Chapter Seventeen

Mineral Industry

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Minerals of economic significance occur throughout Australia, their geological age ranging from Precambrian to Recent. Many of the large deposits such as those at Broken Hill (New South Wales), Mount Isa (Queensland), Olympic Dam (South Australia) and the Kalgoorlie and Pilbara regions of Western Australia and the Alligator Rivers area of the Northern Territory are Precambrian in age. In eastern Australia the major deposits such as the Elura, Cobar, Woodlawn, Hellyer and Rosebery base-metal deposits, the Renison (Tasmania) tin deposit, and most of the gold and black coal deposits, are Palaeozoic in age. The black coals of the Moreton district of Queensland, north-east New South Wales and Leigh Creek, South Australia are of Mesozoic age. Deposits formed in Tertiary times include the brown coal in Victoria, the oil shales of eastern Queensland, the bauxites of Weipa (Queensland), Gove (Northern Territory) and the Darling Range (Western Australia) and the nickeliferous laterites at Greenvale (Queensland) and the mineral sands deposits of the Murray Basin.

Petroleum has been identified in the Australian sediments as old as Precambrian. Australia's major petroleum bearing basins are under Bass Strait (mainly Tertiary) and offshore north-western Australia (mainly Mesozoic). The main onshore basins are the Amadeus, Bowen/Surat, Cooper/Eromanga and Perth Basins.

Australia is self-sufficient in most minerals of economic importance (and much more than self-sufficient in some). Major minerals with known reserves adequate for domestic demand and exports include bauxite (aluminium), black coal, clays, copper, diamonds, gold, iron ore, lead, manganese, mineral sands (titanium and zirconium), natural gas, nickel, salt, silver, uranium and zinc.

THE MINING INDUSTRY

Mining, as specified in the *Australian Standard Industrial Classification (ASIC) 1983* (1201.0), broadly relates to the extraction of minerals occurring naturally as solids such as coal and ores; liquids such as crude petroleum; or gases such as natural gas. It covers extraction by processes such as underground mining, open-cut extraction methods, quarrying, operation of wells or evaporation pans, dredging or recovering from ore dumps or tailings. Activities such as dressing or beneficiating ores or other minerals by crushing, milling, screening, washing, flotation or other processes (including chemical beneficiation) or briquetting, are included because they are generally carried out at or near mine sites as an integral part of mining operations. Natural gas absorption and purifying plants are also included, but establishments mainly engaged in refining or smelting of minerals or ores (other than preliminary smelting of gold), or in the manufacture of such products of mineral origin as coke, cement and fertilisers, are excluded.

The mining sector contributed $17,030 million or 4.6 per cent of Australia's Gross Domestic Product (GDP) of $372,172 million in 1989–90 ($13,498 million or 4.0% in 1988–89).

Mining operations

The following table shows key items of data on the operations of the various areas of the mining industries.

MINING ESTABLISHMENTS: SUMMARY OF OPERATIONS BY INDUSTRY CLASS, 1989–90

ASIC code	Description	Establishments at 30 June	Employment at end of June(a)	Wages and salaries (b)	Turnover	Stocks: Opening	Stocks: Closing	Total purchases transfers in and selected expenses	Value added	Fixed capital expenditure less disposals
		no.	no.	$m	$m	$m	$m	$m	$m	$m
	Metallic minerals									
	Ferrous metal ores									
1111	Iron ores	23	8,843	389.6	2,451.8	274.6	259.9	699.2	1,737.9	134.5
1112	Iron ore pelletising									
	Non-ferrous metal ores									
1121	Bauxite	12	2,125	79.0	473.3	32.5	37.2	124.1	354.0	44.0
1122	Copper ores	15	3,571	153.9	885.9	115.1	142.4	304.0	609.2	89.9
1123	Gold ores	233	9,841	375.3	4,106.5	432.5	504.3	2,017.1	2,161.2	588.7
1124	Mineral sands	26	2,315	74.6	821.7	88.0	124.1	256.4	601.4	235.9
1125	Nickel ores	7	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
1126	Silver–lead–zinc ores	20	4,875	222.7	1,459.0	129.6	166.3	446.3	1,049.4	158.5
1127	Tin ores	8	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
1128	Uranium ores	2	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
1129	Non-ferrous metal ores n.e.c.	7	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
11	*Total metallic minerals*	*353*	*35,266*	*1,440.5*	*11,089.9*	*1,308.7*	*1,464.4*	*4,300.0*	*6,945.6*	*1,383.9*
	Coal, oil and gas									
120	Coal	154	28,982	1,519.3	7,527.4	497.1	665.1	3,157.3	4,538.0	642.4
1300	Oil and gas	107	5,326	274.0	5,715.5	237.3	269.2	465.8	5,281.6	1,067.6
12–13	*Total coal, oil and gas*	*261*	*34,308*	*1,793.3*	*13,242.9*	*734.4*	*934.3*	*3,623.2*	*9,819.6*	*1,710.1*
	Construction materials									
1401	Sand and gravel	214	1,925	46.6	377.1	12.0	16.6	157.5	224.2	55.7
1404	Construction materials, n.e.c.	321	4,040	127.2	1,017.7	62.0	73.9	465.9	563.7	88.5
14	*Total construction materials*	*535*	*5,965*	*173.8*	*1,394.8*	*74.0*	*90.5*	*623.4*	*787.9*	*144.2*
	Other non-metallic materials									
1501	Limestone	38	496	14.7	69.3	5.8	5.0	38.3	30.4	4.8
1502	Clays	29	273	8.6	41.9	3.2	3.8	21.8	20.6	6.7
1504	Salt	18	687	19.4	139.4	24.9	26.5	48.8	92.2	16.3
1505	Non-metallic minerals, n.e.c.	79	1,378	53.4	594.8	54.3	56.6	133.9	463.3	15.4
15	*Total other non-metallic minerals*	*164*	*2,834*	*96.1*	*845.5*	*88.2*	*92.0*	*242.8*	*606.4*	*43.1*
	Total mining (excluding services to mining)	**1,313**	**78,373**	**3,503.7**	**26,573.1**	**2,205.3**	**2,581.1**	**8,789.4**	**18,159.5**	**3,281.3**
New South Wales(c)		328	22,538	1,095.2	4,664.4	361.1	499.2	1,700.8	3,101.8	521.1
Victoria		163	3,286	155.8	3,504.6	103.6	93.2	343.7	3,150.5	536.1
Queensland		332	19,441	894.5	6,888.6	466.9	590.1	2,865.6	4,146.2	502.8
South Australia		97	3,236	115.0	1,243.0	157.4	175.0	298.4	962.2	103.1
Western Australia		309	25,523	1,054.5	8,804.7	847.8	950.2	3,062.2	5,844.9	1,511.6
Tasmania		44	2,053	99.3	423.1	46.7	56.4	179.2	253.7	23.5
Northern Territory		40	2,296	89.5	1,044.6	221.8	217.1	339.6	700.3	83.1

(a) Includes working proprietors. (b) Excludes the drawings of working proprietors. (c) Includes Australian Capital Territory.

Source: Census of Mining Establishments: Details of Operations by Industry Class, Australia (8402.0).

Mineral production

Statistics on quantities of selected minerals produced and contents of selected metallic minerals produced for 1987–88 and earlier years are contained in *Year Book Australia 1990*. Data for all minerals for more recent years are available in the annual publication *Mineral Production, Australia* (8405.0).

Mineral processing and treatment

As few minerals can be directly used in the form in which they are mined, most minerals must undergo considerable processing and treatment before utilisation. The following table shows the production of the main manufactured products of mineral origin during recent years.

PRODUCTION(a) OF PRINCIPAL MANUFACTURED PRODUCTS OF MINERAL ORIGIN

Commodity		*1987–88*	*1988–89*	*1989–90*
		METALS (b)		
Non-ferrous				
Alumina	'000 tonnes	10,330	10,602	11,041
Refined aluminium	'000 tonnes	1,074	1,226	1,235
Refined copper	'000 tonnes	186	211	245
Lead bullion (for export)(c)	'000 tonnes	201	181	198
Refined lead	'000 tonnes	182	184	197
Refined zinc	'000 tonnes	306	303	295
Refined tin	tonnes	501	377	381
Ferrous				
Pig iron	'000 tonnes	5,544	5,875	6,188
Precious				
Refined gold(d)	kg	111,934	169,653	233,301
Refined silver	kg	304,426	305,013	368,378
		FUELS		
Coal products				
Metallurgical coke	'000 tonnes	3,727	3,889	n.a.
Brown coal briquettes	'000 tonnes	809	751	n.a.
Petroleum products				
Diesel-automotive oil	megalitres	9,399	9,774	10,282
Industrial fuel and marine fuel	megalitres	229	175	142
Fuel oil for burning	megalitres	2,079	2,272	2,479
Automotive petrol	megalitres	15,997	15,913	16,214
		BUILDING MATERIALS		
Clay bricks	millions	1,900	2,175	2,086
Portland cement	'000 tonnes	6,158	6,901	7,075
		CHEMICALS		
Sulphuric acid	'000 tonnes	1,818	1,904	1,464
Superphosphate(e)	'000 tonnes	n.a.	n.a.	2,659

(a) Some products exclude production of single establishment manufacturing establishments employing less than four persons and production of establishments predominantly engaged in non-manufacturing activities but which may carry on in a minor way, some manufacturing. (b) Excludes secondary metal with the exception of basic iron. (c) Metallic content. (d) Newly won gold of Australian origin. (e) Double and triple superphosphate expressed in terms of single phosphate, i.e., nine per cent P equivalent.

Source: Australian Bureau of Agricultural and Resource Economics (non-ferrous, precious metals and petroleum products only).

Exports

The value of Australian exports of mineral resources grew by 14 per cent in 1990–91 to a record $27.5 billion. Exports of mineral resources in 1990–91 accounted for 42 per cent of total exports, compared with 40 per cent in 1989–90.

Major contributors to the increase in 1990–91 were crude oil, up $977 million (95%) to $2,004 million; gold, up $873 million (31%) to $3,685 million; steaming coal, up $485 million (23%) to $2,636 million; liquefied natural gas (LNG), up $470 million (132%) to $825 million; iron ore, up $354 million (16%) to $2,560 million; and refined petroleum products, up $217 million (39%) to $774 million. The only substantial decreases came from aluminium, down $172 million (8%) to $1,958 million; zircon concentrate, down $102 million (38%) to $169 million; and lead, down $55 million (12%) to $391 million.

The 14 per cent growth in the value of mineral resources exports in 1990–91 was mostly attributable to volume increases, as the price index of mineral resources exports rose by only two per cent. Production increases for about two-thirds of the mineral commodities underpinned the growth in export volumes in 1990–91. The most substantial production rises in 1990–91 were for zinc mine production (up 16%), refined lead (up 12%), silver and lead mine production (both up 3%) and refined gold (up 21%). Some offsetting production falls were recorded for manganese (down 31%) and mineral sands concentrates (down an average of 27%).

MINERAL EXPLORATION

Exploration consists of the search for new ore occurrences or undiscovered oil or gas and/or appraisal intended to delineate or greatly extend the limits of known deposits of minerals or oil or gas reservoirs by geological, geophysical, geochemical, drilling and other methods. This includes construction of shafts and adits primarily for exploration purposes but excludes activities of a developmental or production nature. Exploration for water is excluded.

Mineral exploration for other than petroleum

Onshore legislation

Each State or Territory has its own Mining Acts and Regulations governing the prospecting for and working of mineral deposits. These Acts and Regulations although similar in principle are different in detail.

Rights to explore for minerals are awarded by granting prospecting licences and (for larger areas) exploration licences or exploration permits. Each tenement sets out conditions such as minimum exploration expenditure each year, methods of prospecting and tenure of agreement. The tenure is usually limited and if renewed for a further period there is usually a requirement that the area of the tenement be reduced in size. Unless specifically stated in an agreement the discovery of minerals gives the holder of the tenement no legal rights except rights in priority over other applicants for mining titles over the area in which a discovery is made.

Suitable prospects are converted to mining tenements by making application for lease under the appropriate Mining Act. In the case of large-scale, capital-intensive operations mining titles may be acquired by negotiation with the appropriate Minister for Mines. The agreed terms and conditions may be embodied in an Act of the State Parliament.

Most States and Territories make provision for a Miner's Right which permits an individual to prospect or fossick for minerals on Crown Land.

Offshore legislation

Following the enactment of the *Seas and Submerged Lands Act 1973*, the High Court confirmed that the Commonwealth has sovereignty over the territorial sea and sovereign rights over the resources of the whole of Australia's continental shelf. However, in the Offshore Constitutional Settlement between the Commonwealth and the States reached in June 1979, it was agreed that responsibility for mining of the seabed on the landward side of the outer limit of the three nautical mile territorial sea, should lie with the States, while the Commonwealth should have responsibility for areas beyond.

The *Minerals (Submerged Lands) Act 1981*, passed by the Commonwealth Parliament in June 1981, provides for joint Commonwealth–State authorities to be responsible for major matters under the legislation, with the States being responsible for day-to-day administration. The legislation came into force on 1 February 1990. Pending enactment of similar legislation by the States, offshore mining within coastal waters is administered under the onshore mining legislation of the States and the Northern Territory.

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

Mineral exploration expenditure

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

PRIVATE MINERAL EXPLORATION EXPENDITURE (OTHER THAN FOR PETROLEUM)
($ million)

	1984–85	*1985–86*	*1986–87*	*1987–88*	*1988–89*	*1989–90*
New South Wales	49.5	51.8	47.6	61.5	50.6	55.1
Victoria	15.2	12.3	15.5	33.9	21.7	21.0
Queensland	79.5	88.6	120.6	159.3	139.8	128.4
South Australia	57.6	48.9	11.0	18.9	16.6	13.2
Western Australia	189.8	205.2	323.3	466.3	387.2	315.4
Tasmania	17.8	10.6	10.9	10.4	13.1	11.8
Northern Territory	28.0	24.6	27.9	48.9	68.6	62.6
Australia	**437.3**	**442.0**	**556.8**	**799.2**	**697.6**	**607.5**

Source: Actual and Expected Private Mineral Exploration, Australia (8412.0).

Petroleum exploration

Onshore legislation

In Australia, full control of petroleum mining rights is vested with the relevant State or Territory Government. Any organisation or individual proposing to undertake petroleum exploration or development must first satisfy the relevant Government that it has access to the necessary financial and technical resources to undertake the proposed operations.

Three main types of petroleum title are available:

- the exploration title, where the holders are typically given exclusive rights over an area to explore for petroleum by conducting surveys and drilling wells, etc.;
- the production title, which is required for commercial production of petroleum and gives the holder the right to produce and sell the petroleum, is granted subject to the payment of a royalty; and
- retention leases are available in the Northern Territory under the *Petroleum Act 1984* and provide security of tenure over sub-economic discoveries.

Royalty arrangements vary from State to State. Most onshore royalties are determined as a percentage of the well-head value of all petroleum production.

Commonwealth legislation provides for the replacement of all Commonwealth excise on liquefied petroleum gas and crude oil, and State/Territory royalty, with a Resource Rent Royalty (RRR) where the relevant State or Territory Government has negotiated an acceptable agreement with the producers and has agreed upon a revenue sharing formula with the Commonwealth. A RRR applies to the Barrow Island oilfield in Western Australia.

Offshore legislation

As part of the Offshore Constitutional Settlement (OCS) between the Commonwealth and the States, responsibility for administering petroleum exploration and development within the outer boundary of the three nautical mile territorial sea rests with the relevant State or Territory while the Commonwealth has responsibility for the continental shelf beyond the territorial sea. Under the OCS, the States/Northern Territory and the Commonwealth agreed to a common petroleum mining code.

The Commonwealth legislation, *the Petroleum (Submerged Lands) Act 1967,* provides for a joint authority for the adjacent area (beyond the territorial sea) of each State and the Northern Territory consisting of the relevant Commonwealth and the State/Territory Minister. The joint authorities are concerned with major matters arising under the legislation and in the case of disagreement the view of the Commonwealth Minister prevails. Day-to-day administration is the responsibility of the State or Territory Minister as the Designated Authority.

The offshore legislation provides for:

- exploration permits, providing exclusive exploration rights over a specific area;
- production licences to authorise development and commercial production from discovered fields; and
- retention leases to allow security of tenure over sub-economic discoveries.

Offshore projects except the North West Shelf are subject to Petroleum Resource Rent Taxation (PRRT). The tax is levied at a rate of

40 per cent on net project revenues. All exploration expenditures incurred by the explorer in PRRT liable areas are allowable deductions. The North West Shelf project is subject to an excise on crude oil production and a royalty on the net wellhead value of all petroleum production.

The Timor Gap Zone of Co-operation Treaty designates an area of the Continental Shelf between Australia and Indonesia subject to control by a Joint Administration. Revenue collected from petroleum production taxation is shared between the two nations. The Treaty has provisions to prevent double taxation.

In order to encourage offshore petroleum exploration, the Commonwealth conducts a coordinated strategy involving the regular release of exploration acreage, improved collection and dissemination of exploration data to explorers and enhanced company awareness about Australia's title acquisition and taxation agreements. A major feature of the strategy is that explorers are given advance notice of future releases of exploration acreage.

Petroleum exploration expenditure

The table below shows expenditure on private petroleum exploration in Australia during the last six years.

PRIVATE PETROLEUM EXPLORATION EXPENDITURE
($ million)

	1984–85	*1985–86*	*1986–87*	*1987–88*	*1988–89*	*1989–90*
Onshore	419.6	367.8	171.0	271.9	233.6	143.2
Offshore	373.6	398.0	134.1	223.2	405.7	439.4
Total	**793.2**	**765.8**	**305.2**	**495.1**	**639.3**	**582.6**

Source: Actual and Expected Private Mineral Exploration, Australia (8412.0).

ADMINISTRATION

Mineral rights in Australia are held by the State and Territory Governments and the granting of exploration and mining titles is administered by them under the respective State or Territory legislation. The Commonwealth Government holds rights to minerals in Federal Territories and to certain prescribed substances in the Northern Territory, within the meaning of the Atomic Energy Act (principally uranium). The Commonwealth Government is also able to influence overall development and production activity in the mineral industry by virtue of its constitutional powers with respect to international trade, customs and excise, taxation and foreign investment. Certain specially-formed bodies such as the Joint Coal Board have been given administrative responsibility in defined areas. The Government has also established consultative mechanisms, such as the Australian Coal Industry Council, to provide an advisory, rather than administrative, role.

Mineral royalties

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

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

MINERAL ROYALTY RECEIPTS: GOVERNMENTS
($'000)

	1984–85	*1985–86*	*1986–87*	*1987–88*	*1988–89*	*1989–90*
New South Wales(a)	109,194	118,569	135,486	97,166	99,387	128,966
Victoria(b)(c)	206,086	249,489	198,964	157,059	109,037	149,144
Queensland(a)	142,533	196,110	176,451	196,013	178,301	207,994
South Australia	27,739	58,352	33,592	36,011	34,914	44,004
Western Australia(d)	131,640	162,208	154,056	162,648	171,972	252,016
Tasmania	1,043	1,507	1,641	3,048	3,800	6,394
Northern Territory	5,483	8,079	7,186	10,642	9,514	24,079
Commonwealth Government(c)	312,701	394,510	272,501	285,052	182,670	273,077
Total	**936,419**	**1,188,824**	**979,877**	**947,639**	**789,595**	**1,085,674**

(a) Includes royalties on sand and gravel from Crown lands. (b) Includes royalties on brown coal paid by State Electricity Commission. (c) Includes royalties received under the *Petroleum (Submerged Lands) (Royalty) Act 1967–68*. (d) Includes prepaid royalty of $50 million in respect of diamond royalty agreement.

Source: Federal, State and Territory departments responsible for mining.

Government assistance

The Commonwealth Government and the various State Governments provide assistance to the mineral industry in a variety of ways. These were described in detail in *Year Book Australia 1990*.

RESEARCH

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

Bureau of Mineral Resources, Geology and Geophysics (BMR)

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

- fossil fuels — including their origin and distribution in space and time; onshore sedimentary basin analysis; geophysical investigations of the structure of onshore basins; framework studies of Australian offshore areas; and modern marine processes;
- minerals — including their origin and distribution in space and time; metallogenic provinces; the weathered zone; and related resources; airborne geophysical mapping and interpretation; crustal geophysics; and the origin and distribution of offshore mineral deposits;
- ground water, and basin hydrogeology;
- earthquake hazards;
- national and international geoscience maps;
- overseas programs — including land geoscience in South-East Asia; marine geosciences in the south-west Pacific; geoscientific cooperation with China; and Antarctica;
- petroleum and mineral resource assessment; and
- national geoscience database.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Minerals research by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is undertaken within the Institute of Minerals, Energy and Construction. The objective of the Institute is to increase the international competitiveness, export earnings, gross domestic product and value of services provided by the minerals, energy and construction industries.

Divisions (and their respective headquarters locations) of the Institute engaged in minerals energy and construction research are the Division of Geomechanics at Syndal (Victoria); the Division of Coal Technology at North Ryde (New South Wales); the Division of Mineral Products at Port Melbourne (Victoria); the Division of Mineral and Process Engineering at Clayton (Victoria); the Division of Exploration Geoscience at Perth (Western Australia); the Division of Fuel Technology at

Lucas Heights (New South Wales); and the Division of Building, Construction and Engineering at Highett (Victoria). The Institute's headquarters is located in Sydney (New South Wales).

University research

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

Research by private enterprise

The Australian Mineral Industries Research Association Limited (AMIRA) is a non-profit organisation which was set up in 1959 by the Australian mineral industry to manage jointly sponsored research and development on behalf of the industry. There are approximately 140 members of AMIRA, drawn from all parts of the mineral, coal and petroleum industries. Membership ranges from small exploration companies to large mining houses and includes suppliers of services to the industry. The policy of the Association is determined by a council elected by members.

AMIRA has no research facilities so organisations such as CSIRO, universities, consultants, suppliers or member companies carry out the research as contractors to AMIRA.

INTERNATIONAL RELATIONS

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

- Association of Tin Producing Countries (ATPC);
- International Lead and Zinc Study Group (ILZSG);
- Association of Iron Ore Exporting Countries (APEF);
- UNCTAD Intergovernmental Group of Experts (IGE) on Iron Ore; and
- International Nickel Study Group (INSG).

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