly on economic conditions in Japan which include the restructuring of the Japanese economy as well as its overall economic growth, and, in the longer term, exports from new suppliers such as Indonesia and China. Australian exports of steaming coal are expected to grow at about 5%/year for the next few years but coking coal exports will grow at a much slower rate. Domestic demand should continue its well established growth pattern with increases of between 1 and 3 Mt/year, or an average growth of about 1.2%/year from 1986 to 1995, with most growth resulting from a rise in steaming coal consumption. Australian mine capacity is able to meet increased demand.

Brown Coal

While most brown coal mined is used for domestic electricity generation a marked growth in demand for brown coal briquettes for export is expected. Production will continue to increase in line with increased demand for electricity in Victoria. Further increases in production will occur should the South Australian government construct a coal fired powerstation based on one of that State's brown coal deposits.

Copper

Mine production of copper should increase to 252 000 t in 1988 when Olympic Dam and a number of other smaller mines come on stream. In the medium term mine production could increase further if a number of deposits undergoing intensive evaluation are developed. Exports of both copper in concentrate and refined copper are expected to increase with increased mine production.

Crude Oil

The balance of world oil demand and supply suggests that prices will not return to their late 1970s level in the short to medium term. Australian crude oil demand is expected to grow between 1.8 and 2.9%/year. Domestic capacity to meet this demand peaked in 1985-86. The ensuing decline in national self-sufficiency should provide incentives for new oil discoveries which are commercially viable to be developed soon after discovery. Projects recently committed to production include North Herald, South Pepper and Saladin (WA), Whiting (Victoria) and the Challis Field (NT).

Diamonds

In its first year of full production from the AK-1 lamproite pipe, the Argyle mine easily exceeded its planned production of 25 million carats/year. The mine has now settled to a production of about 30 million carats/year and is expected to continue at this rate. Annual production will be about $280 million/year.

Fertilisers

Termination of Christmas Island's phosphate operation on 31 December 1987 is likely to create opportunities for development of deposits at Phosphate Hill, Qld, and Mount Weld, WA. Initial production of phosphate rock, possibly by the early 1990s, from both projects combined is likely to be in the range 1.5 Mt to 2.0 Mt/year. Completion of two proposed ammonia/urea complexes, possibly by the early 1990s, will move Australia from its current status of a net importer of nitrogenous fertiliser to net exporter.

Gold

Rapid increases in capacity forecast for the next three years could result in production of more than one and a half times 1987 output. The result could, on the basis of present prices, provide export earnings of $2.5 billion to $3 billion or almost treble the current returns. Among the larger projects expected to be completed over the next two years are the Big Bell open cut, the Kalgoorlie 'Big Pit' expansion and the Hedges project. In addition the Olympic Dam copper-uranium-gold project, which commences production in mid 1988, is expected to contribute up to 3 000 kg/year.

Industrial Minerals

Export revenue to Australia from sales of industrial minerals (other than fertiliser commodities and mineral sands which are discussed separately) should increase substantially in the next 5 years. Commodities contributing most to the expected increase are silicon and finely-ground silica 'flour', kaolin, and caustic-calcined and dead-burned magnesite.

Iron and Steel

Despite over-supply and sluggish world demand, the outlook in the short term for Australian iron ore production and exports has improved following higher than expected world steel production rates in late 1987. Further iron ore export growth is expected in the longer term mainly to meet requirements for steel output expansion in the developing countries of East Asia, possibly assisted by further market penetration in Eastern Europe. Australian steel output will continue to be determined by domestic demand, for which continuing slow growth from current levels is predicted.

Lead and Zinc

Forecast mine production of lead and zinc should increase to 480 000 t and 770 000 t respectively in 1988 as the two new mines opened in 1987, Hellyer and Cadjebut, approach planned output. Mine production could increase further in the medium term if a number of deposits undergoing intensive evaluation are developed. Exports of lead and zinc in concentrate should increase with increased mine production. Exports of zinc metal may increase if the study into the expansion of the Risdon refinery is found to be economically viable.

Lithium

Production is based on a large tonnage high grade resource and further expansion of production of both high grade and glass grade concentrates for the domestic and, particularly, the export market is likely.

Manganese

Prospects for a recovery in demand for Australian manganese ore have improved following an increase in world steel production rates towards the end of 1987 and an expected further increase in requirements for manganese alloy production at Bell Bay; increased production of manganese alloys is expected following a capacity increase at Bell Bay in 1987. Australia is well placed to further increase exports of manganese alloys to Pacific Basin countries following the Bell Bay expansion.

Mineral Sands

Reasonably strong growth in demand is expected for mineral sand products. In the short to medium term export growth will come from increased shipments of rutile and zircon. Ilmenite exports are expected to fall slightly as more material is diverted to synthetic rutile production (up-graded ilmenite), although this diversion will be partly offset by increased ilmenite output from Capel and North Stradbroke Island. Exports of ilmenite are projected to rise again after 1990 with the commissioning of the Cooljarloo project in Western Australia.

Nickel

A likely scenario for the nickel market over the next two or three years is that commercial stocks will remain at relatively low levels and nickel

prices will continue to be volatile in response to short-term changes in supply and demand. In the longer term demand is expected to grow, weakly, and there is likely to be little difficulty in supply keeping pace with this growth. Australia's share of world mine production is expected to fall in the early 1990s with the closure of the Greenvale mine; Australia's share of world nickel supply may not fall however if imported lateritic nickel ore is used as feedstock for the Yabulu nickel refinery.

Oil Shale

There is little prospect for the development of an oil shale deposit in Australia over the next few years. The low price and ready availability of oil will continue to restrict development opportunities.

Silver

Australian silver production is almost entirely the by-product of lead, zinc, gold and to a smaller extent nickel production. Most of the silver is exported in lead and zinc concentrates or lead bullion. Production is expected to rise by about 10% during the next three years.

Tin

Australia's tin industry, which has undergone major rationalisation since the tin price collapse in 1985, could expand production slightly if stable or rising prices attract new producers. Price stability arising from the running down of stocks to normal levels could be affected by increased production in non-ATPC countries with low cost resources. The market will be affected by supply pressures since demand has been, and will remain at best, relatively static.

Tungsten

The outlook for tungsten continues to be weak because of low demand and poor prices, which declined almost continuously from 1981 to 1986. While prices increased slightly towards the end of 1987, the industry remains very depressed. Future prospects depend largely on a substantial increase in industrial activity throughout the world. With tungsten production dominated by the Peoples Republic of China the direction of the industry in other countries will depend largely on the level of Chinese exports. No major increases in production, exports or investment are expected before the early 1990s.

10. CURRENT STATUS OF LEGAL AND INSTITUTIONAL ARRANGEMENTS FOR MINERAL RESOURCES DEVELOPMENT

Mineral resources development in Australia is to a very large extent a matter for private enterprise, working within the constraints of the current international market. The role of governments is partly to facilitate development and partly to give due consideration to and allocate priorities for the achievement of other objectives.

Under the Australian constitution, responsibility for resources development is shared between the Commonwealth Government and State Governments. Generally, ownership of minerals is reserved to the Crown and is vested in the State or Territory in which they occur. The State and Northern Territory Governments, therefore, regulate the operations of industry and are responsible for the issue of exploration and development titles and the day to day supervision of mining and associated operations. The legal and institutional relationships between miners and State Governments are embodied in Mining Acts specific to each State. These Acts typically cover prospecting, exploration and mining leases, licences

and permits, royalties, safety and engineering, environmental and rehabilitation safeguards.

A major exception to the above situation is in the area of offshore minerals and petroleum, where the Commonwealth Government holds the ultimate responsibility. Special arrangements have been developed to ensure that exploration and development of resources in offshore locations are co-ordinated between the Commonwealth and State/Northern Territory Governments.

A further exception is that the Commonwealth Government retains ownership of uranium in the Northern Territory. There is legislation in place and there are administrative arrangements agreed with the Northern Territory Government relating to the development of uranium in the Territory.

The extent of the Commonwealth Government's role in resource development generally is largely defined by the constitutional powers allocated to it. The more important of these deal with the management of the national economy, taxation, industrial disputes extending beyond the limits of any one State, international trade and commerce (including export controls), international relations, foreign capital inflow and foreign investment, and aboriginal affairs. These powers enable the Commonwealth Government to influence the development and operation of export-oriented resource industries.

The Commonwealth Government levies income tax and there is also an export levy on certain categories of coal. The States levy royalties and in some cases additional resource-related charges (e.g. via freight rates on the transportation of minerals).

The Commonwealth Government has certain powers in relation to industrial relations via its constitutional powers over consultation and arbitration for the prevention and settlement of industrial disputes extending beyond the limits of any one State.

The Commonwealth's power to control exports of minerals is based on its constitutional powers over trade and commerce with other countries. These controls are used where necessary in the national interest to ensure that:

- fair and reasonable market prices and other conditions of sale are achieved;
- adequate supplies are available for the domestic industry;
- Australia's international and strategic obligations are met;
- account is taken of environmental considerations.

In recent years the Government has been reviewing the administration of export controls and has announced a relaxation or removal of export controls on a range of minerals. The situation from 1 January 1988 is summarised in Section 8.

The Commonwealth's powers over foreign investment flow from its powers over such matters as foreign corporations and trade and commerce with other countries.

The State Governments have primary responsibility for protection of the environment. However in cases where a project likely to have significant environmental effects requires Commonwealth approval (e.g. in relation to export approvals or foreign investment approvals), the Commonwealth Minister giving the approval is required to initiate action under the

Commonwealth Environment Protection legislation, and subsequently take into account the environmental effects of the proposal in the decision-making process.

Commonwealth legislation relating to aboriginal land rights applies to the Northern Territory and to two areas of aboriginal land in Victoria and Jervis Bay (part of the Australian Capital Territory); this legislation provides for aboriginal control over mining on aboriginal land and the payment to aboriginies of royalty equivalents and compensation for disturbance. In addition, land rights legislation has been enacted in New South Wales and South Australia.

In recognition of the key roles played by the States in the development of the minerals industries, the Commonwealth Government attaches importance to consultation with them on policy matters. Consultation on matters specifically related to the minerals section is maintained at a number of formal and informal levels and in particular through the Australian Minerals and Energy Council (AMEC), comprising Commonwealth, State and Northern Territory Ministers for minerals and energy.

TABLE 1. MINERAL PRODUCTION: QUANTITY AND EX-MINE VALUE OF MINERALS PRODUCED

	Unit of quantity	1985 Quantity	1985 Value ($'000)	1986 Quantity	1986 Value ($'000)	Six months ended 30 June 1987 Quantity
Antimony ore and concentrate	t	2 102	2 740	909	1 489	530
Antimony-gold concentrate	t	—	—	75	48	—
Antimony in mine products	t	1 458	(a)	1 131	(a)	636
Barite	t	22 423	781	5 819	239	4 862
Bauxite	'000 t	31 839	n.a.	32 384	n.a.	16 398
Bismuth concentrate	t	n.a.	n.a.	1 489	n.a.	n.a.
Bismuth content	t	n.a.	(a)	n.a.	(a)	n.a.
Cadmium in mine products	t	2 776	(a)	2 079	(a)	1 069
Carbon dioxide	—	n.a.	556	n.a.	580	n.a.
Clay, total value	—		44 468		47 066	
Bentonite and bentonitic clay	t	29 070	1 635	39 933	1 325	n.a.
Brick clay and shale	'000 t	6 196 (b)	20 973 (b)	6 918	27 482	3 792
Cement clay and shale	t	419 120 (b)	1 023 (b)	459 969	1 587	n.a.
Kaolin and ball clay(b)	t	165 827	9 730	185 617	10 530	n.a.
Other clay(b)	'000 t	1 789	2 351	1 776	3 022	n.a.
Coal						
Black(c)	'000 t	158 256	4 911 508 (e)	170 067	5 302 444 (e)	92 020
Brown	'000 t	36 985	183 835	37 604	238 821	22 142
Cobalt in mine products	t	3 036	(a)	2 914	(a)	1 261
Construction materials(d)	'000 t	146 504	825 526	144 816	893 992	n.a.
Copper ore and concentrate(f)	t	923 715	370 768 (e)	887 562	360 956 (e)	415 889
Copper content	t	242 112	(a)	231 737	(a)	106 599
Copper in mine products	t	259 765	(a)	248 368	(a)	113 475
Copper-tin concentrate	t	919	n.a.	586	n.a.	—
Copper content	t	197	(a)	132	(a)	—
Tin content	t	11	(a)	7	(a)	—
Diatomite	t	7 587	1 339	9 048	1 697	9 071
Dolomite	t	626 147	2 908	719 864	3 481	341 223
Felspar	t	6 704	50	10 006	96	5 221
Garnet concentrate	t	5 835	204	9 724	340	n.a.
Gemstones						
Diamonds(g)	'000 carats	7 070	64 367	29 232	256 963	16 251
Opal	—	n.a.	47 024	n.a.	56 790	n.a.
Sapphire	—	n.a.	11 264	n.a.	13 022	n.a.
Other	—	n.a.	514	n.a.	498	n.a.
Gold bullion, etc.(h)	kg	74 915	806 777	105 172	1 274 082	n.a.
Gold in mine products	kg	58 521 (j)	(a)	75 079	(a)	48 844
Gold ore and concentrate	t	70 063 (k)	4 661 (k)	10 258 (k)	11 844	n.a.
Gypsum	t	1 744 470	9 956	1 671 001	8 578	894 622
Ilmenite concentrate	'000 t	1 419	64 678	1 238	70 594	690
Iron ore and concentrate	'000 t	97 447	2 186 146 (e)	94 015	2 227 364 (m)	48 812
Iron oxide	t	40 990 (m)	2 327 (m)	38 888 (m)	2 326 (m)	16 821 (m)
Kyanite and sillimanite	t	650	69	901	129	39
Lead ore and concentrate(f)	t	905 634	323 629 (e)	788 539	282 949 (e)	381 139
Lead content	t	455 156	(a)	396 136	(a)	197 082
Lead in mine products	t	497 954	(a)	447 673	(a)	221 485
Leucoxene concentrate	t	13 809	4 003	14 143	5 315	5 979
Limestone	'000 t	8 570 (o)	40 118 (o)	10 747 (b)	57 322 (b)	5 311 (b)
Lithium concentrate	t	12 009	1 429	8 530	2 682	n.a.
Magnesite	t	57 535	4 902	41 441	1 827	31 054
Manganese ore	'000 t	2 003	105 554	1 649	88 381	859
Mica	t	1 574	128	24	2	51
Mineral pigment—red ochre	t	—	—	20	6	n.a.
Molybdenite concentrate	t	27	n.a.	22	21 (e)	9
Molybdenum content	t	9	(a)	8	(a)	3
Monazite concentrate	t	18 735	9 523	14 822	9 503	6 364
Nickel ore	t	2 260 527	17 548	2 116 543	25 434	1 066 864
Nickel concentrate	t	483 207	400 310	402 398	283 374	195 400
Nickel in mine products	t	85 757	(a)	76 739	(a)	35 250
Peat	t	15 707	932	7 265	501	3 496 (b)
Pebbles for grinding	t	972	77	1 127	122	521
Perlite	t	2 740	111	3 838	140	2 514
Petroleum, total value	—	—	10 097 800 (e)	—	6 419 952 (e)	
Crude oil and condensate	ML	33 377	n.p.	29 764	5 024 645	16 125
Natural gas	'000 000 m3	13 464	n.p.	14 869 (p)	847 331 (p)	7 205
Ethane(q)	'000 m3	164 200	n.p.	(s)	(s)	85 400

Liquefied petroleum gas (LPG)(q)	ML	4 124	n.p.	3 929	547 977	1 903
Phosphate rock	t	33 116	759	33 659	1 225	6 745
Pyrophyllite (incl. chlorite)	t	7 317	386	8 588	476	3 178
Rhodonite, industrial	t	2	1	28	31	—
Rhyolite	t	1 611	96	1 498	90	756
Rutile concentrate	t	211 615	85 202	215 774	109 724	130 148
Salt	'000 t	5 635 (u)	102 303 (u)	6 130	117 755 (v)	2 985 (v)
Serpentine	t	46 127	517	47 425	565	32 781
Shell grit	t	—	—	2	1	—
Silica (glass, chemicals, etc.)	'000 t	2 091	24 545 (m)	2 091	22 969	712 (m)
Silver ore and concentrate	t	—	—	3 842	7 694	1 627
Silver in mine products	kg	1 085 933	(a)	1 022 761	(a)	495 109
Sulphur in mine products	t	435 313	(a)	453 012	(a)	245 220
Talc	t	132 074	1 104 (b)	179 467	1 119 (b)	101 598
Tantalite-columbite concentrate	kg	109 694	4 521	140 172	4 662	n.a.
Tin concentrate	t	11 542	88 609	17 261	105 706	8 035
Tin content	t	6 363	(a)	8 508	(a)	4 086
Tungsten						
Scheelite concentrate	t	2 187	16 909 (e)	1 899	10 930 (e)	932
W content	t	1 272	(a)	1 142	(a)	543
Wolframite concentrate	t	1 371	7 559	835	3 712	—
W content	t	699	(a)	458	(a)	—
Uranium oxide	t	3 781	308 499	4 899	407 299	2 065
Vermiculite	t	615	9	657	13	n.a.
Xenotime concentrate	t	46	586	41	336	8
Zinc ore and concentrate	t	1 386 681	333 169 (e)	1 337 180	322 664 (e)	688 681
Zinc content	t	686 307	(a)	643 334	(a)	336 222
Zinc in mine products	t	759 083	(a)	711 958	(a)	366 662
Zircon	t	501 440	62 104	451 824	72 438	238 491
Total value(w)			22 108 391		19 719 710 (x)	

(a) Included in value of mineral in which contained.
(b) Excludes Western Australia.
(c) Raw.
(d) Excludes Australian Capital Territory.
(e) Estimate.
(f) Includes premiums for other recoverable metals, mainly silver.
(g) Includes industrial diamonds.
(h) Includes retorted and alluvial gold.
(j) Excludes gold in gold ore and concentrate for South Australia.
(k) Excludes South Australia.
(m) Excludes Tasmania.
(o) Excludes Queensland and Western Australia.
(p) Includes ethane.
(q) Excludes refinery production.
(s) Included in natural gas.
(u) Excludes Queensland.
(v) Excludes Victoria.
(w) Includes estimates for values of minerals not available separately.
(x) Excludes bismuth-gold concentrate and ACT construction materials.

TABLE 2. SMELTER AND REFINERY PRODUCTION OF PRINCIPAL METALS

	Unit of quantity	1985	1986	1987
Alumina	'000 t	8 792	9 423	10 105
Aluminium	t	851 286	881 910	1 003 947
Blister copper (a)	t	167 669	169 622	177 081
Copper	t	163 833	163 958	182 446
Gold, newly won				
Australian origin	kg	49 184	68 723	97 453
Overseas origin	kg	5 039	13 463	18 819
Lead (b)	t	200 147	156 239	201 317
Lead bullion (a)	t	183 161	188 403	197 171
Pig iron	'000 t	5 607	5 889	5 572
Raw steel (c)	'000 t	6 578	6 703	6 125
Silver	kg	329 024	336 194	309 046
Tin	t	2 683	1 399	563
Zinc	t	288 686	303 115	310 189

(a) Metallic content. (b) Includes lead content of lead alloys from primary sources. (c) Includes recovery from scrap.

TABLE 3. OVERSEAS TRADE IN PRINCIPAL MINERAL PRIMARY PRODUCTS

	Unit of quantity	1985 Quantity	1985 Value f.o.b. ($'000)	1986 Quantity	1986 Value f.o.b. ($'000)	1987 Quantity	1987 Value f.o.b. ($'000)
EXPORTS (a)							
Alumina	'000 t	7 169	1 432 501	7 687	1 427 168	8 299	1 539 322
Aluminium (ingot metal)	t	563 716	861 918	579 528	975 088	710 425	1 420 106
Coal, black	'000 t	89 116	5 102 551	92 784	5 366 749	101 141	5 044 542
Copper	t	156 453	274 450	140 133	247 567	127 385	266 997
Diamonds (c)(d)	carat	3 231 997	33 511	3 376 323	38 561	170 770	18 682
Gold	kg	49 879	668 130	58 685	972 143	86 384	1 693 543
Ilmenite concentrate (b)	t	1 151 921	39 746	1 034 209	48 454	1 045 497	61 003
Iron ore and pellets	'000 t	86 914	1 997 225	79 678	1 939 009	78 258	1 685 809
Iron, ingot steel and ferroalloys	'000 t	685	155 491	607	164 938	773	165 613
Lead	t	429 722	357 781	412 213	361 122	387 785	513 406
Nickel	–	n.a.	496 933	n.a	438 397	n.a.	382 789
Petroleum							
Crude oil and condensate	ML	6 822	1 642 387	4 296	655 322	6 086	973 124
Enriched crude and other refinery feedstock	ML	7	1 192	106	12 052	130	20 975
LPG	'000 t	1 609	491 935	1 495	297 909	1 360	247 933
Rutile concentrate	t	211 723	83 473	229 665	116 412	256 781	149 890
Salt	'000 t	5 166	97 439	5 213	102 470	2 745 (f)	56 446 (f)
Silver	kg	776 065	50 028	957 648	53 450	906 661	59 169
Tin	t	5 667	87 165	7 512	58 351	7 163	60 000
Tungsten concentrate	t	3 300	22 762	2 526	13 482	2 055	10 475
Uranium oxide (U_3O_8)	t	3 424	314 749	4 166	372 604	3 754	342 145
Zinc	t	633 472	514 802	661 823	488 720	659 335	524 313
Zircon concentrate	t	495 891	63 881	445 690	74 495	465 003	108 416
Other			472 111		629 460		965 198
Total value			15 262 161		14 853 923		16 309 896
IMPORTS							
Aluminium	t	1 079	3 370	736	3 113	1 060	4 191
Asbestos, all types	t	12 194	11 386	9 245	7 158	3 536	1 852
Clay (excl. activated)	t	63 186	9 965	54 221	10 365	52 684	13 677
Diamonds (c)	carat	1 905 069	56 082	2 357 013	63 884	2 953 558	77 502
Gold	kg	7 972	89 303	7 263	91 431	7 420	104 534
Ingot steel, ferroalloys	t	62 502	39 039	79 010	39 404	155 017	69 183
Nickel, matte and metal	t	858	6 075	2 952	8 627	1 296	8 200
Petroleum							
Crude oil	ML	3 305	766 634	4 026	514 877	5 042	812 637
Enriched crude and other refinery feedstock	ML	3 307	737 839	3 371	457 651	2 910	437 953
Phosphate rock	'000 t	1 810	94 207	1 698	97 330	1 666	101 387
Potassium fertiliser	t	204 633	28 464	199 395	26 516	274 506	25 891
Sulphur	t	392 344	57 863	398 101	70 559	379 560	55 544
Other			128 549		150 634		197 596
Total value			2 028 776		1 541 549		1 910 147

(a) Quantities refer to total metallic content of all ores, concentrates, intermediate products, or refined metal; value of metals contained in host mine and smelter products (e.g. silver in lead concentrate or lead bullion) is not separately available and is included in the value of the mineral product or metal in which it is exported. (b) Excludes leucoxene and beneficiated ilmenite. (c) Comprises unsorted and sorted gem and industrial diamonds. (d) Excludes data for unsorted gem and industrial diamonds from May 1986. (f) Excludes common salt in bulk from 1 January 1987 to 30 June 1987.

TABLE 4. MINERAL EXPLORATION EXPENDITURE ($ million)

	1984-85	1985-86	1986-87
Petroleum exploration (a)			
Onshore	429.6	367.8	171.0
Offshore	373.6	398.0	134.1
Total	803.2	765.7	305.2
Mineral exploration			
Government	14.3	7.9	7.2
Private	437.3	442.0	556.8
Total	451.6	449.9	564.0
Oilshale exploration	3.5	1.8	n.a.
Total expenditure	1 258.3	1 217.4	n.a.

(a) Private exploration expenditure; no government exploration expenditure since 1983-84.

Totals may not equal sum of figures shown because of rounding.

TABLE 5. PATTERN OF MINERAL TRADE

	1985(r)		1986		1987	
	$ million	%	$ million	%	$ million	%
Exports						
Japan	6 262.7	41.0	6 086.5	41.0		
Other Asian and Oceania	3 451.1	22.6	3 159.5	21.3		
UK	591.9	3.9	682.6	4.6		
Other EEC	1 331.7	8.7	1 947.1	13.1	not yet available	
USA	1 746.0	11.4	1 453.1	9.8		
Others	1 878.8	12.3	1 525.1	10.3		
Total	15 262.2		14 853.9			
Imports						
Middle East	1 134.8	55.9	664.2	43.1		
Indonesia	152.2	7.5	158.9	10.3		
Other Asian	156.2	7.7	231.5	15.0		
Oceania	308.9	15.2	214.9	13.9		
Canada	91.6	4.5	102.5	6.6	not yet available	
USA	53.7	2.6	53.0	3.4		
Europe(a)	58.3	2.9	69.4	4.5		
Others	73.1	3.7	47.1	3.1		
Total	2 028.8		1 541.5			

(a) Includes USSR and UK.

TABLE 6. INFLOW OF FOREIGN INVESTMENT IN AUSTRALIAN MINING INDUSTRY ($ million)

Year	Direct Investment	Portfolio and Other Investment	Total Investment
1984–85	−422	812	389
1985–86	−12	−1 379	−1 391
1986–87	−59	87	28

TABLE 7. MAJOR DEPOSITS - RESOURCES

COMMODITY Deposit	Proved		Probable		Unspecified	
	Mt	Grade	Mt	Grade	Mt	Grade
BAUXITE						
Darling Range	700	32%Al_2O_3	500	32%Al_2O_3	200	
Gove	200	51%Al_2O_3			210	
Weipa	510	55%Al_2O_3	780	55%Al_2O_3	1710	
COAL - black (Basins containing 150 Mt)						
Bowen Basin	26 600					
Callide Basin	200					
Collie Basin	741					
Gunnedah Basin	2 150					
Ipswich Basin	600					
Leigh Creek (deposit)	150					
Sydney Basin	29 800					
Tarong Basin	500					
Tasmania (whole state)	530					
Surat - Moreton Basin	4 700					
COAL - brown (Basins and deposits containing 1 000 Mt)						
Latrobe Valley	39 700					
North St Vincents Basin	1 800					
COPPER						
Benambra					8	3%Cu 5%Zn
Cobar	0.8	1.9%Cu	0.8	2.5%Cu		
Gecko	3.1	3.9%Cu	1.6	3.9%Cu		
Mount Isa	65	3.3%Cu	60	3.5%Cu		
Mount Lyell	3.1	1.6%Cu	7.4	2.1%Cu		
Olympic Dam	(a) 7.7	3.7%Cu 1.6kg/tU_3O_8 0.4g/tAu 14.7g/tAg	450	2.5%Cu 0.8kg/tU_3O_8 0.6g/tAu 6.0g/tAg	(b) 2.3	5.8g/tAu 0.3%Cu 0.1kg/tU_3O_8 1.5g/tAg
Scuddles					1.3	5.1%Cu 1.7%Zn 1.3g/tAg
					4	2.9%Cu
Warrego	1.9	2.3%Cu				
Woodlawn (see lead, zinc, silver)						

COMMODITY Deposit	Proved		Probable			Unspecified	
	Mt	Grade	Mt	Grade		Mt	Grade
DIAMONDS							
Argyle	57	6.8carats/t	14	6.1carats/t			
GOLD							
Boddington	30	2.3g/t Au	15	0.9g/t Au			
Fimiston	5.4	5.7g/t Au				30	
Granites	1.5	8 g/t Au					
Great Boulder (Victory - Defiance)	14.6	4.5g/t Au					
Hellyer (see lead, zinc, silver)							
Kalgoorlie (Tailings)	30	1 g/t Au					
Kidston	39.2	1.82g/t Au 2.2g/t Ag	20.1	1.8g/t Au			
Mount Charlotte	7.1	4.3 g/t Au	1.3	4 g/t Au			
Mount Leyshon	6.3	1.8 g/t Au					
Mount Morgan (Tailings)	25.3	1.08g/t Au					
Norseman	2.8	6.5g/t Au					
Olympic Dam (see copper)							
Paddington	8.4	3.2g/t Au					
Pajingo	1.4	11 g/t Au 40 g/t Ag					
Rosebery (see lead, zinc, silver)							
Telfer	21.3	2.39g/t Au	9.8	2.0 g/t Au			
Temora (Gidginbung)	4.5	2.5 g/t Au					
IRON ORE							
Channar						200	62.4%Fe
Deepdale						2000	57.0%Fe
East Deepdale						506	57.0%Fe
McCameys Monster	162	62.0%Fe	88	62.0%Fe			
Middleback Range						64	
Mount Tom Price and Paraburdoo	680	63.7%Fe	100	63.7%Fe			
	160	58.0%Fe					
	36	62.0%Fe					
Mount Whaleback					1	100	
Newman - Marra Mamba						700	
Nimingarra, Kennedy Gap, etc						100	59.3%Fe
Paraburdoo East Range						160	62.1%Fe
Yandicoogina	443	58.5%Fe	800	58.5%Fe	1	815	58.3%Fe

Commodity Deposit	Proved		Probable		Unspecified	
	Mt	Grade	Mt	Grade	Mt	Grade
LEAD, ZINC, SILVER						
Benambra (see copper)						
Broken Hill						
North Mine	4.2	12.1%Pb 9.6%Zn 192 g/tAg	2.1	10.1%Pb 7.7%Zn 140 g/tAg		
ZC Mines	29.6	8.0%Pb 11.0%Zn 70 g/tAg	12.3	5.0%Pb 10.0%Zn 50 g/tAg		
Cadjebut	1.0	3.1%Pb 15.2%Zn	2.3	5.6%Pb 13.5%Zn		
Cobar	0.8	0.5%Pb 4.1%Zn	0.8	0.8%Pb 2.5%Zn		
Elura	20.0	6.0%Pb 8.7%Zn 150 g/tAg	4.6	6.5%Pb 8.3%Zn 47 g/tAg		
Hellyer			15.0	6.9%Pb 13.0%Zn 0.4%Cu 2.3g/tAu 156 g/tAg		
Hilton	11	6.7%Pb 9.1%Zn 154 g/tAg	38	6.4%Pb 9.3%Zn 150 g/tAg		
Lady Loretta			9.0	6.5%Pb 14.8%Zn 95 g/tAg		
Mount Isa	42	5.9%Pb 6.7%Zn 150 g/tAg	5.0	5.5%Pb 7.4%Zn 128 g/tAg		
Que River	0.6	6.8%Pb 11.7%Zn 0.4%Cu 3.2g/tAu 190 g/tAg				
Rosebery	4.5	3.8%Pb 13.1%Zn 0.72%Cu 2.9g/tAu 119 g/tAg	3.1	4.5%Pb 14.0%Zn 0.35%Cu 2.1g/tAu 120 g/tAg		
Scuddles					9.3	15.8%Zn 1.3%Pb 108 g/tAg 1.2g/tAu
Woodcutters	0.5	7.9%Pb 16.7%Zn 187 g/tAg	1.0	7.5%Pb 12.9%Zn 154 g/tAg		
Woodlawn	2.4	4.8%Pb 11.8%Zn 1.4%Cu 102 g/tAg	0.2	0.6%Pb 1.9%Zn 2.9%Cu 20 g/tAg		

Commodity Deposit	Proved		Probable		Unspecified	
	Mt	Grade	Mt	Grade	Mt	Grade
LITHIUM						
Greenbushes	28.3	2.82%Li_2O	13.6	3.14%Li_2O		
MANGANESE						
Groote Eylandt	192	35%Mn				
NICKEL						
Agnew	1.3	2.3%Ni	18.2	2.3%Ni		
Greenvale					10.6	1.4%Ni 0.1%Co
Kambalda					26.0	3.2%Ni
Mount Windarra					5.2	1.4%Ni
PHOSPHATE ROCK						
Phosphate Hill	1068	17.3%P_2O_5				
Mount Weld	160	18.0%P_2O_5				
TIN						
Greenbushes (hard rock)			31.6	0.11%Sn 0.04%Ta_2O_5 0.03%Nb_2O_5		
Greenbushes (soft rock)	6.5	0.02%Sn 0.003%Ta_2O_5	3.0	0.03%Sn 0.002%Ta_2O_5		
Renison	4.7	1.3%Sn	9.3	1.2%Sn		
TUNGSTEN						
King Island					(b)2.8	1.39%WO_3
Mount Carbine	9Mt	0.1%WO_3				
URANIUM						
Ranger						
No.1 Orebody	11.8	0.3%U_3O_8				
No.3 Orebody			35.0	0.2%U_3O_8		
Olympic Dam (see Copper)						
Jabiluka 1 Orebody					(b) 1.3	0.25%U_3O_8
Jabiluka 2 Orebody					(b)52.0	0.39%U_3O_8
Koongarra						
No 1. Orebody					(b) 4.938	0.269%U_3O_8
Yeelirrie	35	0.15%U_3O_8				
Beverley					(b) 6	0.27%U_3O_8

(a) Part of probable reserves
(b) Proved plus probable reserves

TABLE 8. AUSTRALIAN IDENTIFIED RESOURCES OF MAJOR MINERALS AND FUELS (31 DECEMBER 1987)

MINERAL COMMODITY	Demonstrated resources			Inferred resources		
	Economic	Subeconomic		Economic	Subeconomic	Undifferentiated
		Paramarginal	Submarginal			
Antimony (kt, Sb)	n.a.	--	--	16	102	--
Asbestos						
Chrysotile ore (Mt)	19	69	--	16	--	--
Crocidolite fibre (Mt)	--	0.42	2.07	--	--	--
Bauxite (Mt)	2825	2239	137	1390	--	--
Black coal (Gt)						
'in situ'	70.3	3.3	0.04	--	--	}
'recoverable'	49.5	2.0	0.02	--	--	}very large
Brown coal (Gt)						
'in situ'	46.5	--	2.9	--	--	204
'recoverable'	41.9	--	2.5	--	--	(1)183
Cadmium (kt, Cd)	73.3	5.8	77.8	--	--	23.6
Chromite (Mt)	--	2.34	0.52	--	20	--
Cobalt (kt, Co)	22	8	290	--	13	--
Copper (Mt, Cu)	16.9	2.1	1.5	--	--	22.0
Diamonds gem & cheap						
gem (10^6 carats)	160	2	--	38	--	--
industrial (10^6 carats)	196.4	4	--	47	--	--
Fluorine (kt, F)	--	26708	40	--	6418	--
Gold (t, Au)	1274	182	157	154	28	930
Iron ore (Gt)	14.93	12.18	--	6.39	10.36	--
Lead (Mt, Pb)	15.55	3.41	16.38	--	--	6.53
Lithium (kt,Li)	568.4	2.6	--	--	--	--
Manganese ore (Mt)	192	67	311	205	13	--
Mineral sands						
Ilmenite (Mt)	49.89	19.73	--	4.25	6.18	--
Monazite (kt)	237.8	784.3	--	2.3	27.3	--
Rutile (Mt)	9.12	3.84	--	0.24	1.27	--
Zircon (Mt)	13.62	6.13	--	0.26	1.82	--
Nickel (Mt, Ni)	1.1	0.8	6.1	--	1.8	--
Niobium (kt,Nb)	--	37.30	--	--	--	--
Petroleum (recoverable)						
Crude oil (GL)	(2)231	--	(2) 31	n.a.	n.a.	n.a.
Natural (sales) gas ($10^9 m^3$)	(2)832	--	(2)1406	n.a.	n.a.	n.a.
Condensate (GL)	(2)118	--	(2) 64	n.a.	n.a.	n.a.
LPG (GL)	(2) 97	--	(2) 12	n.a.	n.a.	n.a.
Phosphate rock (Mt)	--	2005	--	--	1947	--
Shale oil (GL) (recoverable)	--	--	4328	--	40 595	--
Silver (kt, Ag)	33.76	5.57	17.38	--	--	14.66
Tantalum (kt,Ta)	0.18	17.00	--	--	--	--
Tin (kt, Sn)	184.9	4.7	116.1	8	458	222
Tungsten (kt, W)	36.5	107	77	0.4	76	40
Uranium (kt, U)						
(recoverable)	470	56	--	267	127	--
Vanadium (kt, V)	10	1490	8425	--	2235	--
Zinc (Mt, Zn)	23.99	10.28	23.64	--	--	11.45

t -- tonne; kt -- 10^3 t; Mt -- 10^6t; Gt -- 10^9t; GL -- 10^9 L; n.a. -- not available.

(1) Recovery rate based on that of economic demonstrated resources.
(2) As at 30 June 1987.