



Australian Government
Geoscience Australia

AUSTRALIA'S IDENTIFIED MINERAL RESOURCES 2006



Australian Government Geoscience Australia

Industry, Tourism and Resources Portfolio

Minister for Industry, Tourism and Resources: The Hon. Ian Macfarlane, MP

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* Geoscience Australia grew out of the Bureau of Mineral Resources (BMR) and the Division of National Mapping, both of which were founded soon after World War 2. BMR became the Australian Geological Survey Organisation (AGSO) in 1992, several years after the Division of National Mapping had become the Australian Surveying and Land Information Group (AUSLIG). In 2001, AGSO and AUSLIG merged to become Geoscience Australia, the nation's geoscience research and information agency. Further information is available at www.ga.gov.au.

FRONT COVER: Ravensthorpe lateritic nickel project, Western Australia (BHP Billiton Ltd).

DESIGN AND LAYOUT: Lindy Gratton, Geospatial Applications and Visualisation (GAV), Geoscience Australia.

Foreword

Geoscience Australia provides important information on Australia's future capacity to produce mineral resources. *Australia's Identified Mineral Resources* is an annual nation-wide assessment of Australia's ore reserves and mineral resources, which takes a long term view of what is potentially economic. Data on mining company estimates of ore reserves (JORC Code), which are generally based on short- to medium-term commercial considerations, are included for comparison. The assessment also includes evaluations of long-term trends in mineral resources, international rankings, summaries of significant exploration results, brief reviews of mining industry developments, and an analysis of mineral exploration expenditure across Australia. Comparable information on petroleum resources is published in another Geoscience Australia publication: *Oil and Gas Resources of Australia*.

Australia's Identified Mineral Resources provides technical information on mineral and energy resources, which is used in formulating Australian Government policies and reproduced by the Australian Bureau of Statistics. It also provides government, industry, the investment sector and general community with an informed understanding of Australia's known mineral endowment and levels of exploration activity.

Australia's resource stocks remain healthy overall, although there has been a levelling off of resource trends for several major commodities. Reflecting strong world demand for mineral resources, expansions in mine production of coking coal, iron ore, uranium and other commodities continued in 2005 and the mineral resources sector overall contributed substantively to Australia's prosperity—economically, environmentally and socially. In 2004–05, over 40% of Australia's total exports came from the mineral resources sector and in 2005–06 the value of mineral and energy exports is estimated to be close to \$92 billion.

Although Australia's mineral exploration expenditure continued to recover from the 2001–02 low, it did so in the face of strong international competition. However, that competition has resulted in Australia's share of world non-ferrous mineral exploration budgets falling again.

Australia's Identified Mineral Resources provides fundamental data in support of this work and industry exploration programs. Much of the data can be accessed in a spatial context through the online *Atlas of Australia's Mineral Resources, Mines and Processing Centres*, developed by Geoscience Australia with support from the Minerals Council of Australia and Department of Industry, Tourism and Resources, through the Government's Regional Minerals Program. The atlas, at www.australianminesatlas.gov.au, has a web-based GIS (geographic information system) format and shows the location of mineral and energy resources, mines and production/processing centres.



Neil Williams
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Summary

Australia's economic demonstrated resources (EDR) of the following mineral commodities increased during 2005—bauxite, cobalt, diamond (gem and industrial), iron ore, manganese, nickel, rutile, silver, uranium, zinc and zircon. EDR of black coal, copper, gold and tantalum decreased in the same period. EDR for brown coal, magnesite, molybdenum, niobium, platinum group metals, shale oil, and vanadium remained at levels similar to those reported in 2005.

Increases in EDR were due to on-going drilling and evaluation of known deposits resulting in the transfer (re-assessment) of resources from inferred or sub-economic categories into EDR, and discoveries of new deposits or extensions of known deposits. A few mining companies re-estimated ore reserves and mineral resources more conservatively, notably in regard to black coal, to comply with the requirements of the *Australasian Code for Reporting of Mineral Resources and Ore Reserves* (JORC Code).

World ranking: Australia's EDR of zinc, lead, nickel, mineral sands (rutile and zircon), tantalum, uranium and brown coal remain the world's largest, while bauxite, black coal, copper, gold, iron ore, ilmenite, lithium, manganese ore, niobium, silver and industrial diamond rank in the top six worldwide.

Accessible economic demonstrated resources (AEDR): A relatively small number of mineral deposits are inaccessible for mining because of government policies or environmental and land access restrictions that prevent mining. In particular, this is the case for some mineral sands and uranium deposits.

Resources and current rates of mine production: Ratios of AEDR to current mine production provide rough estimates for the resource life. AEDR of most major commodities can sustain current rates of mine production for many decades. While this is the longer term assessment, resource life based on ore reserves is shorter in duration reflecting a shorter term commercial outlook.

Based on EDR, the resource lives for gold (an average of 20 years at current rates of production), lead (just over 30 years) and zinc (around 30 years) are amongst the lowest. These assessments continue to highlight the need for ongoing successful exploration in the short and medium terms to sustain production of these commodities at current levels.

Mineral exploration: Mineral exploration expenditures in Australia rose by 7.4% to \$1028.3 million in 2004–05, the highest financial year current dollar spending since 1997–98.

Although gold continued to dominate expenditure at \$391.7 million, this was \$6.4 million less than in 2003–04. Strong growth in exploration was recorded for all other commodity groups except diamond where a reduction of 8% saw spending fall to \$23.7 million. Very strong growth was recorded in spending on exploration for uranium, which increased by 97% to \$20.7 million, iron ore by 83% to \$116.4 million, base metals by 72% to \$261.1 million and coal, which rose by 55.6% to \$126.8 million. Mineral sands exploration spending recovered after the fall recorded in 2003–04 with a 16% increase to \$27.6 million.

The increase in exploration activity saw a strong growth in the number of reported intersections of mineralisation and several new discoveries. In response to world demand there was substantial activity in the iron ore sector, with new resources and drilling results released for many smaller deposits and prospects that had previously been too small to be of commercial interest.

Growth in the Chinese economy and its demand for mineral resources, particularly base metals, iron ore and coal continue to play an important role in the outlook for exploration in Australia.

Overall, the outlook for exploration is sound and improvements in levels of exploration can be expected unless there is a sharp reversal of the expected economic performance of key countries or metal prices collapse.

Introduction

Geoscience Australia (and its predecessors) has prepared annual assessments of Australia's mineral resources since 1975. The resource data and related information from *Australia's Identified Mineral Resources* are used by the Australian Bureau of Statistics (ABS) and provide input into Government policy decisions relating to the minerals sector, sustainable development of resources and financial allocations. Other Australian Government departments and agencies that utilised the data in this context during 2006 included the Department of Industry, Tourism and Resources, Department of the Environment and Heritage, the Productivity Commission and the Commonwealth Grants Commission.

In *Australia's Identified Mineral Resources 2006*, estimates of Australia's mineral resources of all major and several minor mineral commodities are reported for 2005 (Table 1). The estimates are based on published and unpublished data available to Geoscience Australia up to the end of December 2005. These resource estimates are compared with national totals of ore reserves for these commodities, as collated by Geoscience Australia from company reports. Mine production data are based on ABARE figures. World ranking of Australia's mineral resources have been calculated mainly from information in publications of the United States Geological Survey (USGS). A summary of significant industry developments is also presented.

Australia's Identified Mineral Resources 2006 provides information and analysis on mineral exploration expenditures in Australia for 2004–05 and calendar year 2005. Trends in expenditure since 1970 and the early 1990s are presented and discussed.

National Resource Classification Scheme

The mineral resource classification scheme used for Australia's national inventory is based on two general criteria: i) the geological certainty of existence of the mineral resource, and ii) the economic feasibility of its extraction over the long term (see Appendix 2 'National classification system for identified mineral resources'). The classification category, Economic Demonstrated Resources, is used instead of 'reserves' for national totals of economic resources. This is because the term 'reserves' has a specific meaning for individual mineral deposits under the criteria of the *Australasian Code for Reporting of Mineral Resources and Ore Reserves* (known as the JORC Code) used by industry for reporting ore reserves and mineral resources.

Economic Demonstrated Resources (EDR) are defined as the sum of measured and/or indicated resources (as defined in Appendix 2), which at the time of determination, profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty (refer Guideline (iii) in Appendix 2). EDR provide a basis for meaningful comparisons of Australia's economic resources with those of other nations. Ore is generally mined from resources in the EDR category. Long-term trends in EDR for bauxite, black coal, iron ore, gold, copper, nickel, lead, zinc, mineral sands and uranium are presented and the reasons for significant changes in resource trends are noted.

Accessible Resources

Geoscience Australia also assesses the amount of resources within EDR that are currently accessible for development and mining. Some mineral deposits are currently inaccessible for mining because of Government policies, or various environmental and land-access restrictions that prevent mining such as: location within National/State parks and conservation zones or military training areas, environmental protection issues and absence of permission from traditional owners. Accessible economic demonstrated resources (AEDR), as shown in Table 1, represent the resources within the EDR category that are currently accessible for mining. It should be noted that the factors which restrict access for mining could change or be abolished in future years.

Resource Life

The national total ore reserves (OR) figures shown in Table 1 are from estimates prepared by companies for mine planning and marketing purposes; they generally have a shorter term outlook than EDR. EDR/production, AEDR/production and OR/production ratios provide information on the resource life of Australia's mineral commodities based on production rates at the time of assessment. Each of these has deficiencies as an indicator of resource life: OR/production is a more conservative (and for some commodities very much more conservative) indicator of resource life than EDR/production. The ratios can change quite rapidly, for example as a result of major changes in production rates, changes in metal prices, and other factors.

Notes for Table 1

Abbreviations: t = tonne; m³ = cubic metre; L = litre; kt = 10³t; Mc = 10⁶ carat; Mt = 10⁶t; Gt = 10⁹t; GL = 10⁹L.

- | | |
|---|--|
| <ul style="list-style-type: none"> a) Total inferred resources in economic, sub-economic and undifferentiated categories. b) Accessible EDR (AEDR) is the portion of total EDR that is accessible for mining. AEDR does not include resources which are inaccessible for mining because of environmental restrictions, government policies or military lands. c) Joint Ore Reserves Committee (JORC) Proven and Probable Ore Reserves as stated in company annual reports and reports to Australian Stock Exchange. d) Sources: Australian Bureau of Agricultural and Resource Economics (ABARE). e) Sources: Geoscience Australia for Australian figures, USGS Mineral Commodities Summaries for other countries. f) World mine production for 2005, mostly USGS estimates. g) Includes chrysotile production. h) Black and brown coal reserves include both JORC reserves and Geoscience Australia estimated reserves for operating mines that do not publish JORC reserves. i) Raw coal. j) Geoscience Australia estimate. | <ul style="list-style-type: none"> k) Saleable coal. l) Excludes Morocco and USA. m) Excludes USA. n) Not reported by mining companies. o) Source: WMC Resources Ltd 2004 Annual Report (di-ammonium phosphate 647 862 t; mono-ammonium phosphate 236 059 t). p) Source: Phosphate Resources Ltd Annual Report 2005 (678 820 dry tonnes of rock shipped; 78 193 dry tonnes of dust shipped). q) Latest production figure is 358 t for 2003 from USGS Mineral Commodities Summaries 2004. r) Source: WEC Survey of Energy Resources for 1999. s) Latest production figure is 0.47 GL from the WEC Survey of Energy Resources for end 2002. t) Tantalum production from company data. u) Source: OECD/NEA & IAEA (2006). Compiled from the most recent data for resources recoverable at <US\$40/kg U. Data for USA is not available for this category. v) Source: NUKEM Market Report, May 2006. * Denotes a commodity for which last year's figures are reported (i.e. as at 31 Dec 2004). Otherwise, figures are as at 31 Dec 2005. |
|---|--|

TABLE 1. Australia's resources of major minerals and world figures as at 31 December 2005.

COMMODITY	UNITS	AUSTRALIA						WORLD		
		Demonstrated Resources			Inferred Resources (a)	Accessible EDR (AEDR) (b)	JORC Reserves(c) (% of AEDR)	Mine Production(d) 2005	Economic Demonstrated Resources(e)	Mine Production(f) 2005
		Economic (EDR)	Subeconomic							
	Para-marginal		Sub-marginal							
Antimony	kt Sb	93	31	53	52	93	58 (62%)	–	1800	117
Asbestos(*) Chrysotile ore Crocidolite fibre	kt	–	46.2	–	75	–	–	–	large	2.3(g)
	kt	–	0.4	–	2	–	–	–	large	
Bauxite	Gt	5.8	0.7	1.4	1.1	5.4	1.9 (30%)	0.06	25	0.165(e)
Black coal in situ recoverable	Gt	55.8	5	12.4	90.9					
	Gt	39.2	2.7	8.2	57	39.1	11.8(h) (30%)	0.398(i)	739(j)	4.5(j)(k)
Brown coal in situ recoverable	Gt	41.5	43.4	18.1	112					
	Gt	37.4	39	16.3	100.8	30	2.6(h) (9%)	0.067(j)	155(j)	0.84(j)
Cadmium	kt Cd	62.9	9.6	18.6	1	62.9	53 (84%)	0.46	583	18
Cobalt	kt Co	1430	188	109	1575	1430	477 (33%)	4.11	6965	50
Copper	Mt Cu	41.4	4.8	1.2	30.4	41.4	20.7 (50%)	0.921	490	14.9
Diamond gem & near gem industrial	Mc	124.2	104.3	0.2	12.7	124.2	122.5 (99%)	15	–	101
	Mc	129.2	108.6	0.3	13.2	129.2	127.5 (99%)	15.6	614	74
Fluorine(*)	Mt F	–	0.2	23.7	21.3	–	–	–	112(l)	2.4
Gold	t Au	5225	1315	118	4403	5173	3343 (64%)	263	42 225	2457
Iron ore	Gt	16.4	0.2	1.8	18.8	16.4	6.9 (42%)	0.262	160	1.5
Lead	Mt Pb	23.8	3.1	8.8	21.9	23.8	10.5 (44%)	0.767	75	3.28
Lithium	kt Li	170	54	26	7	170	145 (85%)	0.049	4100	21.3(m)
Magnesite	Mt MgCO ₃	344	22	35	931	344	37.5 (11%)	0.329	7629	14.9(m)
Manganese ore	Mt	143	23	167	155	143	120 (84%)	3.9	1200	27
Mineral sands Ilmenite Rutile Zircon	Mt	214.9	54.3	0.1	116	178.4	36.2 (17%)	2	1115	9.02
	Mt	20.5	13	0.1	29	14.8	3.41 (17%)	0.177	51	0.38(m)
	Mt	32.9	20.2	0.1	30	24.7	4.8 (15%)	0.43	77	1.08
Molybdenum(*)	kt Mo	0.4	6.3	3.7	441	0.4	0 (–)	–	8600	139
Nickel	Mt Ni	23.9	2.3	1.1	20.3	23.9	7 (29%)	0.189	64.1	1.5
Niobium	kt Nb	194	129	0	389	194	21 (11%)	(n)	4392	33.9
Phosphate rock	Mt	85	980	–	1 085	85	85 (100%)	0.884(o) 0.679(p)	18 000	148
PGM (Pt, Pd, Os, Ir, Ru, Rh)	t metal	19	152.9	5.4	68.1	15.1	0.3 (1.4%)	0.66	71 000	n/a(q)
Rare earths(*) (REO & Y ₂ O ₃)	Mt	0.5	2	12.2	12	0.1	0 (–)	–	89	0.1
Shale oil	GL	4.6	202	3719	41 425	4.6	4.6 (100%)	0	95 885(r)	n/a(s)
Silver	kt Ag	44	15.3	14.8	32.3	44	26.2 (60%)	2.407	283	20.5
Tantalum	kt Ta	52	32	0.2	69	52	40.3 (78%)	0.8(t)	55	1.5
Tin(*)	kt Sn	163	95	134	290	163	64 (39%)	2.813	6100	280
Tungsten(*)	kt W	4.6	31.8	27.7	56.7	4.6	2.5 (54%)	0	2900	76.5
Uranium	kt U	716	16	16	443	562	441 (78%)	9.512	1962(u)	41.87(v)
Vanadium	kt V	0	777	1810	2476	0	0 (–)	0	13 000	42.5
Zinc	Mt Zn	41.8	8.2	14.1	25	41.8	22 (53%)	1.367	228	10.1

Trends in Australia's Economic Demonstrated Resources of Major Mineral Commodities

The trends in EDR for Australia's major mineral commodities have undergone significant and sometimes dramatic changes over the period 1975–2005 (Figure 1). These changes for each commodity can be attributed to one, or a combination of the following factors:

- increases in resources resulting from discoveries of new deposits, and delineation of extensions of known deposits
- depletion due to mine production
- fluctuations in commodity prices and currency exchange rates which can move previously subeconomic resources into EDR
- advances in mining and metallurgical technologies, eg. carbon-based processing technologies for gold have enabled economic extraction of gold from low-grade deposits, which were previously uneconomic
- adoption of the resource classification scheme (JORC Code) by the Australian minerals industry and the subsequent impacts on re-estimation of ore reserves and mineral resources so as to comply with the requirements of the Code. In 1988, the Australian mineral industry adopted the *Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves* (JORC Code). Many companies first used this code for reporting their mineral resources in 1989. The requirements of the Code differed significantly from the resource classification schemes used by companies prior to 1989. This led to a re-estimation of mineral resources by many companies to comply with the Code, and some re-assessments of resource data for other deposits by the former Bureau of Mineral Resources. The impacts of the Code on EDR occurred at differing times for each of the major commodities.

Past trends and changes in EDR for a number of Australia's major mineral commodities are discussed below. It is notable that resources levels for major commodities like black coal, iron ore and base metals have plateaued.

Black Coal

A major re-assessment of NSW coal resources during 1986 by the NSW Department of Mineral Resources and the Joint Coal Board resulted in a large increase in black coal EDR as reported in 1987 (refer 'a' on Figure 1).

EDR for black coal has declined since 1998 due to the combined impacts of mining companies re-estimating ore reserves and mineral resources more conservatively so as to comply with requirements of the JORC Code, and increased rates of mine production.

Bauxite

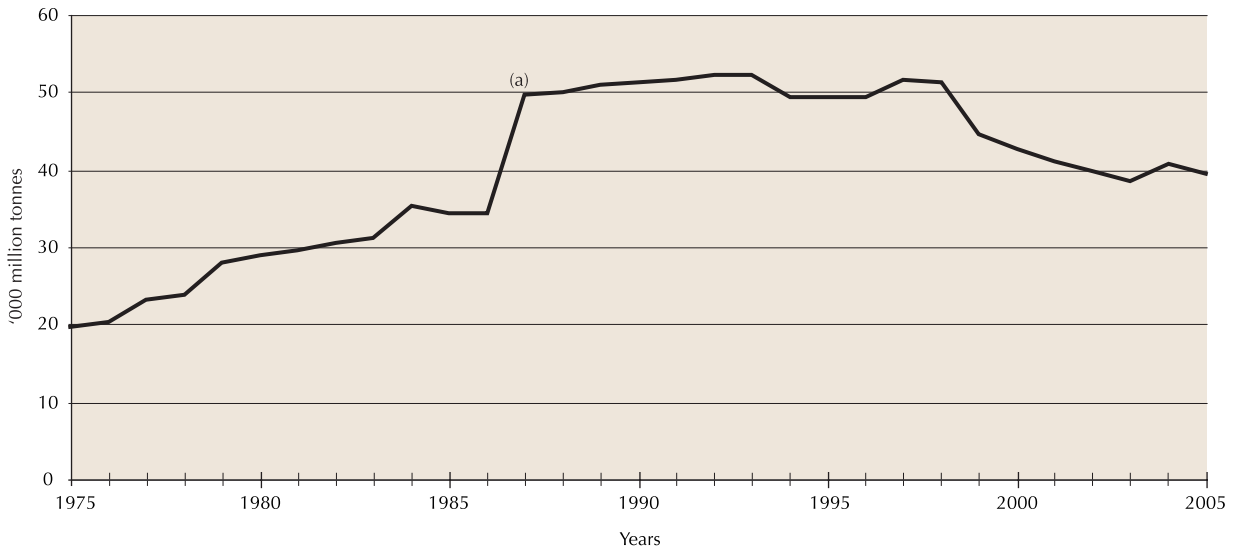
Increases in bauxite EDR in 1989 resulted from delineation of additional resources in deposits on Cape York Peninsula ('b' on Figure 1). Decreases in bauxite EDR in 1992 were due to re-classification of some resources within deposits on Cape York Peninsula so as to comply with requirements for the JORC Code ('c').

Iron Ore

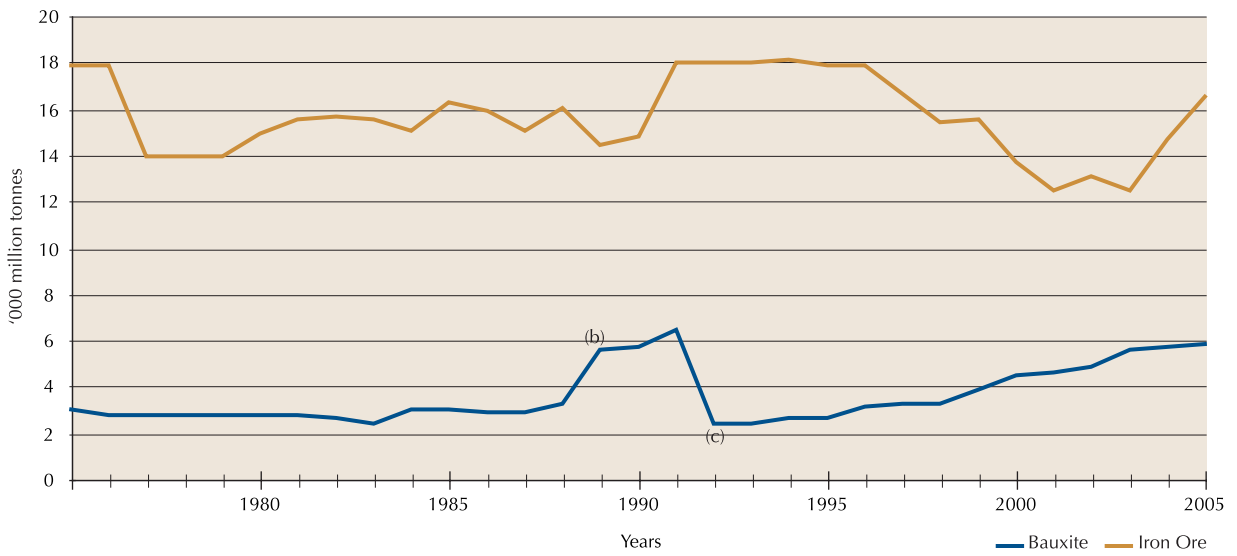
EDR for iron ore has declined since 1996 due to the combined impacts of mining companies re-estimating ore reserves and mineral resources more conservatively so as to comply with requirements of the JORC Code, and increased rates of mine production.

FIGURE 1: Trends in Economic Demonstrated Resources (EDR) for major commodities since 1975.

Black Coal (recoverable)



Bauxite, Iron Ore



Gold

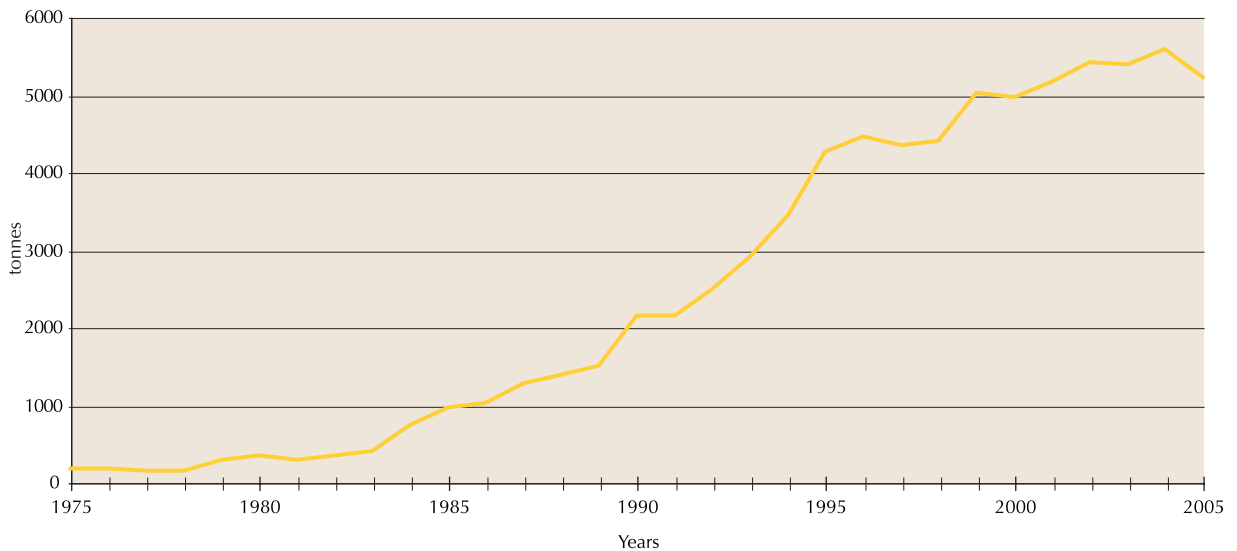
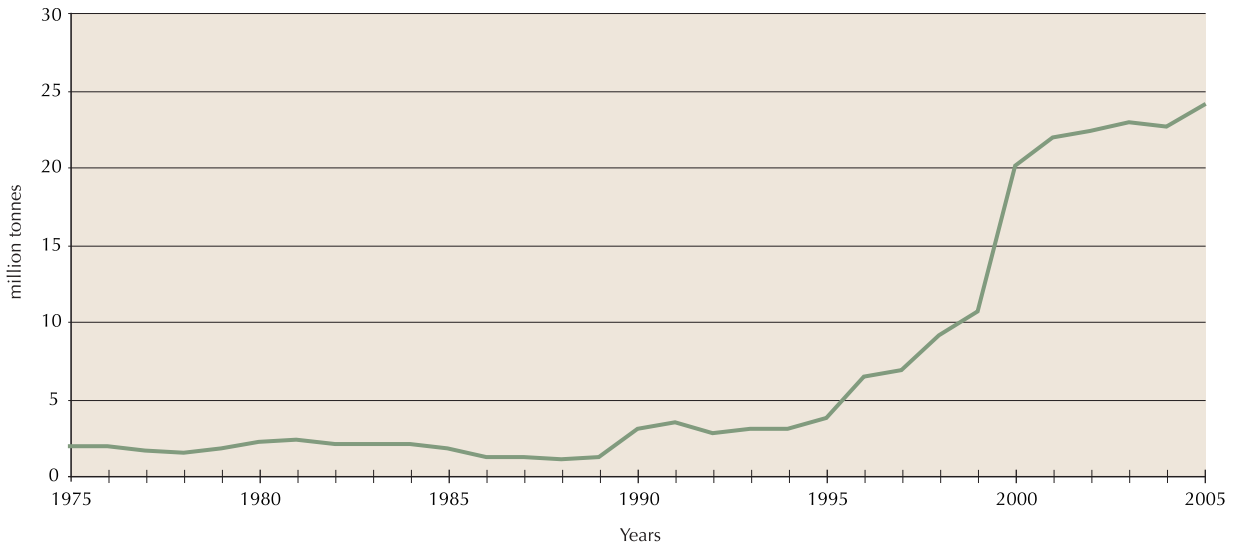
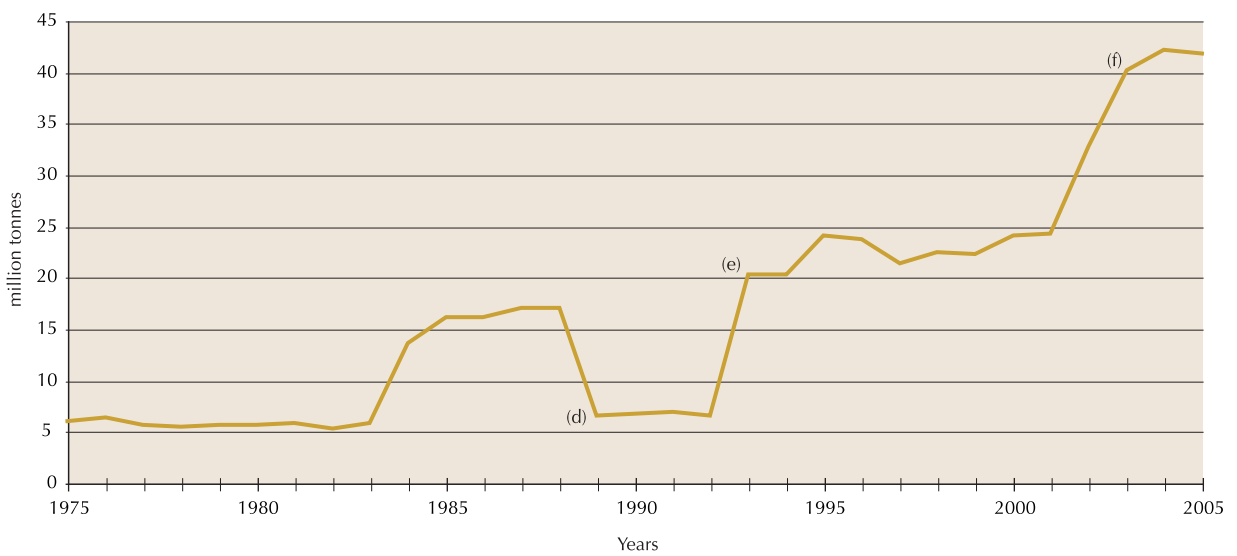


FIGURE 1: Trends in Economic Demonstrated Resources (EDR) for major commodities since 1975 (continued).

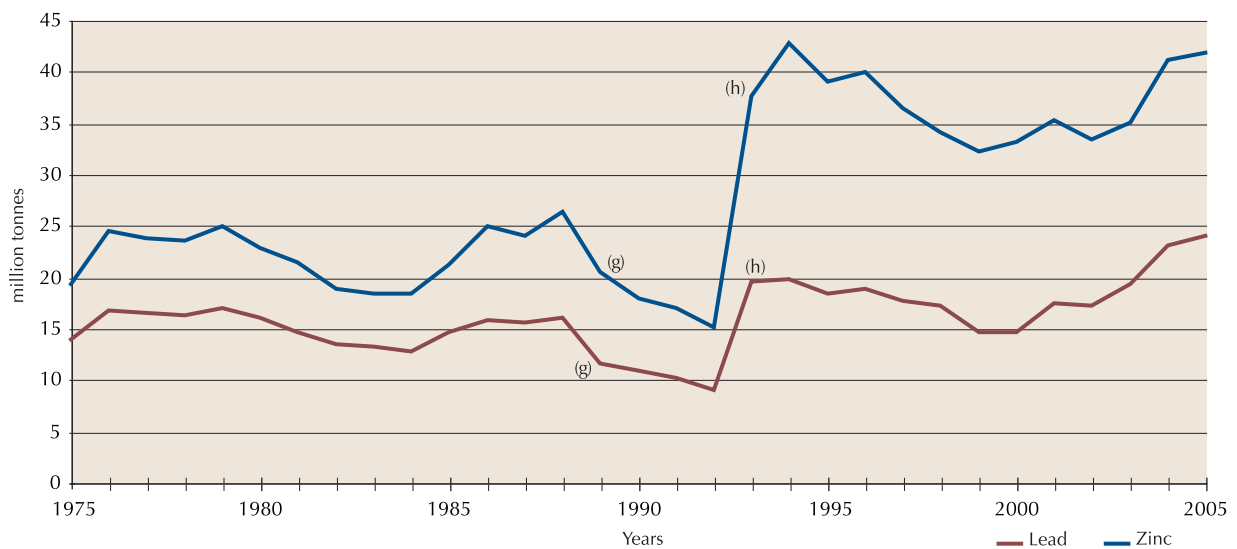
Nickel



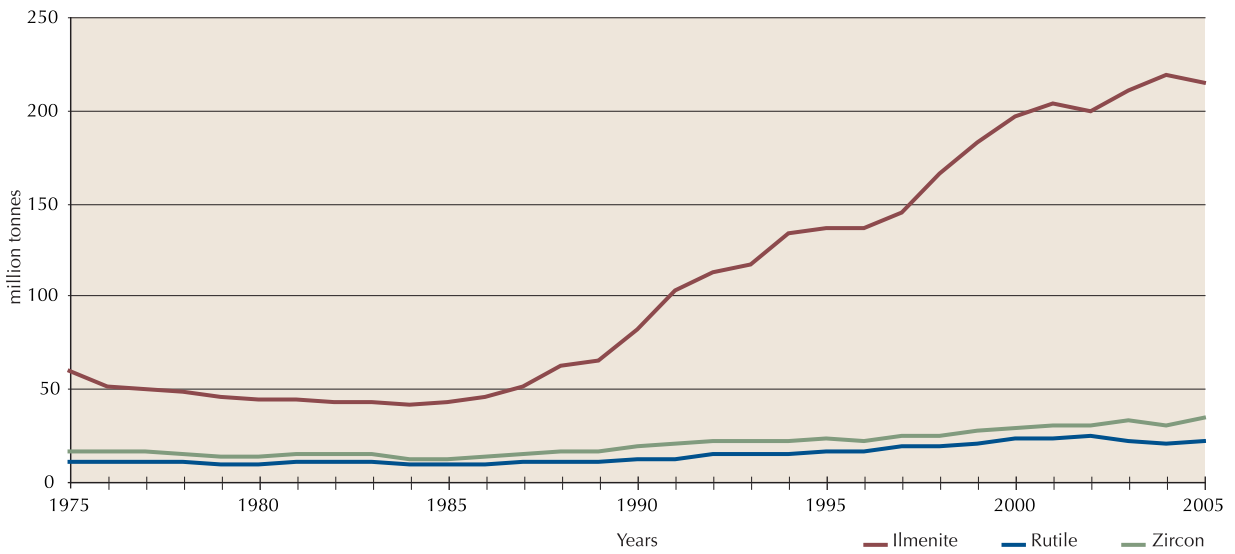
Copper



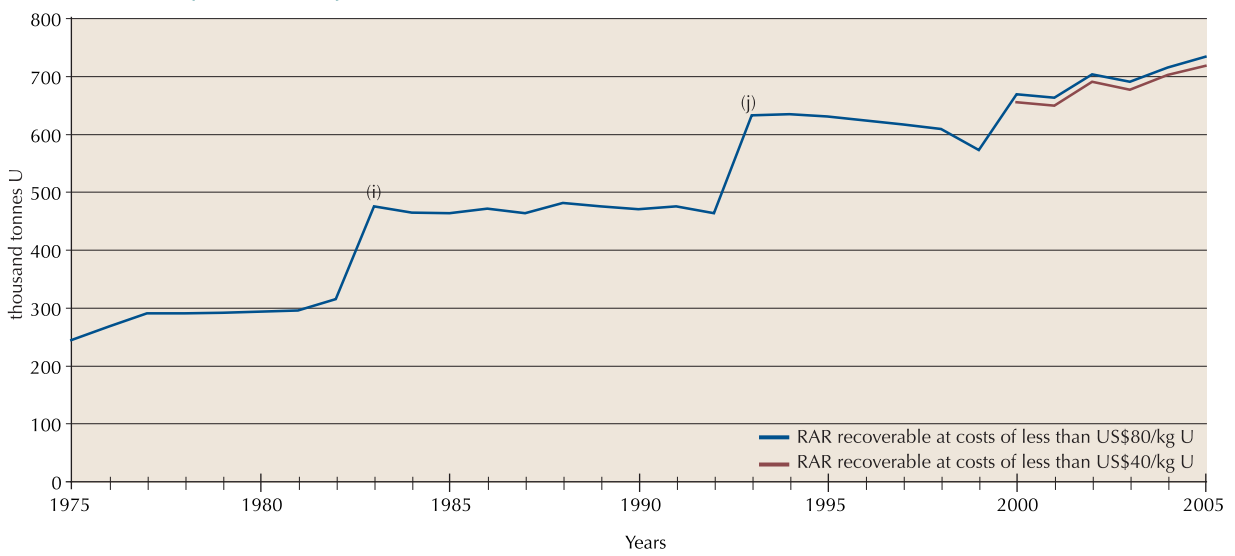
Lead, Zinc



Mineral Sands



Uranium (recoverable)



Gold

Gold EDR has increased steadily since 1975 with a clear increase in the rate of growth in the early 1980s. Much of the increase can be attributed to the successful introduction of the carbon-based processing technology which allowed the profitable processing of relatively low grade ore deposits. In addition, the higher than previous prevailing gold prices (denominated in US\$) supported high levels of exploration for gold to the extent where gold accounted for over half of the total mineral exploration expenditure in Australia for many years. Increased exploration contributed to the increases in EDR.

Nickel

The EDR for nickel increased during the period 1995 to 2001 by 18.2 Mt. This was mainly due to progressive increases in resources of **lateritic deposits** at Bulong, Cawse, Murrin Murrin, Mt Margaret, Ravensthorpe (all in WA), Marlborough (Qld), Syerston and Young (NSW). Australia's EDR of nickel doubled in 2000 (compared to the level at the end of 1999)—this dramatic increase was due to further large increases in resources at the Mt Margaret and Ravensthorpe deposits, and deposits in the Cawse Southern Province (WA). In addition, during the period 1995 to 2001 there were increases in resources of **sulphide deposits** at Yakabindie, and discoveries of the Silver Swan and Cosmos high-grade sulphide deposits (all in WA).

From 2001 onwards, the sharp rises in market prices for nickel led to increased expenditures on exploration and on evaluation drilling at many known deposits. This contributed to a further increase in total EDR of 0.9 Mt for sulphide deposits at Perseverance, Sally Malay, Maggie Hays, Emily Ann, Honeymoon Well and deposits in the Forresteria area (all in WA), Avebury (Tas.), and remnant resources at several sulphide deposits in the Kambalda region including Miitel and Wannaway deposits. During this period, WMC Resources sold several of its mines in the Kambalda region to various junior mining companies. These companies increased the resources at these mines and deposits by further drilling and re-assessments.

In recent years, EDR has remained at about the same level because increases in resources for some deposits have been offset by companies reclassifying their lateritic nickel resources to lower resource categories pending more detailed drilling and resource assessments.

Copper

Following the adoption of the JORC Code by the Australian mineral industry, many companies first used this code for reporting their copper resources in 1989. These companies re-estimated mineral resources in order to comply with the Code. This resulted in a sharp fall in Australia's copper EDR in 1989 ('d').

The sharp increase in copper EDR in 1993 was due mainly to an increase in company announced resources for Olympic Dam deposit (SA). Additional resources were also reported for Ernest Henry (Qld), North Parkes (NSW) and other smaller deposits ('e').

Re-assessments of copper resources by Geoscience Australia in 2002 and 2003 resulted in further transfers (reclassification) of Olympic Dam resources into EDR ('f').

Lead, Zinc

The adoption of the JORC Code in 1988 by the Australian mineral industry led to a re-estimation of mineral resources by many companies to align with the Code, and some re-assessments of resource data for other deposits by the former Bureau of Mineral Resources. This resulted in a sharp fall in Australia's lead and zinc EDR in 1989 ('g').

Increases in EDR for lead and zinc in 1993 were due to re-classification of Paramarginal Resources into EDR for McArthur River (NT) and Hilton deposits (Qld). Additional resources were also reported for Century and Cannington deposits (Qld) ('h').

Mineral Sands

Increases in EDR of **ilmenite** from 1996 to 2003 resulted from discovery and subsequent evaluation drilling of heavy mineral sands deposits in the Murray Basin—these deposits are in Victoria (Wemen and Woonack), NSW (Gingko and Snapper) and SA (Mindarie project). In addition, from 1998 onwards there were progressive increases in resources at mineral sands deposits in the North Swan Coastal Plain area north of Perth, and the Blackwood Plateau region (includes the Beenup deposit) in WA.

Uranium

The majority of Australia's uranium deposits were discovered between 1969 and 1975—approximately 50 deposits (15 with significant resource estimates) were discovered during this short period. Since 1975, only another four deposits have been discovered—of these, only one deposit (Kintyre in the Paterson Province of WA) has Reasonably Assured Resources recoverable at less than US\$40/kg U (equates with EDR). Hence, the progressive increases in Australia's EDR for uranium from 1975 to the present (as shown on Figure 1) were due to on-going delineation of resources at known deposits.

From 1983 onwards, the Olympic Dam deposit has been the major contributor to increases in Australia's EDR. The large increases shown on Figure 1 were due to the following:

- in 1983, initial resource estimates for Olympic Dam and Ranger No. 3 Orebody (NT) made by the former Australian Atomic Energy Commission (‘i’)
- in 1993, further increases in EDR for Olympic Dam (based on estimates reported by WMC Resources Ltd), and first assessment of resources for the Kintyre deposit by the former Bureau of Mineral Resources (‘j’)
- in 2000 and 2002, increases were due to continuing additions to the Olympic Dam resources.

COMMODITY REVIEWS



Ore conveyor from the underground Ridgeway gold-copper mine to treatment plant, New South Wales (Bill McKay, Geoscience Australia).

Bauxite

Bauxite is a heterogeneous naturally occurring material from which alumina (Al_2O_3) and aluminium (Al) are produced. The principal minerals in bauxite are gibbsite ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$), boehmite ($\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$) and diaspor, which has the same composition as boehmite but is denser and harder.

Over 85% of the bauxite mined globally is converted to alumina for the production of aluminium metal, an additional 10% goes to nonmetal uses in various forms of specialty alumina, and the remainder is for non-metallurgical bauxite applications. In nearly all commercial operations, alumina is extracted (refined) from bauxite by a wet chemical caustic leach process known as the Bayer process. Alumina is smelted using the Hall-Heroult process to produce aluminium metal by electrolytic reduction in a molten bath of natural or synthetic cryolite (NaAlF_6).

Australia's aluminium industry is a highly integrated sector of mining, refining, smelting and semi-fabrication centres and of major economic importance nationally and globally. The industry consists of five bauxite mines, seven alumina refineries, six primary aluminium smelters, twelve extrusion mills and two rolled product (sheet, plate and foil) mills. It directly employs over 12 000 people (indirectly many more) and is particularly important in regions such as North Queensland, the Hunter Valley, Southwest Victoria, Southwest Western Australia, the Northern Territory and North Tasmania. The industry is geared to serve world demand for alumina and aluminium with over 80% of production being exported. Figures on the value of industry exports are collated half-yearly by the Australian Bureau of Statistics and the Australian Aluminium Council compiles data on bauxite, alumina and aluminium exports, which it updates on a monthly basis.

Resources

Vast resources of bauxite, located in the Weipa and Gove regions adjacent to the Gulf of Carpentaria and in the Darling Ranges south of Perth, underpin the long-term future of Australia's aluminium industry. Deposits in these regions rank among the world's largest identified resources in terms of extractable alumina content. Bauxite deposits at Mitchell Plateau and Cape Bougainville in the north of Western Australia are uneconomic to develop but are a significant potentially viable future resource.

EDR of 5.8 Gt in 2005 represents an increase of less than 2% compared to the previous year. This resulted from a net effect of new drilling adding to mineral resources and offsetting depletion through production. Subeconomic demonstrated resources increased by 0.1 Gt following an upgrade of some inferred resources in Western Australia. Inferred resources remain unchanged from the previous year.

Accessible EDR

Less than 5% of bauxite EDR is inaccessible for mining. This represents small areas of the Darling range (WA), within mining leases, where for environmental reasons bauxite is not available for extraction. The ratio of AEDR to current mine production shows the resource life for existing bauxite operations is on average around 70 to 75 years. The potential of unexplored regions, however, is likely to extend resource life well beyond this.

JORC Reserves

Approximately 30% of AEDR comprises JORC Code ore reserves as reported by industry. The remaining represents resources assessed by Geoscience Australia as being economically recoverable from *measured and indicated* categories of *mineral resources*, as defined under the Code and other classification systems used by non-listed ASX companies. The surface expression of bauxite and confidence in lateral continuity of thickness and grade make it possible in certain terrains to classify some *inferred resources* as EDR.

Exploration

Data relating to exploration for bauxite specifically are not available nationally.



Bauxite mining at the Huntly mine, Western Australia (Alumina Ltd).

Production

Globally in 2005, Australia was the leading producer of bauxite and alumina, and aluminium metal production was the highest recorded level. Production totalled 60.0 Mt of bauxite, 17.7 Mt of alumina and 1.9 Mt of aluminium (ingot metal).

In January 2006 Comalco, Rio Tinto's wholly owned integrated aluminium subsidiary, announced that 2005 was a record year for bauxite production at its Weipa operation. The site produced 15.5 million dry product tonnes (Mdpt), exceeding the previous record of 12.7 Mdpt in 2004. New infrastructure completed at the Andoom mine as part of the \$230 million Project NeWeipa mine expansion led to the increased production.

World Resources

Based on USGS data for other countries, Australia's demonstrated bauxite resources of 7.8 Gt rank second in the world after of Guinea and ahead of Brazil, Jamaica and China.

Industry Developments

With ability to process bauxite at both Andoom and Lorim Point, Comalco now operates two mines simultaneously at Andoom and East Weipa. To service the mining operation and surrounding communities a new 26 megawatt power station was completed during the period. To ensure reliability of bauxite supply to customers, expenditure of US\$60 million was committed to the construction of a second shiploader and US\$19 million expended on additional tailings storage for the Andoom mine.

Alcan has significant reserves of bauxite within its Ely/Ducie-Wenlock lease located approximately 25 km north of Weipa. Under an agreement with Comalco, the Ely deposit will be integrated into Comalco's overall mining plans, with mining forecast to start about 2010. A drilling program to further evaluate the Ducie-Wenlock deposit, which is contained within the same mining lease as Ely, commenced in 2004.



Bulk alumina loading facility in Kwinana, Western Australia (Alumina Ltd).

Alcan is progressing with its US\$1.3 billion expansion of its Gove alumina refinery in the Northern Territory. The project is scheduled to be completed by 2007 and will lift the refinery's capacity from 2.1 to around 3.8 Mtpa,

In late 2005, the Queensland Government's call for expressions of interest in the Aurukun Bauxite Project attracted ten applications to submit provisional proposals. In March 2006, the Government announced the proposal from the Chinese Aluminium Company (CHALCO) had been short-listed. Under the next phase of the process, CHALCO has been invited to submit a final proposal to conclude a development agreement with the State government. The objectives for development of the Aurukun resource include its development as a source of bauxite for a new alumina refinery in Queensland.

In Western Australia, Alcoa's Pinjarra refinery is aiming to improve its greenhouse intensity by around 12% through a \$440 million refinery upgrade and the construction of two cogeneration power units, which will produce power for the State's electricity market and provide waste heat for the Pinjarra refinery. In January 2006, the Environment Protection Authority provided advice and recommendations to the Minister for the Environment on the project. This includes a set of conditions that need to be met for the proposal to proceed. Following release of the advice, Alcoa announced it was confident it could meet the conditions recommended by the EPA and that early Government approval of the project would allow it to move into the detailed engineering phase and focus on a viable execution strategy.

At Western Australia's other integrated bauxite mining and alumina refining operation, the Worsley joint venture committed to a series of development capital projects designed to take advantage of latent capacity in plant through a series of 28 packages of work estimated to cost US\$192 million. The result will be an increase in alumina production of 250 000 tonnes per annum to a capacity of 3.5 Mtpa. Commissioning and completion of the projects is expected in by the first quarter of 2006 with the resulting production ramp-up to be achieved by around mid-year.

Black Coal

Coal is a combustible sedimentary organic rock that is formed from vegetation which has been consolidated and altered by the combined effects of heat and pressure over millions of years. High rank black coals are generally harder, stronger, contain more carbon, have lower moisture content and produce more energy than lower rank brown coals. Black coals are used mainly in the generation of electricity, steelmaking and cement manufacturing. Other uses include food processing, organic chemical manufacturing and liquefaction.

In Australia the black coal industry is dominated by mining operations in New South Wales and Queensland and in particular mines in the Sydney and Bowen Basins. Locally important mines are at Collie (WA), Leigh Creek (SA) and in the Fingal Valley (Tas).

Resources

In-situ EDR for 2005 decreased 2.8% to 55.8 Gt and recoverable EDR decreased 3.0% to 39.2 Gt. The decrease was mainly due to the reduction and reclassification of resources at the Illawarra and Bowen Basin deposits of BHP Billiton and also at the Hunter Valley Complex of Coal and Allied. This was partially offset by the new resources at Moolarben and the reclassification of resources at Ulan. Queensland (55.0%) and New South Wales (40.8%) had the largest share of recoverable EDR in Australia.

In-situ and recoverable paramarginal demonstrated resources (PDR) were relatively unchanged. In-situ and recoverable subeconomic demonstrated resources (SDR) decreased slightly mainly due to reclassification of resources at Ulan and reductions at BHP Billiton's Illawarra coal deposits. In-situ and recoverable inferred resources increased to 90.9 Gt (up 6.3%) and 57.0 Gt (up 8.2%) respectively, mainly as a result of reclassification of resources at BHP Billiton's Illawarra and Bowen Basin deposits, Coal and Allied's Hunter Valley Complex and increases at Belvedere (Moura West) and Olive Downs and the new Moolarben deposit.

Accessible EDR

Nearly all black coal EDR is accessible with only a relatively small tonnage at Hill River (WA) being quarantined within State Reserves. The resource life of Accessible EDR of 39.1 Gt is about 100 years at current rates of production.

JORC Reserves

JORC reserves are 11.8 Gt or 30% of Accessible EDR. Included in this figure are Geoscience Australia estimates of reserves at some operating mines that had no reported JORC reserves. This constituted 2.4 Gt or about 20% of Accessible EDR. BHP Billiton, Rio Tinto, Xstrata Coal and Anglo Coal manage about 70% of JORC reserves in Australia. The resource life of the JORC reserves of 11.8 Gt is 30 years at current production.

Exploration

Data published by ABS show that exploration expenditure on coal for 2005 totalled \$145.6 million, a significant increase from \$96.9 million in 2004. Expenditure in Queensland was \$86.5 million (59% of the total) and \$43.7 million in New South Wales (30% of the total). Exploration also occurred in South Australia, Western Australia and Victoria.

Production

In 2005 Australia produced 397 Mt of raw coal (375.2 Mt in 2004) which yielded 303 Mt of saleable coal (298.0 Mt in 2004). Exports of black coal during 2005 involved 124.9 of coking coal valued at \$14.9 billion and 107.7 Mt of steaming coal valued at \$6.9 billion. Australia's saleable production of black coal is projected by ABARE to grow to 367 Mt by 2010–11.

World Ranking

Australia has 5% of the world's recoverable black coal EDR and ranks sixth behind USA (28%), Russia (20%), China (12%), India (12%) and South Africa (7%). It produced about 7% of the world's black coal in 2005 and ranked fourth after China (37%), USA (20%) and India (8%).

INDUSTRY DEVELOPMENTS— QUEENSLAND

Rio Tinto Coal Australia (formerly Pacific Coal): A public Environmental Impact Statement was completed for the proposed \$440 million Clermont project. The open-cut is planned to produce up to 15 Mtpa of thermal coal for export. Construction is expected to commence in mid-2006 with coal production to commence in 2009 when operations at the Blair Athol mine cease. At Hail Creek a \$300 million expansion from 5.5 to 8 Mtpa is scheduled to be completed by mid-2006 with the introduction of a second dragline.

BHP Billiton Mitsubishi Alliance (BMA):

The Broadmeadow punch longwall project at Goonyella commenced operations in August 2005. At full capacity the \$102 million mine will produce up to 3.6 Mtpa of high quality coking coal. BMA is investigating adding a second underground longwall mine at Goonyella under the same footprint as the Broadmeadow longwall. In mid-2005 the Goonyella open-cut mine took delivery of Australia's first fleet of Caterpillar 797 350 tonne payload trucks. Leighton Mining secured a \$180 million contract at Peak Downs and Saraji, requiring the prestripping of 68 million bank cubic metres over 21 months. The development of the Norwich Park East Pit will increase production from 4.6 to 5.7 Mtpa by late 2006 and also extend the mine's life.

BHP Mitsui Coal Pty Ltd: In 2005 Excel Coal and BHP Billiton/Mitsui entered into an agreement to share infrastructure between Excel's Millenium mine and the Poitrel mine (the Red Mountain Joint Venture). The 3 Mtpa Poitrel open-cut coking coal mine is expected to be in production in 2006. Mining at the Riverside mine ceased during 2005.

Xstrata Coal: Construction of the Rolleston thermal coal mine was completed in mid-2005. The low strip ratio mine is expected to produce up to 6 Mt in 2006 and to reach 8 Mtpa thereafter. Phase 2 involves a 50% expansion to 12 Mtpa with the addition of another dragline. The mine is expected to have a life of 20 years. Xstrata Coal has approved the installation of a second longwall at Oaky Creek No 1 mine which will increase output from 4.5 to 6.5 Mtpa of coking coal. The equipment will come from the Cumnock mine in New South Wales. The new \$20 million 1.5 Mtpa Wollombi open-cut coking coal mine near Newlands is scheduled to commence production in 2006. The Southern Underground Mine at Newlands ceased in September 2005. The \$25 million Northern punch longwall mine will be operational in early 2006. Xstrata is assessing the potential for longwall mining at the Cook Colliery by trialing a 1.3 Mtpa operation. Xstrata Coal and Tarong Energy are investigating the feasibility of a 1000 MW coal fired power station at Pentland near Townsville. Project approvals would take about two years followed by a three year construction period. A 2.0 Mtpa open-cut mine is proposed for the Togara North deposit which is 12 km from the new Rolleston rail line.



Coal extraction at the Hail Creek mine, Queensland (Rio Tinto Coal Australia Pty Ltd).



Overburden removal at the Rolleston mine, Queensland (Xstrata Coal Australia Pty Ltd).

Anglo Coal: The Dawson mine is upgrading coal handling and preparation capability from 7 to 12 Mtpa. The upgrade is scheduled to be completed in May 2007. Construction of the Lake Lindsay open-cut coking coal began in 2005 and is due to commence production in late 2006. The coal will be processed at the German Creek complex where output will rise from 6 to 10 Mtpa. The mine life at German Creek will be extended by 11 years to 2027. A place change bord and pillar operation commenced in late 2005 in the Aquila seam at German Creek. Production capacity is expected to be raised from 0.5 Mtpa to a minimum 0.75 Mtpa. Mine entry is off the highwall of the old German Creek open-cut mine and is above the Southern Colliery. The \$49 million Bundoora project at German Creek will be a longwall coking coal mine in the German Creek Seam that is expected to start in 2006. Construction at the \$250 million Grasstrees underground longwall mine commenced in 2001 and is due to be commissioned in 2006 at a capacity of 5 Mtpa. The Grasstrees mine is designed to replace production from the Southern Colliery at the German Creek project.

Macarthur Coal: The proposed \$1.0 billion Queensland Coke and Energy project located near the Stanwell Power Station is expected to commence operation in mid-2008, with an initial capacity of 1.6 Mtpa and scope to be increased to 3.2 Mtpa. At maximum capacity the plant will consume about 5.0 Mtpa of coking coal while heat generated from the coke making process will produce up to 370 MW of electricity. In April 2005 the Commonwealth Government granted the project Major Project Facilitation status. The Monto thermal coal project has a revised development plan involving an extensive exploration program and a major feasibility study for a mine of up to 10 Mtpa. This program is likely to take two to three years to complete and include a trial pit. A mining lease application for the 1.0 Mtpa Olive Downs open-cut mine was lodged in November 2005 and development is expected to commence in late 2006. Macarthur plans to spend \$250 million over the next five years developing five new mines by 2010.

Peabody Energy: The 0.6 Mtpa Baralaba open-cut mine commenced in July 2005 and produces PCI and thermal coals.

Wesfarmers: Mining commenced at the Curragh North mine in the first half of 2005. Production is planned to increase from 6.5 to 9 Mtpa in 2006 and mine life to extend from 2016 to 2025. Curragh North is to be connected to the Curragh wash plant by a 22 km overland conveyor.

Felix Resources: The Minerva open-cut coal mine commenced production in July 2005 and should reach full production of 2.5 Mtpa by early 2006. The mine produces a PCI and thermal coal product and has an expected life of 11 years.

Excel Coal: Overburden removal at the Millennium open-cut coking coal mine commenced in October 2005. The initial capacity will be 1.5 Mtpa with plans to raise production to 3 Mtpa when infrastructure constraints ease. The rail loop was commissioned in late 2005 and the wash plant is expected to be commissioned in early 2006.

Tarong Energy: Tarong are considering developing a \$500 million mine at the Glen Wilga deposit in the Surat Basin. The proposal involves supplying 7 to 10 Mtpa to the Tarong Power Station via a 150 km rail link. The mine and wash plant are estimated to cost \$150 to \$200 million and the rail link \$300 million.

Bowen Basin Coal Pty Ltd: The proposed Vermont open-cut mine (about 15 km northeast of Dysart) is planned to produce 4.0 Mtpa of coking and PCI coal. A mining lease was granted in October 2005 and development is contingent on securing allocations of rail transport and port capacity.

Ensham Resources: Undertaking a feasibility study to increase the current output of 9 Mtpa to up to 20 Mtpa by establishing a new longwall mining operation of up to 7 Mtpa and expanding the open-cut operation by 4.0 Mtpa. Ensham is also considering multi-seam mining to reduce strip ratios and to undertake highwall mining to extract coal that is currently sterilised.

Eastern Corporation: Mitsui Coal Holdings proceeded with a joint venture feasibility study of the Broughton open-cut coking coal project which is due for completion in June 2006. Mitsui has acquired an initial 10% interest and has the right to acquire another 20% interest in the project.

American Metals and Coal International: AMCI plan to develop a 4 Mtpa underground coking/PCI underground mine at Carborough Downs commencing in 2006. The Broadlea project north of Carborough Downs is also planned to commence in 2006 at a rate of 1.0 Mtpa. This open-cut hard coking coal mine would use the Carborough Downs coal handling and preparation plant.

Aquila Resources: At the Belvedere hard coking coal deposit near Moura, Aquila is planning a staged development of three longwall mines producing up to 12 Mtpa over a 40 year mine life. The Brazilian company Companhia Vale do Rio Doce (CVRD) has an option to acquire an initial 51% interest in the Belvedere project after CVRD undertakes an Exploration Study. At the Isaac Plains coking and thermal coal project, Aquila and AMCI are expecting the mine to be operating at 1.0 Mtpa by mid-2006 rising to 2.0 Mtpa thereafter. The processing plant will have the capacity to treat a further 1.6 Mtpa from the Isaac Plains South project.

New Hope Corporation: New Hope is planning to increase production at New Acland from 2.4 to 3.75 Mtpa in 2007 and has commenced preliminary planning of a Stage 3 expansion. New Hope is also taking advantage of high coal prices to reopen some mines around Ipswich.

QCoal: The Sonoma open-cut mine located about 6 km south of Collinsville will initially produce 2.0 Mtpa from late 2006. Coking and thermal coal will be railed about 105 km to the Abbott Point Coal Terminal for export.

CSEnergy: The 2.8 Mtpa open-cut mine near the Kogan Creek power station is due to commence operations in early 2007 to provide coal for commissioning purposes. Commercial operation at the power station is planned to begin in September 2007.



The longwall operation at the Dendrobium mine, New South Wales (BHP Billiton Ltd).

INDUSTRY DEVELOPMENTS—NEW SOUTH WALES

BHP Billiton: The US\$200 million Dendrobium underground longwall mine commenced operations in April 2005. The mine will be capable of producing up to 5.2 Mtpa of raw coking coal. Elouera ceased production in June 2005, however, longwall mining restarted using a contract miner in late 2005. The Douglas longwall is scheduled to commence in early 2006 as a replacement for the Appin Colliery.

Coal and Allied: In early 2005 a mining lease was granted for the West Pit Extension. Work is underway at Bengalla to increase production to over 10 Mtpa. A feasibility study on the Mount Pleasant project is examining two open-cut operations with an initial total capacity of 5.5 Mtpa. The North Pit will mine five coal seams and the South Pit 8 seams over a 25 year period. In late 2005 approval was granted to construct a \$65 million facility at the Hunter Valley Complex to recover ultra-fine coal from tailings to feed the Bayswater and Liddell power stations. Up to 1.3 Mtpa of ultra-fine coal is planned to be recovered commencing in late 2006.

Xstrata Coal: The \$50 million Glendell open-cut, scheduled to commence in 2007, will use the infrastructure at Mount Owen. The \$12 million Ravensworth West is scheduled to commence in 2006 and will operate for six years at a rate of 1.5 Mtpa. An open-cut mine commenced at Baal Bone in early 2005 at a rate of 0.5 Mtpa for three years. The Cumnock open-cut is expected to be completed in late 2008 and the company is investigating whether mining can continue beyond that time. At Ulan a new 400 m wide longwall face is scheduled to go into production in August 2006 with a capacity of 5.5 Mtpa. A second longwall at Ulan West is being planned at a capacity of 4 Mtpa. Xstrata is also planning to increase production at the Liddell open-cut by 1.5 Mtpa.

Anglo Coal: A detailed feasibility study has been completed for an open-cut mine on the upper seams at the Saddlers Creek deposit. Conceptual studies have been completed for a longwall operation in lower seams.

Centennial Coal: The \$185 million Mandalong project commenced longwall operations in early 2005 at a rate of up to 4.0 Mtpa. The Mannering Colliery (previously Wyee) commenced at the same

time at a rate of 0.5 Mtpa using a "super panel" continuous miner operation. The Munmorah mine was closed in April 2005 due to difficult ground conditions. Centennial purchased the Austral Coal Tahmoor project in early 2005. From June to December 2005 a low seam mining specialist extracted coal from the Irondale seam at Ivanhoe No 2. Centennial is seeking development approval for the \$100 million Anvil Hill open-cut thermal coal project where production is planned to be 10.5 Mtpa by 2008.

Excel Coal: The Wambo coal handling and rail loadout was completed in late 2005 and the rail spur and loop is expected to be commissioned in early 2006. The new Wambo prestrip fleet is also due to be commissioned in early 2006. In August 2005 development commenced on the \$97 million North Wambo longwall mine adjacent to the open-cut. The longwall will extract 3 Mtpa from the Wambo seam commencing in late 2006. Construction is expected to begin in early 2006 at the Wilpinjong project from which Excel is contracted to supply up to 7 Mtpa of thermal coal to Macquarie Generation's Bayswater and Liddell power stations for 19 years from January 2007. At Chain Valley the inter-seam driveage to the Fassifern seam commenced in mid 2005 to extend the mine life by up to 20 years.

Gloucester Coal: The Duralie open-cut is to be extended into an area of low strip ratio coal. Gloucester is continuing studies for the extension of Duralie to 2017. The Duralie trial underground mine is proposed to commence in mid-2008. At Stratford production at the Roseville open-cut extension is planned to commence in mid-2006.

Felix Resources: Underground development started in 2005 on the Ashton underground longwall mine. Start-up is expected in 2007 at a capacity 2.0 Mtpa of semi-soft coking coal over a 13 year mine life. The proposed Moolarben thermal coal project consists of a 4.0 Mtpa open-cut planned to commence in 2008 followed by a 3.0 Mtpa longwall mine in 2009.

Resource Pacific Holdings: The Newpac No 1 Colliery is a bord and pillar operation producing up to 0.9 Mtpa of semi-soft coking coal. It is currently being developed into a longwall operation to produce 4.0 Mtpa by January 2007.

Gujarat NRE: NRE No 1 Colliery started bord and pillar coal mining in September 2005 from the Balgownie seam at Russel Vale at an initial rate of 1.0 Mtpa. In July 2005 Gujarat bought the nearby Avondale and part of the Huntly Colliery for \$80 million and renamed the project the Gujarat NRE No 2 Colliery.

Yanzhou Coal Mining: At the Austar project, Longwall Top Coal Caving (LTCC) is proposed to be used to extract the thick Greta seam. Development began in mid-2005 and operations are expected to commence in mid-2006 with an initial production of 2.5 Mtpa. LTCC can be used in seams heights from 4.5 to 12.5 m and some 80 LTCC faces are currently in operation in China.

Werris Creek Coal Pty Ltd: The Werris Creek open-cut thermal coal mine commenced in mid-2005 at a rate of about 1.6 Mtpa creating up to 70 new full time jobs.

Newcastle Coal Company: Construction at the Tasman underground thermal coal mine commenced in November 2005. The 1.0 Mtpa bord and pillar mine will use the Bloomfield coal handling and preparation plant and rail loader.

Northern Energy Corporation: At Ashford near Inverell scoping studies commenced in late 2005 to assess development options prior to a feasibility study in 2006. The study is investigating a possible 1 to 2 Mtpa open-cut coking coal mine utilising combined truck and rail transport options.

Idemitsu Kosan Co Pty Ltd: The \$39 million Boggabri open-cut thermal coal mine is expected to start production in mid-2006 at a rate of 1.5 Mtpa over eight to 10 years. Idemitsu and Whitehaven Coal Mining are planning to commence an open-cut coal mine at East Boggabri. Whitehaven Coal Mining also is planning to develop the Belmont open-cut thermal coal mine with a capacity of 1.5 Mtpa by 2008.

INDUSTRY DEVELOPMENTS—WESTERN AUSTRALIA AND TASMANIA

In Western Australia **Griffin Coal** commenced coal exports through the **Port of Bunbury** in April 2005. The **Aviva Corporation** is undertaking a \$1.3 million pre-feasibility study into an Ironmaking and Cogeneration project based on the Central West coal deposit located near Eneabba. Aviva is proposing a project output of 2.0 Mtpa of iron and 200 MW of power. The study is expected to be completed in 2006 and will investigate an initial 0.5 Mtpa Ironmaking unit, 50 MW of Cogeneration and 0.6 Mtpa of coal production. WA White Energy Pty Ltd is proposing to mine 30 ktpa of coal near Jurien mainly for brickworks, nurseries, agricultural use and mineral processing plants. Cornwall Coal in Tasmania purchased a second-hand short wall which is planned to be installed at the Duncan bord and pillar operation.

INDUSTRY DEVELOPMENTS—INFRASTRUCTURE

In Queensland **Babcock and Brown Infrastructure** (BBI) announced the commencement of a \$350 million first stage expansion to 68 Mtpa at the Dalrymple Bay Coal Terminal which is expected to be completed by July 2007. Two more stages are scheduled to be completed by the end of 2008 to take the capacity to up to 85 Mtpa. In late April 2005 BBI was granted interim authorisation to start a queue management system to reduce the queue of vessels waiting off Dalrymple Bay. The R.G.Tanna Coal Terminal at the **Port of Gladstone** is undergoing a \$167 million expansion from 40 to 54 Mtpa which is planned to be finished by the end of 2006. The new infrastructure includes a third rail unloading station, a third shiploader and two additional coal stockpiles. In April 2005 the Queensland Government announced another \$46.5 million upgrade of the R.G.Tanna Coal Terminal to 62 Mtpa with the addition of a fourth coal berth. The Central Queensland Port Authority plans to spend up to \$400 million to develop a new coal terminal at Wiggins Island to the west of the R.G.Tanna terminal at Gladstone. Phase 1 of the new terminal would handle up to 20 Mtpa from 2009 and when fully developed would have a capacity of 70 Mtpa. The Queensland Government is conducting a \$25 million feasibility study into upgrading the Abbott Point coal terminal from 15 to 50 Mtpa at a cost of \$400 million. The upgrade would also require construction of 70 km of rail line to link the mines of Central Bowen Basin to Abbott Point. The project is expected to be completed in 2009. In July 2005 BMA announced the approval of Phase 2 of the Hay Point coal terminal expansion program to lift capacity by 4 Mtpa to 44 Mtpa in 2007.

In New South Wales at the **Port of Newcastle Port Waratah Coal Services** (PWCS) commenced construction on a \$170 million project in November 2005 to raise loading capacity at the Kooragang Coal Terminal from 89 Mtpa to 102 Mtpa by late 2007. In April 2005 the Australian Competition and Consumer Commission granted conditional authorisation to continue the Capacity Distribution System until the end of 2007. In August 2005 the Newcastle Coal Infrastructure Group (NCIG) was selected by the New South Wales Government to be the preferred developer and operator of a third coal loader at the Port of Newcastle. NCIG propose to construct a \$500 million terminal with a capacity of 45 to 60 Mtpa with an initial 30 Mtpa first stage by 2009.

The Central Queensland port programs will link up with a \$335 million upgrade by Queensland Rail on the Goonyella and Blackwater coal rail systems. Altogether the works will increase rail capacity by nearly 70% to 175 Mtpa by early 2007. **Australian Transport and Energy Corridor Ltd** has invited mining sector partners to join the proposed \$775 million Toowoomba to Gladstone railway which would open up the Surat Basin. The line north from Toowoomba will involve construction of 210 km of new track and upgrades to the connecting lines to Gladstone. **Australian Rail and Track Corporation** (ARTC) is currently spending over \$152 million upgrading the Hunter Valley rail network to increase capacity from 85 to 100 Mtpa by 2008.

Approvals were granted in December 2005 for the construction of a 220 km water pipeline from the Burdekin Falls Dam to Moranbah in Central Queensland. SunWater will construct the \$270 million pipeline which is scheduled to transport 9000 megalitres per annum of water by December 2006. The capacity is expected to be increased to 16 600 megalitres per annum by July 2007. A 71 km southern extension is planned to support mining operations in the Dysart region.

INDUSTRY DEVELOPMENTS—RESEARCH AND DEVELOPMENT

CSIRO has adapted missile inertial guidance systems to automatically and continuously align longwall equipment. Currently a longwall stops twice a day while miners use a string line to realign equipment. In June 2005 the Federal Industry Minister called for submissions to the \$500 million Low Emissions Technology Demonstration Fund (LETDF). The key eligibility criterion is an ability to potentially deliver significant greenhouse gas abatement with commercial up take in the long term.

COAL21 is an initiative of the **Australian Coal Association** aimed at reducing greenhouse gas emissions in Australia. COAL21 is a collaborative consensus-building program involving participants from federal and state governments, the coal and electricity industries, and research organisations.

The **Cooperative Research Centre for Coal in Sustainable Development** (CCSD) is an unincorporated joint venture consisting of 18 participating organisation. CCSD commenced in July 2001 and \$61 million will be invested over seven years to pursue the goal of optimising the contribution of coal to a sustainable future. The **Cooperative Research Centre for Greenhouse Gas Technologies** (CO2CRC) is focussed on carbon dioxide (CO₂) capture and geological storage (geosequestration). The **GEODISC** program established that the geological features of Australia are suitable for geological storage of carbon dioxide. CO2CRC is building on these findings and plans to achieve a demonstration project within the term of CO2CRC.

Brown Coal

Brown coal or lignite is a low rank, consolidated, brownish-black coal that has a high moisture and volatile content. The majority of brown coal production is used to generate electricity. Other uses include production of synthetic natural gas, home heating, fertiliser, industrial carbon and oil well drilling mud. In Australia, deposits of brown coal occur in all states and are Tertiary in age (15 to 50 million years). Extensive deposits occur in Victoria with the largest being in the Gippsland Basin, where the Latrobe Valley coalfield contains some of the thickest seams in the world (up to 330 m thick). Brown coal is only mined in Victoria where the mines of Anglesea, Loy Yang, Yallourn and Hazelwood supply coal to local power stations. At Morwell brown coal is used to make briquettes for industrial and domestic heating.

Resources

Recoverable EDR for 2005 was 37.4 Gt a decrease of 0.3% from 2004. Recoverable PDR and SDR remained unchanged at 39.0 Gt and 16.3 Gt respectively. Recoverable inferred resources also remained unchanged at 100.8 Gt. Victoria accounts for over 96% of Australia's identified resources of brown coal. All EDR is located in Victoria and about 89% of total EDR is located in the La Trobe Valley.

Accessible EDR

Approximately 80% of brown coal EDR is accessible. Quarantined resources include the APM Mill site that has a 50 year mining ban (commenced in 1980), Holey Plains State Park and the Morwell township area. The resource life of Accessible EDR (30.0 Gt) is close to 450 years.

JORC Reserves

No brown coal resources are compliant JORC Code reporting. Geoscience Australia estimates reserves at the operating mines from published information. Reserves are about 2.6 Gt with nearly 60% being at Loy Yang. The resource life of published reserves is close to 40 years.

Exploration

Data relating to exploration for brown coal specifically are not available nationally. The Victorian Department of Primary Industries reported that in 2004–05 \$13.6 million was spent on brown coal exploration and \$152.2 million on brown coal mining development.

Production

Australian brown coal production for 2004–05 was 67.2 Mt (valued at \$843 million), all from Victoria. The La Trobe Valley mines of Yallourn (17.7 Mt), Hazelwood (18.7 Mt) and Loy Yang (29.8 Mt) produce about 98% of Australia's brown coal. Locally significant brown coal operations occur at Anglesea (0.9 Mt) and Maddingley (19 kt).

World Ranking

Australia has about 24% of world recoverable brown coal EDR and is ranked number one in this commodity. Australia produces about 8% of the world's brown coal and is the fifth largest producer after Germany (22%), Russia (10%), USA (9%) and Greece (8%).

Industry Developments

In September 2005 the Victorian Government approved the continuation of International Power Australia's \$400 million West Field Coalfield development in the Latrobe Valley. The major river and road diversion projects are expected to begin in early 2006. When the diversion projects are completed the **Hazelwood** mine life will be extended from 2009 to 2030.

At the **Yallourn** mine the \$120 million diversion of the Morwell River, one of the largest earthmoving exercises ever undertaken in Victoria, was officially opened in September 2005. The project allows access to new coal reserves and guarantees the continuation of the Yallourn power station for at least another 30 years. The four year project created a new 3.5 km river bed that passes through the Yallourn East Coalfield.

The new L310 1.4 km long conveyor at **Loy Yang** was commissioned in late 2005. The \$10.7 million conveyor was required as part of the mines future development. It facilitates the repositioning of Dredger 15 and connects L300 to the existing L315 conveyor.

During 2005 Monash Energy, a subsidiary of **Anglo Coal**, completed a series of drying and gasification trials on Victorian brown coal. Monash plan to construct a demonstration drying and gasification plant followed by a commercial scale development that will convert syngas into liquids such as synthetic diesel.

The Latrobe Valley 2100 Coal Project (LV2100) undertaken in 2004–05 examined the potential development of the Latrobe Valley's brown coal fields to the end of this century. Some of the findings of the LV2100 study include:

1. Water is unlikely to constrain future brown coal development.
2. No regional issue would prevent the continued use of Victoria's brown coal resources.
3. The major infrastructure services which presently exist are adequate for present use and are capable of meeting future requirements.

In May 2005 the Victorian Government announced the increase of the brown coal royalty from 2.39 to 5.88 cents per GJ from 2006. The new levy (representing about A\$17 million per annum) will help pay for the Energy Technology and Innovation Strategy to stimulate greenhouse gas reduction technologies.

A \$6.3 million pilot project is planned to be constructed in 2006 to demonstrate the scope to lift efficiency and cut emissions by up to 5% in conventional brown coal power stations. The 15 tonne per hour plant will use Mechanical Thermal Expression (MTE) technology developed in the Cooperative Research Centre for Clean Power from Lignite to remove moisture from lignite by a combination of heat and physical pressure.

Copper

Australia is a major copper producer with mining and smelting operations at Olympic Dam (SA) and Mt Isa (Qld). Other significant copper producing operations are at Northparkes and Cadia-Ridgeway (NSW), Ernest Henry, Osborne, and Mt Gordon (Qld), Nifty and Golden Grove (WA) and Mt Lyell (Tas). Copper (Cu) and copper alloys are used in building construction, electrical equipment such as electrical cables, and industrial machinery and equipment.

Resources

Australia's EDR fell by 1 Mt to slightly less than 41.4 Mt of copper, a decrease of 2%. South Australia has the largest EDR at 27 Mt, which increased by 6% in 2005 and is now around 65% of the national total. The majority of these resources are associated with the Olympic Dam deposit. South Australian EDR increased by just over 1.5 Mt following pre-feasibility drilling of the Prominent Hill deposit. Queensland has the second largest EDR with 19% of the national total, followed by Western Australia (7%) and New South Wales (6%).

Subeconomic demonstrated resources increased by 25% to 6.1 Mt, made up of 4.8 Mt in the paramarginal demonstrated resource category and 1.3 Mt in the submarginal demonstrated resource category. The increase of 1.2 Mt in paramarginal resources compared to 2004 largely reflects activity in the Mt Isa region of Queensland where evaluation of a range of deposits is in progress. Most of the paramarginal resources are in Queensland and Western Australia with 48% and 20% respectively, followed by South Australia (15%).

Inferred resources rose marginally (1%) to just over 30 Mt in 2005. South Australia holds 65% of Australia's inferred resources followed by Queensland at 13%, Western Australia and New South Wales both with 9%.

Accessible EDR

All copper EDR is accessible. At Australia's 2005 rate of production, EDR is sufficient for 45 years production. If, however, resources classified as reserves under the JORC Code are considered, they will support only 22 years at the 2005 production rate.

JORC Reserves

JORC Code reserves account for around 49% of AEDR. The remaining AEDR comprise those measured and indicated resources (reported by mining companies), which Geoscience Australia considers will be economic over the long term.

Exploration

Spending on exploration for copper rose by 90% in 2005 to \$105.8 million. Expenditure in South Australia (\$46 million) was 43% of all copper exploration and was directed mainly on both the search for further Olympic Dam style mineralisation in the Gawler Craton, and resource definition drilling at Olympic Dam and Prominent Hill. Queensland had 36% of spending on exploration for copper across a range of projects and New South Wales 11%, with the remaining 12% distributed largely in Western Australia and to a lesser extent in the Northern Territory, Tasmania and Victoria. Expenditure on exploration for copper made up 9% of all mineral exploration. Significant exploration results reported during 2005 include:

Olympic Dam (SA): Since acquiring WMC in June 2005 for \$9.2 billion, BHP Billiton has continued an intensive drilling program aimed at delineating the size of the deposit which remains open, particularly to the south and at depth.



The Cadia copper-gold open-pit mine, New South Wales (Bill McKay, Geoscience Australia).

Carrapateena (SA): RMG Services reported intersecting Olympic Dam style iron oxide copper-gold mineralisation in a hole drilled 100 km southeast of Olympic Dam. Hole CAR002 intersected haematite alteration, sulphide development and brecciation over 185 m between 469 m and 654.2 m. The interval from 476 m to 654.2 m (178.2 m) yielded 1.83% Cu and 0.64g/t Au.

Balcooma (Qld): Kagara Zinc Limited reported significant intersections of copper mineralisation including 52 m @ 4.5% Cu, 21g/t Ag and 0.37g/t Au, 44 m @ 4.5% Cu, 20g/t Ag and 0.49g/t Au and 61 m @ 3.1% Cu, 12g/t Ag and 0.32g/t Au. Kagara announced an interim upgraded Balcooma copper resource of 3.3 Mt @ 3.9% Cu, 18g/t Ag and 0.43g/t Au.

Golden Grove (WA): Based on encouraging drill intercepts, Oxiana Ltd initiated a major exploration program seeking additional volcanic hosted massive sulphide deposits (which often occur in clusters) including testing for extensions to existing orebodies or stacked repetitions.

Einasleigh (Qld): Copper Strike Limited intersected further high grade copper intersections including 15 m @ 11.76% Cu from 244 m and subsequently announced an inferred resource for Einasleigh of 1.2 Mt @ 3% Cu, followed with an inferred resource at a nearby lower grade deposit (Kaiser Bill) of 11 Mt @ 0.84% Cu, 0.15g/t Au and 6.3g/t Ag.

West Whundo (WA): At its Whundo project, near the Radio Hill mine in the Pilbara region, Fox Resources Ltd announced further copper-bearing intersections to those reported in 2004. Results included 14 m @ 5.65% Cu and 14 m @ 2.45% Cu. West Whundo is part of the Whundo project, which is based on the old Whundo copper mine. Subsequent exploration at West Whundo has confirmed the presence of a supergene copper zone composed primarily of chalcocite. Results include 8 m @ 19.94% Cu from 24 m below surface, 10 m @ 10.85% Cu from 18 m below surface and 12 m @ 9.50% Cu from 24 m below surface. Fox announced a measured plus indicated resource for West Whundo of 0.894 Mt @ 2.0% Cu, 1.4% Zn and 3.3g/t Ag, and an indicated resource for Whundo of 32 000 t @ 5.3% Cu, 8.0% Zn and 45g/t Ag.

Cloncurry (Qld): Exco Resources NL reported copper-cobalt-gold mineralisation at its Notlor prospect including intersections of 46 m @ 2.42% Cu, 0.97g/t Au and 0.25% Co and 24 m @ 3.48% Cu, 1.38g/t Au and 0.27% Co.

Mutooroo (SA): Havilah Resources reported that drilling indicates a well mineralised shallow system. Results include 26 m @ 1.55 % Cu and 0.18% Co from 101 m and 31 m @ 1.71% Cu and 0.18% Co from 78 m. Havilah reported that an optimised pit contains 11.5 Mt @ 1.1% copper and 0.096% cobalt supporting a 1 Mtpa operation producing about 10 ktpa Cu and 1 ktpa Co. Havilah also announced that the nearby Kalkaroo deposit could support a 6.5 Mtpa operation producing 31 ktpa Cu, 186 tpa Mo and 95 000 ozs Au per annum for almost eleven years from a measured resource of 70 Mt @ 0.47% Cu, 0.46g/t Au and 124ppm Mo.

Kanmantoo (SA): Hillgrove Resources Limited encountered mineralised intersections including 47 m @ 1.13% Cu, 25 m @ 1.24% Cu and 0.28g/t Au and 15.6 m @ 1.25% Cu. These results are reported by the company to have potential to increase the existing resource at Kanmantoo which is currently 18.37 Mt @ 1.1% Cu and 0.2g/t Au.

Roseby (Qld): Universal Resources Ltd discovered a new satellite copper gold system, the Ivy Ann Prospect, at its Roseby Project near Mt Isa. Intersections include 108 m @ 0.84% Cu from surface and 88 m @ 0.93% Cu from 44 m which are expected to add further to the resources of the company's Cloncurry project.

Browns East (NT): At its oxide prospect 80 km south of Darwin, Compass Resources NL reported intersections of 20 m @ 2.07% Cu, 0.30% Co and 0.37% Ni and 12 m @ 2.17% Cu, 0.03% Co and 0.09% Ni. The company believes it is likely that the oxidised copper cobalt nickel mineralisation is the weathered near surface expression of the Browns East deposit (resource of 30.5 Mt @ 1.29% Cu, 1.28% Pb, 0.13% Co and 0.13% Ni).

Buckley River (Qld): Drilling by CopperCo Ltd yielded an intersection of 18 m @ 3.9% Cu from 55 m, including 11 m @ 5.8% Cu.

Production

In 2005, Australia's mine production of copper totalled 921 kt of contained copper, 7% higher than in 2004 (860 kt). Queensland continued to dominate production with 399 kt (largely from Mt Isa), which is the same as in 2004, and accounted for 43% of Australian production. South Australia remained the second largest producer with 213 kt (down 5%), all from Olympic Dam and representing 23% of total production. Other production was: New South Wales (190 kt, up 14% reflecting start of production from the Tritton mine), Western Australia (90 kt, up 137% reflecting Whim Creek opening and Telfer re-opening) and Tasmania (30 kt, down 6%).

The value of Australia's exports of copper concentrates and refined copper in 2005 totalled just under \$4 billion, 53% more than in 2004 (\$2.57 billion) and 3% of the value of total merchandise exports. The increase reflects higher copper prices in 2005 with the average up by 24% to \$4852/t compared to the average of \$3915/t in 2004. In line with increased production of copper in 2005 was an 11% increase of exports to 784 kt. Copper had the largest increase in mineral export earnings in the December quarter 2005, up \$395 million (42%) to \$1.3 billion.

World Ranking

Based on USGS data for other countries, Australia has the second largest EDR of copper (9%) after Chile (29%) and ahead of USA and Indonesia (both 7%) and Peru, Poland and Mexico (all 6%). As a producer, Australia ranks fifth in the world with 6% after Chile (36%), USA (8%) and Indonesia and Peru (both 7%).

Industry Developments

Mt Isa (Qld): Copper-in-concentrate production in 2005 from Xstrata Plc's Mt Isa and Ernest Henry operations was 306 kt, an increase of 8% over 2004. However, copper smelter production

of 220 kt was almost 7% lower than 2004, primarily as a result of improvement activities and limitations to furnace gas off-take through reduced availability from a third party owned acid plant. Consequentially, the Townsville copper refinery produced 219 kt of saleable cathode, 8% lower than in 2004, due to the lower anode supply. The expansion of the Mt Isa copper smelter remains on track to increase capacity from 240 ktpa to 280 ktpa by mid 2006 through the installation of a second rotary holding furnace, a copper slag cleaning furnace and a converter slag treatment plant. A new leaching plant will also recover around 2.5 ktpa of additional copper from the smelter's electrostatic dust precipitator. Prefeasibility work will be undertaken during 2006 on evaluating the potential to exploit the significant known resources contained within the 500 orebody and "halo" mineralisation surrounding the 1100 orebody. At Mt Isa's Enterprise copper mine, development of an additional high-grade mining zone (5.3 Mt @ 4.5% Cu) is progressing according to schedule. This will enable the mine to maintain its rated capacity of 3.5 Mtpa. Late in 2005 a decision was made to further increase the copper smelter and refinery capacities to 300 ktpa to match the future copper-in-concentrate production from the Ernest Henry and Mt Isa copper mines.

Olympic Dam (SA): BHP Billiton continued a pre-feasibility study (initiated by WMC) into the expansion potential for Olympic Dam, announcing that an open-pit would be the preferred mining method, approximately doubling copper and trebling uranium capacity from an investment of up to US\$5 billion. As a consequence, major infrastructure for water, energy, transport and a township expansion would be required. The timeframe the project is pre-feasibility resolution by end 2007, feasibility conclusion by early 2009, and construction from 2009 to 2013 resulting in operation of the expanded facilities from 2013 onwards.

Prominent Hill (SA): Oxiana Ltd's pre-feasibility study indicated the Prominent Hill mine would probably comprise an open pit to be mined at the rate of 8 Mtpa, with an initial operating life of nine years, commencing in 2008 and producing 90 000–100 000 tpa Cu and 110 000–130 000 ozs Au per annum. Work on a bankable feasibility study commenced in August 2005 and is scheduled to be completed in August 2006.



Aerial view of Olympic Dam processing facilities, South Australia (BHP Billiton Ltd).

Telfer (WA): After almost two years under construction, Newcrest Mining Ltd's re-development of Telfer as a gold-copper mine began staged production in early 2005. It is expected to produce 800 000 oz of gold and 55 000 t of copper in 2006 with an expected mine life of 25 years.

Tritton (NSW): Tritton Resources commenced shipping copper concentrates from its newly commissioned Tritton mine and forecast copper production at 26 kt for 2005–06, slightly above the 24 ktpa planned.

Cadia (NSW): Pre-feasibility mining studies indicated panel caving is an appropriate extraction method at Cadia East Underground where Newcrest reports an ore reserve of 6 Moz Au and 630 kt Cu.

Roseby (Qld): The first stage of Universal Resources' feasibility study into the Roseby copper project near Mt Isa envisages an open pit mining operation over a nine year mine life processing around 8 Mtpa with a capital cost of around \$238 million and producing 50 ktpa Cu and 15 000–28 000 ozs Au per annum. The final stage of the study is now underway for a resource of 124 Mt @ 0.72% Cu. Xstrata Copper is part funding the feasibility study with \$4.4 million and spending a further \$2.2 million seeking additional copper sulphide mineralisation within the Roseby tenement area. Principal exploration targets are expected to be beneath and adjacent to the native copper deposits within the Roseby Feasibility Project.

Redbank (NT): Redbank Mines expanded an existing pilot plant and commenced copper production in March 2006 from indicated and inferred resources of 4.2 Mt @ 1.5% Cu.

Lady Annie (Qld): A bankable feasibility study by CopperCo Ltd proposes an open pit mine initially producing 15 000 tpa Cu before ramping up to 18 000 tpa over an eight year mine life for a development cost of \$54 million from an ore reserve of 9.8 Mt at 1.2% Cu that incorporates the Lady Annie, Mt Clarke and Flying Horse deposits. In addition, CopperCo is yet to calculate initial resource estimates for the Swagman, Mount Kelly Workings and Mount Kelly Fault Zone deposits.

White Range (Qld): Following further drilling, Matrix Metals Limited has revised its bankable feasibility study to incorporate an upgraded resource estimate of 13.87 Mt @ 1.1 % Cu for a project with an initial cost of \$A39 million and producing 15 000 tpa Cu over a six-year mine life. Subsequent drilling intersections at the McCabe deposit include 18 m @ 3.5% Cu from 99 m and 8 m @ 3.4% Cu from 37 m.

Diamond

Diamond is composed of carbon and is the hardest known natural substance, but a sharp blow can shatter it. It also has the highest thermal conductivity of any known material at room temperature. Diamonds are thought to form 150–200 km below the Earth's surface at high temperatures (1050–1200°C) and pressures (45–55 kilobars). They are carried to the surface within kimberlites and lamproites that intrude through the crust. These intrusions form narrow cylindrical bodies, called 'pipes' and only a very small proportion have significant diamond content. When pipes are eroded, liberated diamonds may accumulate in alluvial deposits. Diamonds may be found far from their source as their hardness allows them to survive multiple episodes of erosion and deposition.

The quality of diamonds is subdivided into gem, near gem and industrial categories. In rare cases, up to 90% of diamonds in a deposit are of gem quality but most economic deposits contain 20 to 40% gem quality diamonds. Current uses for diamond include jewellery, stone cutting and polishing, computer chip manufacture, machinery manufacture, mining and exploration, construction and transportation services. A large proportion of industrial diamond is manufactured and it is also possible to produce synthetic diamonds of gem quality.

Resources

EDR for gem/near gem was 124.2 Mc and industrial 129.2 Mc, both up 132% compared with 2004 resulting from the decision to proceed with underground mining at Argyle and a related upgrade of around half of the mineral resource to ore reserve based on the results of a \$70 million comprehensive feasibility study.

Accessible EDR

All diamond EDR is accessible for mining. At Australia's 2005 rate of production, EDR is sufficient for eight years production.

JORC Reserves

JORC Code reserves account for almost all AEDR. The remaining AEDR comprise those measured and indicated resources (reported by mining companies), which Geoscience Australia has assessed as being economic in the long term.

Exploration

ABS data indicate that expenditure on exploration for diamond in Australia in 2005 was \$22.8 million, down 10% on 2004. Exploration continues to be concentrated in Western Australia, notably the Kimberley region, Northern Territory and South Australia.

Ellendale (WA): Limited trial mining of alluvial gravels in paleo-channels at the Ellendale 9 North project in the Kimberly region yielded 7336 c at an average mined grade of 20.65 cpht with at an estimated sales price of US\$195 per carat. The average size of the 20 000 diamonds was 0.37 c but eight stones in excess of 5 c were recovered, including a 9.92 c yellow gem, the largest found so far from alluvial material in the Ellendale area. This operation was undertaken by Blina Diamonds NL, in conjunction with 54% owner Kimberley Diamond Company (KDC), from within the footprint of a proposed waste dump for the Ellendale 9 mine. Trial mining of a similar paleo-gravel system at Terrace 5 is underway in conjunction with exploration within the Terrace 5 catchment to delineate associated paleo-channels and pipes and assess three large known pipes (Ellendale Pipes 10, 12 and 13).

Abner Range (NT): South of the McArthur River mine, a diamondiferous kimberlite (ABN21) with an estimated area of 1.3 hectares was discovered by Gravity Diamonds Ltd after drilling a Falcon® airborne gravity anomaly. A total of 33 diamonds ranging in size from 0.3 mm to 6 mm were recovered from seven holes. The company reported that, despite drilling difficulties, diamonds in excess of 0.3 mm were recovered from each hole processed. The largest stone was 0.147 c and colourless with a slight green tinge, transparent and mostly free of inclusions. In excess of 60% of the stones recovered are similarly colourless, transparent and free of inclusions. A bulk sampling program is scheduled for the 2006 field season. Strong kimberlitic indicator mineral results were returned from tenements adjacent to the ABN 021 discovery and the fresh morphology suggests additional targets exist. The Merlin cluster of kimberlites lies some 50 km east of the Abner Range.

Flinders Ranges (SA): Flinders Diamonds Ltd reported that exploration in the Peterborough-Nackara area some 120 km northeast of Port Pirie returned diamonds. Microdiamonds were recovered from five of eight samples tested. The company reported that of the 50 new kimberlites sampled in the past year, 20 have been shown to be diamondiferous. Further targets have been identified for testing. Flinders has entered into an alliance with De Beers.

Timber Creek (NT): Total diamond recovery from Tawana Resources NL's TC-01 kimberlite, 360 km south-southwest of Darwin, is reported as 17 387 diamonds weighing 839 ct at an overall grade of 22 cpht and includes a 4.66 c clear, good quality diamond. Tawana has entered into an alliance with De Beers.

Ullawarra (WA): In the Pilbara region, some 290 km north of Carnarvon, Paramount Mining Corporation Ltd reported the presence of a diamond indicator mineral, pyrope garnet, considered to have come from a possible kimberlite pipe (ULW 1) reported in 2004.

Production

Australia produced 30.7 Mc of diamond in 2005, making it the world's second largest producer of diamond by weight after Russia, with Botswana and Congo (Kinshasa) ranking third and fourth respectively. As a producer of gem/near gem diamond, Australia is the third largest after Botswana and Russia, and as producer of industrial grade diamond Australia is the second largest.

Production was almost entirely from the Argyle mine, which produced 30.5 Mc—mostly industrial and cheap diamonds with an average price of US\$15–16, but making it the leading global producer. Production was 48% higher than in 2004 despite mining constraints within the deepening open pit.

Production from Kimberley Diamond's (KDC) Ellendale mine in the West Kimberley region increased to 123 334 c in 2004/2005, up from 60 850 c in the previous period. Production was nearly all from the Ellendale 9 pipe where high-value fancy yellow gem diamonds were mined. The average grade for the period was 6.81 cpht and the average sale price was US\$226 per carat. KDC is targeting production of 240 000 carats in fiscal 2006.

World Ranking

Australia's EDR of industrial diamond ranks third (22% of current world total EDR), after the Congo (Kinshasa) and Botswana (26% and 23% respectively). Detailed data are not available on world resources of gem/near gem diamond but Australia has stocks amongst the largest for this category.

Industry Developments

Argyle (WA): In December 2005, after a comprehensive feasibility study, Rio Tinto Ltd announced it would extend Argyle's mine life by investing US\$760 million on converting to an underground block cave operation. It will take three years to bring the underground mine fully on stream. An additional US\$150 million will be spent on a related open pit cutback to enable production to continue in the transition period, and beyond, as the open pit operation is wound down and the new underground mine is ramped up. Average annual production over the life of the underground mine from 2007 to 2018 is expected to be about 60% of Argyle's historical annual average of 34 Mc and of similar quality. Rio Tinto Ltd negotiated a reduced royalty rate of 5% on all production from the start of 2006, down from 7.5% previously.

Ellendale (WA): Work began at Ellendale Pipe 4 on construction of a new 4.4 Mtpa processing plant and open cut mine some 15 km south of the existing Ellendale Pipe 9 operations. Forecast production from Ellendale 4 is more than 2.7 Mc over a seven year life. A two-stage expansion of the existing 2.2 Mtpa Ellendale 9 East processing plant is also in progress, initially increasing the throughput capacity by 50% to 3.3 Mtpa at a cost of \$26 million. The second stage involves installing a high pressure rolls crusher to lift production to 4.4 Mtpa. The crusher will make it possible to treat the 30% of ore which is currently being reported as encapsulated lights. Test work indicates that 20% of diamonds are not being recovered from this ore. The upgrades are expected to reduce cash costs by up to 20% and contribute to an increase in total Ellendale output from 120 000 cpa to 700 000 cpa by the third quarter of 2006.

Merlin (NT): Since re-processing of the x-ray sorthouse tailings began in July 2005, as the first stage of North Australian Diamonds Limited's redevelopment of Merlin mine, in excess of 12 000 c has been recovered from 2600 t as 146 000 individual diamonds. These include three diamonds of greater than 10 carats (c): a 14.21 c gem quality clear white diamond, a 10.97 c brown near gem diamond and 10.27 c light brown gem quality fragment for a larger stone. Yellow diamonds represent 5% of the diamonds recovered from the x-ray sorthouse tailings and these achieved an average valuation of US\$1454/c with two 'fancy yellow' stones valued at US\$4500/c. The yellow diamonds are non-fluorescent and are unlikely to have been recovered in previous mining. The Merlin operation was previously owned by Ashton/Rio Tinto, which recovered 500 000 c from nine pits from 1998 to 2003. Stage 2 of the development will involve processing of remaining ore from tailings, remnant ore from previously mined pits and ore minable because of re-optimised pit designs. Crushing and liberation tests on primary kimberlite ores from the Ywain and Kaye pipes resulted in improved liberation and

recovery of diamonds with grades of 84.6 cpht and 13.4 cpht representing increases of over 40% and 30% on previously mined ore.

Gold

Gold prices remained strong throughout 2005 but this strength could not maintain exploration expenditure, which fell in the face of very strong non-gold metal prices which in turn underpinned substantial growth in base metal exploration. Production recovered in 2005 and with developments currently occurring is expected to increase again in 2006. Exploration generated a large number of intersections of economic significance justifying further work but there remained a lack of discovery of large or world-class deposits.

Gold has a range of uses but the two principal applications are as an investment instrument and in the manufacture of jewellery. Secondary uses, in terms of the amount of gold consumed, are in electronic and dental applications.

Resources

Australia's gold resources occur and are mined in all States and the Northern Territory. At the end of 2005, total Australian gold resources were 205 t higher than at the end of 2004. After allowing for the replacement of those resources lost to production (263 t) newly delineated resources added to the national inventory totalled 470 t (13 Mozs) in 2005.

Australia's EDR fell by 364 t (11.7 Mozs) in 2005 to 5225 t and accounted for 78% of total demonstrated resources, a reduction on the 82% share in 2004. In 2005, EDR increased in Queensland, Victoria, South Australia and the Northern Territory. Western Australia continued to dominate EDR with 55% of the national total, which was a slightly reduced share. In 2005 its EDR was 2856 t. South Australia had the second largest EDR.

Subeconomic demonstrated resources rose by 224 t in 2005. Both paramarginal and submarginal demonstrated resources increased in 2005 with the greatest growth occurring in the paramarginal category which rose by 213 t to 1315 t. Western Australian paramarginal resources rose by 183 t to 955 t which was 73% of total paramarginal resources. Increases also occurred in the paramarginal category in Queensland, New South Wales and Victoria. The submarginal demonstrated resources rose by 11 t to 118 t, over half of which was in Western Australia.

Inferred resources rose by 345 t to 4403 t. Western Australia continued to dominate inferred resources accounting for about 44% of total inferred resources which was a similar level as in 2004.

The ratio of demonstrated to inferred resources fell sharply from 1.7:1 in 2004 to 1.5:1 in 2005. This is a further improvement and builds on the significant improvement recorded in 2004. The result in 2005 was caused by a combination of reduced demonstrated resources and increased inferred resources. It indicates that the availability of inferred resources that may be upgraded by future exploration to the potentially minable categories improved further in 2005.

Accessible EDR

EDR for gold are essentially unencumbered (less than 1% is in any form of restricted area). At Australia's 2005 rate of production, EDR is sufficient for an average 20 years production. If, however, resources classified as reserves under the JORC Code are considered, they will support only 12 years at the 2005 production rate. This is similar to the 2004 reserve:production ratio. These are average figures and there are some operations that may continue after the 22 or 12 year periods and there are others that will close before the end of those periods. These figures continue to highlight the need for ongoing successful exploration in both the short and medium terms.

JORC Reserves

EDR is the sum of the JORC Code reserves categories plus those resources from the measured and indicated resource categories assessed by Geoscience Australia as likely to be economic. In 2005 just under 64% of EDR fell into the JORC reserves category an increase on the 60% recorded in 2004 but the same level as in 2003.

Exploration

On the basis of calendar year exploration spending reported by ABS, gold remained the dominant target in 2005 but its share of total spending fell sharply from 45% in 2004 to 34%. This substantial fall was caused by the combined impact of sharply increased spending on base metals and reduced spending on gold exploration. Gold exploration spending fell by \$29.9 million in 2005 to \$384.1 million. Although Western Australia dominated exploration by attracting \$241.3 million (\$42.4 million less than in 2004) its share of total gold exploration fell to 62.8%. All other regions had gold exploration during the year and encouraging results were reported from them. Selected highlights which are indicative of the year's activity are reported at the end of this section.

It should be noted that ABS data reported on above will not include exploration for copper-gold mineralisation where the explorer nominates copper as the principal commodity. Such expenditure will be reported as exploration for copper. This may have occurred in South Australia and New South Wales where exploration for Olympic Dam and Cadia style mineralisation was prominent. Both States recorded substantial increases in copper exploration spending with South Australia rising by 87% to \$46 million and New South Wales by 72% to \$11.7 million.

On a financial year basis, ABS reported gold exploration spending for 2004–05 was \$391.7 million, a reduction of \$5.4 million over 2003–04. Increases in New South Wales, Queensland and the Northern Territory were insufficient to offset reductions in other jurisdictions. Western Australia was the focus of gold exploration with \$259.6 million (66% of total spending).

Data published by the Canadian company Metals Economics Group (MEG) on company exploration budgets for non-ferrous minerals indicates that intended budgets for gold exploration in Australia for 2005 totalled US\$331.4 million (A\$430 million using the exchange rate used by MEG). This budget was about 12% higher than actual spending reported by ABS. The differences between reported budgets and actual spending on gold exploration may in part have been caused by the rapid increase in base metals exploration resulting in gold budgets being reduced as additional funds were directed to base metals.

The MEG data show that 35% of gold exploration budgets were expected to be directed at grassroots exploration while 34% was directed to minesite exploration. The remaining 31% was for late stage exploration. These shares are indicative of the trend to brownfields exploration that Australia has been experiencing in the major commodities.

New gold mineralisation was found across the continent and at depth below known deposits. A variety of styles of mineralisation also continued to be found. The Archaean greenstones of Western Australia's Yilgarn Craton remain a very favourable target, but the reported results that follow suggest that substantial opportunities exist in other provinces.

Strong intersections were reported from all jurisdictions. Two results of particular interest were the copper-gold intersections reported at Carrapateena in South Australia's Gawler Craton and at the Karlawinda Bore prospect 65 km southeast of Newman, Western Australia. Continuing encouraging results were reported from the Woolgar prospect in Queensland and from the historic mining areas of Bendigo and Ballarat in Victoria.

NEW SOUTH WALES

- Newcrest Mining Limited announced an initial reserve estimate for the Cadia East project. The Probable Reserve of underground minable ore totalled 165 Mt @ 1.1g/t Au and 0.38% Cu for contained metal of 6.0 Mozs Au and 0.63 Mt Cu. Resources at Cadia East, which include the reserve, total 830 Mt containing 18.2 Mozs Au and 2.9 Mt Cu in the indicated and inferred resource categories.
- Alkane Exploration Ltd reported an encouraging intersection from drilling into the Hangingwall zone at the Wyoming One deposit. A zone of 12 m @ 3.45g/t Au (from 329 m depth) included 4 m @ 5.37g/t Au. In drilling to test structures in the Porphyry and Northern Zones adjacent to the Hangingwall Zone, significant mineralisation was encountered in east-west structures in the porphyry. Intersections included 5 m @ 7.65g/t Au, 14 m @ 15.48g/t Au and 66 m @ 13.8g/t Au which included 11 m @ 54.69g/t Au. Recent drilling returned 66 m grading 19.49g/t Au from 268 m.
- Moly Mines Limited reported encouraging drill results from on-going diamond drilling at the Dargues Reef gold project near Braidwood. Drilling has increased the extent of the mineralisation with significant intersections in new holes. The intersections include 74.0 m @ 2.6g/t Au, 50.0 m @ 2.8g/t Au and within these are high-grade zones including 25 m @ 6.1g/t Au, 11 m @ 8.9g/t Au and 5.5 m @ 7.9g/t Au. A parallel lode north of the main system returned 7 m @ 7.6g/t Au. The company announced an inferred resource of 3.72 Mt @ 3.0g/t Au for 0.36 Mozs for the project.
- At the Phoenix prospect, part of Malachite Resources NL's Tooloom project, 65 km west of Casino, results included 63 m @ 1.28g/t Au and 0.6% Sb from 7 m and 57 m @ 1.32g/t Au and 0.16% Sb from 5 m.
- Straits Resources continue to improve the resource base at the Hillgrove project in the New England Fold Belt east of Armidale. Feasibility work during the September quarter has shown that a low tonnage high-grade production plan at Hillgrove is viable in the short term with operations concentrating initially on the high-grade antimony areas at Syndicate. The current resource stands at 2.4 Mt @ 5.4g/t Au and 1.6% Sb.

NORTHERN TERRITORY

- At the Cosmo Deeps deposit, 150 km south of Darwin, Northern Gold NL (now GBS Gold Australia Pty Ltd) has explored beneath the east and west flanks of the old Cosmo open pit. Drilling results included 4.1 m @ 10.1g/t Au from 622 m downhole and 4.7 m @ 7.1g/t Au from 358 m downhole in the Eastern Lodes. In the Western Lodes results included 7.5 m @ 2.0g/t Au from 176 m downhole and 3.9 m @ 6.3g/t Au from 199 m downhole. Cosmo Deeps has an indicated plus inferred resource of 9.7 Mt @ 4.0g/t Au (1.24 Mozs Au).

VICTORIA

- Bendigo Mining Ltd announced the discovery of a new gold reef on the Sheepshead Line at Bendigo. The Alexandria Reef is at least 900 m long, 3–10 m wide and about 50 m high. Although Bendigo report that further drilling is required to assess the grade of the reef the level of quartz, arsenopyrite and free gold observed in core suggests that it is probable that the reef will host economic grades. The company also announced that drilling had extended the Greater Garrad Reef, which contains 40% of Bendigo's gold reserves, by a further 250 m. Infill drilling returned 11 m @ 20g/t Au, a grade consistent with bulk sample grades from the reef.
- Ballarat Goldfield NL reported further significant gold intersections from drilling at its Ballarat East prospect at Ballarat. An intersection of 30 m (true width) @ 24g/t Au from 562 m is interpreted as a continuation of an ore shoot previously intersected 100 m to the north which yielded 5.1 m @ 11.3g/t Au, 6.0 m @ 9.0g/t Au and 1.55 m @ 42g/t Au. Other results reported include 2.0 m @ 28.8g/t Au, 3.0 m @ 11.0g/t Au and 4.5 m @ 7.1g/t Au.

- Goldstar Resources NL reported visible gold in intersections from the first three holes drilled at its Eureka prospect at Walhalla. Although the current work is exploring beneath old workings it is the first modern exploration of the target. Intersections reported include 1.85 m @ 16.48g/t Au, 2.00 m @ 64.61g/t Au and 1.9 m @ 4.37g/t Au.
- A diamond drill intersection of 7.9 m @ 10.0g/t Au, including 3.5 m @ 21.6g/t Au, at approximately 1270 m RL, was reported by Leviathan Resources Limited from the Magdala North mineralisation at Stawell. The Magdala orebody had previously been thought to narrow at depth but this intersection suggests that the mineralisation thickens and extends to the north.
- At the Glen Wills project near Omeo, Synergy Metals Ltd reported intersecting 1.7 m @ 11.3g/t Au in a hole designed to test the down plunge extension of known mineralisation. The new intersection is about 30 m below previous intersections. A later hole yielded 3.5 m @ 5.81g/t Au in a quartz sulphide breccia with minor visible gold. Synergy also reported high-grade intersections from the Sunnyside project 3 km from Glen Wills. High-grade intersections reported were 1.8 m @ 18.87g/t Au, 0.8 m @ 208.9g/t Au and visible gold was reported from two other holes for which assay results are not yet available.
- An intersection of 2.65 m @ 57.77g/t Au and 6.71% Sb was reported by A.G.D. Mining Ltd from its Augusta project 50 km east of Bendigo. The company is re-furbishing flotation and gravity equipment for use at the project.

QUEENSLAND

- At the Cracow project, near Cracow, Sedimentary Holdings Limited announced the discovery of the new Kilkenny zone 400 m west of the Crown Shoot. An intersection of 23.9 m @ 7.4g/t Au including 5.9 m @ 21g/t Au was reported. Subsequent drilling yielded 21 m @ 9.6g/t, 1 m @ 103g/t Au including visible gold and 9.8 m @ 3.1g/t Au.
- Ongoing drilling at Woolgar, an epithermal gold project, 100 km north of Richmond, by Strategic Minerals Corporation NL yielded high-grade intersections from an anomaly linking the Grand Central and Camp Vein structures. Drilling returned 1 m @ 263g/t Au from 29 m, 6 m @ 10.24g/t Au from 41 m and 6 m @ 16.75g/t Au from 74 m. Subsequent drilling at Camp Vein returned 1 m @ 21.0g/t Au, 3 m @ 30.04g/t Au and 7 m @ 21.29g/t Au. At Soap spar, intersections of 6 m @ 16.75g/t Au and 19 m @ 6.74g/t Au were reported. Later drilling at Soap spar gave 1 m @ 34.7g/t Au, 1 m @ 14.3g/t Au and 5 m @ 5.43g/t Au.
- Straits Resources have discovered a large mineralised system beneath the old Yandan epithermal gold mine. An initial intersection of 176 m @ 2.4g/t Au, including a high grade zone of 27.5 m @ 8.1g/t Au, was followed up by another intersection of 194 m @ 2.1g/t Au including 30.5 m at 8.6g/t Au. Another hole stopped in mineralisation with 2.5 m at 248g/t Au.
- The first hole drilled by Echelon Resources Ltd at the Cockatoo/Parsons prospect 700 m south of the old Mount Leyshon open pit, 30 km south Charters Towers, returned 5 m @ 37g/t Au, 56g/t Ag, 0.1% Cu, 0.4% Pb and 3.1% Zn from 975 m downhole. Included in this intercept was 0.7 m @ 260g/t Au.
- Republic Gold Limited reported that drilling at its Hodgkinson Basin projects in north Queensland has resulted in a doubling of resources. The deposits involved are Northcote, Sleeping Giant, Atric, Reedy and Hurricane. Reported aggregate resources are: Indicated 3.25 Mt @ 2.3g/t Au and Inferred 3.65 Mt @ 1.7g/t Au for a total of 0.434 Mozs of gold.
- Deep diamond drilling was undertaken by Resolute Mining Limited at the Mount Wright project 15 km north of Ravenswood to assist in the technical aspects of the project feasibility study. The aim was to increase confidence in deeper parts of the resource model and the results of 37 m @ 4.34g/t Au from 559 m, 26 m @ 3.97g/t Au from 559 m and 62 m @ 5.43g/t Au from 602 m were successful.

- Citigold Corporation Ltd released a comprehensive report on gold resources at Charters Towers. The project has a probable ore reserve of 0.8 Mt @ 13g/t Au for 0.33 Mozs Au. The reserve is part of an indicated resource estimated by the company to be 0.74 Mt @ 15g/t Au. These estimates are within an overall project inferred resource of 23 Mt @ 14g/t Au for a gold content of over 10 Mozs.

SOUTH AUSTRALIA

- Oxiana Limited announced the addition of 1 Mozs of gold at the Prominent Hill deposit, 650 km northwest of Adelaide. Aggregate indicated and inferred resources in the Copper-Gold Breccia stand at 101 Mt @ 1.5% Cu and 0.55g/t Au and the Eastern Gold Zone has 21 Mt @ 1.2g/t Au. The metal content of resources now stands at 1.5 Mt Cu and 2.6 Mozs Au. The Copper-Gold Breccia mineralisation remains open.

TASMANIA

- Drilling of the Pinafore Reef in the Lefroy Goldfield, 40 km north of Launceston, by Lefroy Resources Ltd returned high-grade intersections below old workings and some 200 m along strike from previously reported high-grade intersections. The new results included 1 m @ 23.88g/t Au from 54 m, 10 m @ 2.41g/t Au from 60 m including 1 m @ 13.62g/t Au. Lefroy subsequently announced an inferred resource of 304 000 t @ 22.9g/t Au for 225 000 ozs of gold.
- At the Mount Charter gold prospect in northwest Tasmania, Bass Metals Ltd reported an intersection of 58 m @ 1.84g/t Au and 35g/t Ag from surface from an initial diamond drill hole. Later drilling reported returned 80 m @ 1.6g/t Au and 61g/t Ag.
- In northeast Tasmania, TasGold Ltd reported an encouraging intersection from its Panama prospect. The intersections in a single hole included 0.5 m @ 9.16g/t Au and 35.8g/t Ag from 61 m downhole and 0.5 m @ 2.19g/t Au and 16.5g/t Ag from 97.25 m downhole. The mineralisation occurs in what the company reports as previously unknown, stacked, near-surface narrow gold bearing quartz veins. This hole targeted a down dip extension of mineralisation intersected in 2004.

WESTERN AUSTRALIA

- A discovery of concealed gold mineralisation was reported by WMC Resources Ltd at its Karlawinda Bore prospect 65 km southeast of Newman. Intersections in two holes were 1 m @ 14.2g/t Au, 7 m @ 4.6g/t Au including 1 m @ 21.8g/t Au and 6 m @ 4.5g/t Au including 1 m @ 18.3g/t Au.
- Avoca Resources Ltd reported further high-grade intersections from its Trident deposit at Higginsville including 7 m @ 72g/t Au in a new lode. Infill drilling elsewhere in the deposit yielded 60 m @ 7.6g/t Au and 1 m @ 162g/t Au. Indicated and inferred resources totalling 485 000 ozs have been delineated. Avoca announced an initial resource for Trident of indicated resources at 2.72 Mt @ 5.1g/t Au for 450 000 ozs and inferred resources at 0.26 Mt @ 4.3g/t Au for 36 000 ozs. Later drilling at Trident yielded 27 m @ 88g/t Au at the projected junction of the Western Zone and Athena Lode which included 10 m @ 229g/t Au. Also reported was 25 m @ 3.4g/t Au in a new mineralised zone between the Eastern and Western zones.
- At the Coyote deposit, on the Western Australian side of the Tanami, Tanami Gold reported that diamond drilling had significantly increased confidence in the geological model, grade distribution and continuity of mineralisation. The new high-grade Scooby Lode returned 'bonanza' grade intersections including 0.2 m @ 847g/t Au from 178.1 m and 0.3 m at 143g/t Au from 173 m. Coyote has a total resource of 2.7 Mt @ 5.2g/t Au. The Company notes that due to the high-grade, nuggetty nature of the deposit the resource estimate is considered to be conservative. The mining leases required for Stage 1 development at Coyote were granted in October and the Environmental Protection Agency determined that the project is unlikely to cause any significant environmental impact. Production from the deposit commenced in August 2006.
- A1 Minerals Limited advanced exploration of the Brightstar prospect 30 km southeast of Laverton. Drilling to assist with the establishment of resources at the Brightstar Alpha prospect (previously called the Brightstar Discovery Zone) returned 7 m @ 16.95g/t Au, 19 m @ 3.3g/t Au and 11 m @



Super Pit dust control, Western Australia (Kalgoorlie Consolidated Gold Mines Ltd).

2.93g/t Au. A1 acquired the Mikado gold mine located 15 km southwest of Brightstar Alpha and has renamed it Brightstar Beta. In-pit drilling at Brightstar Beta returned high-grade intersections within 20 m of the surface. These included 14 m @ 18.5g/t Au, 3 m @ 58.1g/t Au and 2 m @ 38.1g/t Au. A1 announced a mineral resource estimate for both the Alpha and Beta deposits. A total measured, indicated and inferred resource for Brightstar Alpha was 1.122 Mt @ 3.72g/t Au for 134 030 ozs and for Brightstar Beta it was 1.762 Mt @ 4.52g/t Au for 266 260 ozs Au.

- Anglo Australia Resources NL reported spectacular intersections from new palaeochannel mineralisation at its Mandilla project 70 km south of Kalgoorlie. The new zone, referred to as Endymion, had intersections including 3 m @ 226.22g/t Au, 3 m @ 71.82g/t Au and 1 m @ 128.78g/t Au, all at depths of 16 to 19 m below surface. Anglo Australian announced an upgraded resource estimate for Mandilla where a probable reserve of 70 000 t @ 7.52g/t Au is contained within an indicated resource of 53 000 t @ 10.22g/t Au. The reserve covers planned pits over the West Mandilla and Endymion mineralisation.
- Ongoing exploration at the Sickle deposit, 10 km southeast of Laverton, by Crescent Gold Limited returned high-grade mineralisation from 500 m north of the deposit's main zone. Intersections included 2 m @ 14.2g/t Au from 77 m, 12 m @ 4.4g/t Au from 58 m and 8 m @ 3.3g/t Au from 51 m. Crescent reported indicated plus inferred oxide resources of 3.11 Mt @ 2.1g/t Au and indicated and inferred primary ore resources of 6.59 Mt @ 1.5g/t Au for the Sickle deposit. In July, Crescent announced a 20% increase in the aggregate resources in its Laverton region deposits. The resources, in 23 deposits and heap leach and low grade stockpiles, total 25.848 Mt @ 1.5g/t Au and are dominated by the Sickle (6.05 Mt @ 1.8g/t Au), Lord Byron (4.125 Mt @ 1g/t Au) and Armstrong deposits (6.469 Mt @ 0.9g/t Au). Of the total resource 17.206 Mt @ 1.5g/t Au is in the Inferred resource category.
- Agincourt Resources Limited reported that ongoing diamond drilling has intersected wide gold mineralisation at its new Woodley North Lode near Wiluna. Intersections included 42.6 m @ 6.0g/t Au and 27.7 m @ 9.9g/t Au and are reportedly some of the thickest intersections recorded since the discovery of the 1 Moz Bulletin lode in 1992. In another discovery, Agincourt reported

that drilling at the Carroll Prior prospect 2.5 km south of the current Williamson Pit at its Wiluna project, had intersected significant gold mineralisation. The mineralisation is hosted in sheared, quartz veined and altered felsic rocks and intersections included 22 m @ 3.3g/t Au, 14.7 m @ 2.2g/t Au and 11.6 m @ 3.0g/t Au.

- Independence Group NL reported that drilling at Tropicana, east of Laverton, by AngloGold Ashanti had returned intersections including 38 m @ 3.0g/t Au, 26 m @ 2.29g/t Au and 26 m @ 2.2g/t Au. The company suggests that this is in a potential new gold province on the southeast margin of the Yilgarn Craton.
- Shallow, high-grade intersections were reported by Independence Group NL from the Pithara prospect at its Dalwallinu project 250 km northeast of Perth. This discovery was made under shallow cover and intersections included 7 m @ 21.8g/t Au from 20 m, 9 m @ 6.3g/t Au from 19 m and 6 m @ 4.9g/t Au from 12 m. The company noted that although mineralisation known to October had a short strike length it appears to be thickening with depth.
- At the Mt Berghaus project in the Pilbara region, De Grey Mining Ltd continued to report strong intersections including 3 m @ 25.74g/t Au, 7 m @ 6.92g/t Au and 5 m @ 10.34g/t Au. Strike length of the mineralisation exceeds 5.5 km.
- Wedgetail Exploration NL reported high grade intersections in drilling at its All Nations prospect 15 km east of Nullagine in the Pilbara region. Intersections included 16 m @ 8.45g/t Au from 11 m, 11 m @ 4.48g/t Au from surface and 7 m @ 6.01g/t Au from 28 m. About 15 km northeast of All Nations the company intersected 15 m @ 4.39g/t Au, 11 m @ 5.84g/t Au and 7 m @ 23.51g/t Au.
- Northern Star Resources Limited reported shallow high-grade intersections from the first drilling program at its Range prospect 130 km north of Halls Creek. Preliminary results reported include 5 m @ 15.08g/t Au and 34.94g/t Ag from 23 m, 2 m @ 1.02g/t Au and 26.5g/t Ag from 18 m and 1 m @ 1.08g/t Au and 33.5g/t Ag from 38 m.
- Barra Resources Limited reported high-grade intersections from the Tailor Shoot beneath the old Lady Robinson open pit at its Burbanks project 8 km southwest of Coolgardie. The drilling extended the shoot and provided increased confidence in the geometry and grade of the shoot. Intersections reported include 12 m @ 21.9g/t Au, 25 m @ 17.0g/t Au and 36 m @ 7.4g/t Au.
- High-grade near surface intersections were reported by Ramelius Resources Ltd from infill drilling and resource extension drilling at its Wattle Dam project near Spargoville. Intersections included 10 m @ 66.5g/t Au from 9 m, 14 m @ 20.1g/t Au from surface and 6 m @ 10.5g/t Au from 22 m. In November, Ramelius announced that it had committed to mining the Wattle Dam Deposit.
- Drilling by Giralia Resources NL at its Mixy prospect in the Snake Well project, 450 km north of Perth, returned high-grade intersections of 11 m @ 14.99g/t Au including 3 m @ 42g/t Au and 10 m @ 5.85g/t Au including 1 m @ 52g/t Au. Later results reported included 11.4 m @ 13.69g/t Au, 4.6 m @ 9.81g/t Au and 3 m @ 8.88g/t Au.
- Hannans Reward Ltd reported an intersection of 4 m @ 20.87g/t Au from 64 m at its Sunday prospect at Leonora. This is about 250 m from an earlier intersection of 1 m @ 21.66g/t Au. A later intersection returned 21 m @ 1.48g/t Au including 8 m @ 3.52g/t Au from a downhole depth of 40 m.
- At the Lord Percy prospect, 22 km south of Norseman, Mawson West Ltd announced significant new intersections including 3 m @ 19.76g/t Au from 50 m and 7 m @ 6.3g/t Au from 80 m.
- Regis Resources NL announced a scoping study for the Moolart Well project, 100 km north of Laverton. The deposit hosts 458 000 ozs in laterite to a depth of 100 m. The scoping study will evaluate technical and economic options for development of a mine. In addition a further 25 000 m of drilling will be done. Results of the study are due by the end of 2005. Drill results reported include 46 m @ 12.04g/t Au from 24 m, 12 m @ 22.53g/t Au from 36 m and 36 m @ 3.93g/t Au from 24 m.

- At the Kunanalling project near Kalgoorlie, Cazaly Resources Limited has identified gold mineralisation at the Picante prospect. Drilling on the shoot yielded 7 m @ 13.6g/t Au from 5 m downhole, 24 m @ 4.1g/t Au and 16 m @ 5.2g/t Au. This drilling followed up early successful drilling on the prospect. A resource of 39 500 ozs was subsequently reported.
- St Barbara Mines Limited reported that testing for extensions of the Undaunted Lode at Marvel Loch yielded high grade intersections including 12 m @ 25.8g/t Au from 364 m and 3 m @ 42.5g/t Au from 345 m below surface. Underground production at Marvel Loch is being sourced from the Undaunted Lode.
- In the first half of 2005, Jackson Gold Ltd more than doubled resources at its Wallbrook project, 120 km northeast of Kalgoorlie, to 423 500 ozs. These are composed of Indicated Resources of 4.546 Mt @ 2.05g/t Au and Inferred Resources of 1.702 Mt @ 2.27g/t Au. The resources are in the Crusader, Eleven Bells, Redbrook and Red Flag deposits.
- Croesus Mining NL estimated that at the end of June the reserves at its Norseman project were 2.2 Mt @ 7.8g/t Au for 545 000 ozs. This is the highest level of reserves in the 70 year history of continuous operation of the Norseman project. The reserves are included in a total resource of 2.2 Mozs of gold in 16.6 Mt of ore @ 4.2g/t Au.
- Carrick Gold Limited announced a 50% increase in resources at its Lindsay's Tenements 50 km north northeast of Kalgoorlie. The aggregate resource is 23.2 Mt @ 2.2g/t Au for 1.67 Mozs Au. Of the total, 19.7 Mt @ 2.2g/t Au is in the Inferred resource category. Subsequent drilling at the project returned high-grade intersections at the Parrot Feathers prospect including 1 m @ 102.45g/t Au, 4 m @ 4.65g/t Au and 1 m @ 16.51g/t Au.
- In the Pilbara region, Northwest Resources Limited announced encouraging high-grade intersections from drilling at its Nullagine project about 18 km east of Nullagine. At Round Hill results included 6 m @ 40.12g/t Au from 30 m, 14 m @ 8.92g/t Au from 10 m and 4 m @ 6.22g/t Au from 37 m. Subsequent drilling returned 14 m @ 11.69g/t Au from 10 m downhole, 5 m @ 11.28g/t Au from 18 m downhole and 4 m @ 6.47g/t Au from 8 m downhole. At Little Wonder West the company reported 24 m @ 1.81g/t Au from 7 m downhole, 16 m @ 2.36g/t Au from 18 m) and 11 m @ 3.10g/t Au from 29 m.

Copper-Gold

NEW SOUTH WALES

- Drilling by Golden Cross Resources Ltd at the Copper Hill project near Molong returned encouraging intersections including 164 m, from surface, @ 0.90g/t Au and 0.62% Cu. Included in the intersection was 124 m @ 1.11g/t Au and 0.68% Cu. Other results included 48 m @ 0.33g/t Au and 0.69% Cu, 10 m @ 0.11g/t Au and 0.47% Cu and 6 m @ 0.64g/t Au and 0.36% Cu. Further drilling returned 129.8 m @ 1.8g/t Au and 0.79% Cu from 48 m and ended in mineralisation. The intersection includes 22 m @ 2.26g/t Au and 1.19 % Cu and this deeper, high grade zone is only 100 m below surface.
- Alkane Exploration reported a resource estimate for the Galwadgere deposit near Wellington. The indicated resource is 2.09 Mt @ 0.99% Cu and 0.3g/t Au at a 0.5% Cu cut-off grade.
- Goldminco Corporation announced results of drilling at the recently discovered, Estoril porphyry copper-gold prospect in the Temora Project area of the Lachlan Fold Belt. Intersections reported include 112 m @ 0.3g/t Au and 0.24% Cu, 66 m @ 0.45g/t Au and 0.23% Cu and 38 m @ 0.47g/t Au and 0.26% Cu.

NORTHERN TERRITORY

- Recent drilling at Adelaide Resources Ltd's Rover copper-gold project in the Tennant Creek region has confirmed the potential of the system. Rover 12 returned an intersection of 55 m @ 0.31% Cu and 0.02g/t Au including 15.1 m @ 0.57% Cu and 0.03g/t Au from 465.3 m.

QUEENSLAND

- Exco Resources NL reported copper-cobalt-gold mineralisation at its Notlor prospect in its Cloncurry project at Cloncurry. Intersections reported include 46 m @ 2.42% Cu, 0.97g/t Au and 0.25% Co and 24 m @ 3.48% Cu, 1.38g/t Au and 0.27% Co.

SOUTH AUSTRALIA

- RMG Services reported intersecting Olympic Dam/Prominent Hill style iron oxide copper-gold mineralisation in a hole drilled at its Carrapateena Prospect, 100 km southeast of Olympic Dam. Hole CAR002 intersected a sequence of variable intensity of haematite alteration, sulphide development and brecciation, over 185 m between 469 m and 654.2m. The interval from 476 m to 654.2 m (178.2m) yielded 1.83% Cu and 0.64g/t Au. RMG's drilling was 50% funded through the South Australian Government's PACE plan to encourage mineral exploration in the State. Teck Cominco Ltd subsequently reached agreement to undertake further exploration on the prospect.
- Red Metal Limited reported a previously unrecognised gossanous ironstone at the Wombat prospect near Wallaroo. Subsequent aircore drilling returned low grade copper and copper-gold mineralisation including 30 m @ 0.52% Cu, 29 m @ 0.44% Cu and 0.1g/t Au and 5 m @ 0.43% Cu and 0.05g/t Au. A three-hole diamond drilling program later confirmed wide intervals of low grade copper+/-gold mineralisation. One hole returned a significant copper-gold intersection of 36 m @ 1.14% Cu and 0.29g/t Au which included 10 m 2.45% Cu and 0.7g/t Au. The tenement is held by Adelaide Resources Limited and the Phelps Dodge Australia Inc/Red Metal Ltd Alliance is earning a 70% joint venture interest.



Drilling rigs at the Prominent Hill copper-gold deposit, South Australia (Oxiana Ltd).

WESTERN AUSTRALIA

- Dominion Mining Ltd reported new mineralisation from the Wongan Hills prospect 130 km northeast of Perth. Results included 3 m @ 0.7% Cu and 1.35g/t Au, 36 m @ 0.57% Cu, including 6 m @ 1.9% Cu and 2.4g/t Au, 9 m @ 0.69% Cu including 2 m @ 2.08% Cu and 1.6g/t Au.
- At the Yagahong prospect in Reward Minerals Ltd's Gabanintha project, 45 km southeast of Meekatharra, the company report high-grade copper-gold intersections north of the former Yagahong gold open pit. Included in the intersections were 7 m @ 11.3g/t Au and 1.32% Cu, 12 m @ 6.53g/t Au and 1.5% Cu and 4 m @ 9.66g/t Au and 2.30% Cu. Later drilling also yielded strong results including 2 m @ 12.39g/t Au and 2.46% Cu from 94 m and 4 m @ 6.80g/t Au and 1.38% Cu from 84 m. Reward announced an indicated resource at 1g/t Au cut-off of 511 470 t @ 4.35g/t Au for 71 559 ozs.
- Deep drilling by Batavia Mining Limited at its Deflector deposit 200 km east of Geraldton, resulted in encouraging intersections of copper-gold mineralisation. Results reported include 4.9 m @ 19.2g/t Au and 0.94% Cu from 309.6 m, 2.2 m @ 30.2g/t Au and 5.96% Cu from 225.8 m and 1.5 m @ 11.9g/t Au from 232.4 m. These were followed by later results which included 9.00 m @ 65.2g/t Au and 3.95% Cu, 2.88 m @ 11.8g/t Au and 0.38% Cu and 2.00 m @ 7.30g/t Au and 0.54% Cu.

Production

Australian gold production reported by ABARE for 2005 was 263 t an increase of about 5 t on the level reported for 2004. The Super Pit at Kalgoorlie in Western Australia was again the largest producer with an output of nearly 26 t (just over 0.8 Moz). In 2005 Western Australia dominated Australian production with 173 t which was just under two-thirds of total Australian output (Table 2).

TABLE 2. Australian gold production 2001 to 2005

	2001 (t)	2002 (t)	2003 (t)	2004 (t)	2005 (t)
New South Wales	17.10	23.48	27.49	29.14	29
Victoria	3.50	3.24	3.11	3.46	6
Queensland	31.89	25.06	26.24	23.16	23
South Australia	4.31	3.14	5.33	5.12	6
Western Australia	196.59	187.20	189.07	164.32	173
Tasmania	6.18	6.05	9.31	10.60	8
Northern Territory	20.51	17.95	22.85	22.27	18
Australia	280.08	266.14	283.39	258.07	263

Source: ABARE Australian Commodity Statistics 2005 and ABARE Australian Mineral Statistics March and December Quarters 2005.

ABARE's longer-term outlook is for gold production to rise to 331 t in 2009–10. The outlook for future production is reliant on new mines coming on stream successfully at expected levels of output especially, for example, operations such as Telfer and Ballarat and the proposed Boddington (WA), Bendigo (Vic) and Cowal (NSW) projects. In addition there is potential for production from projects currently still at the exploration stage, eg. Prominent Hill, to contribute later in the period.

World Ranking

The USGS estimate of world gold reserves of 42 000 t was similar to 2005. According to the USGS, South Africa still has the world's largest reserve of gold at 6000 t (14.3%) a similar level as in 2004. According to the USGS Australia has the second largest reserve with approximately 12% of the world's holdings.

According to the World Gold Council annual mine production of gold in 2005 was 2494 t, an increase of 31 t over 2004. South African production in 2005 was 296 t or about 12% of world production enabling South Africa to remain the leading producer. It was followed by Australia with 263 t (10.6% of world) and the USA which had an estimated production of 262 t or 10.5% of world output.

Industry Developments

NEW SOUTH WALES

- Barrick have commenced construction of the **Cowal** Project, located near West Wyalong. Construction began in the fourth quarter of 2004, stripping for the north tailings storage facility has been completed and construction of the first lift has been initiated. Gold production is expected to average approximately 230 000 ounces at an average total cash cost of about \$240 per ounce over the first three years. Production commenced in the second quarter of 2006.

NORTHERN TERRITORY

- Renison Consolidated Mines NL announced that it had completed financing arrangements for the development of the **Toms Gully** mine, 90 km southeast of Darwin. The project will be a 45 000 ozs per annum underground mine. Development and operation of the mine is to be by PT Petrosea Tbk, a subsidiary of Clough limited, under the terms of an Alliance Agreement with Renison. Petrosea has taken an equity investment in Renison. Additional drilling aimed at

adding resources and upgrading inferred resources to the indicated category returned high-grade intersections including 2.2 m @ 10.7g/t Au, 1.3 m @ 15.3 g/t Au and 1.5 m @ 11.3 g/t Au.

QUEENSLAND

- BMA Gold Ltd continued with development of its **Twin Hills** gold mine in central Queensland with the first ore produced in December. The decline had reached 210 m by September. The treatment plant from Rishton, near Charters Towers, was refurbished and successfully commissioned using waste material. Mining will commence in the 60 m deep Area 1 zone which has reserves of 24 000 t @ 18.9g/t Au. Treatment of the first ore was scheduled for December, as is development of the 100 to 300 m deep Area 2 zone, with reserves of 261 000 t @ 25.6g/t Au. Drilling has continued in the shallow Area 3 zone, which has a resource of 196 000 t at 8.3g/t Au and is more suited to open cut mining. Intersections included 6 m at 22.9g/t Au, 6 m at 10.4g/t Au, 1 m at 83.2g/t Au and 3 m at 19.1g/t Au.

VICTORIA

- Perseverance Corporation Ltd poured the first gold from its new production facility at Fosterville, east of Bendigo, in May 2005. At the end of June mechanical commissioning of all circuits was completed and process commissioning was continuing with close to 90% gold recovery being achieved at that time.
- Bendigo Mining Ltd announced in May 2005 that construction of plant for the Bendigo project commenced and that commissioning was scheduled for the June quarter 2006 at an annual production rate of 0.12 Mozs. The company expects production to increase to over 0.5 Mozs annually from 2011.
- Bendigo City Council issued a permit for the establishment and operation of the Augusta gold-antimony open pit mine near Costerfield in central Victoria. The project will commence mining early in the first quarter of 2006 with production due early in the second quarter of 2006. Plant construction commenced in December 2005
- Ballarat Goldfields commenced underground development at Ballarat East in November 2004 and accessed the first mining block in September 2005.

WESTERN AUSTRALIA

- Troy Resources NL commenced mining at the Lords project near Sandstone, some 15 months after the discovery of the Lord Henry and Lord Nelson deposits. Annual production is expected to be 60 000 ozs.
- Nustar Mining Corporation Ltd poured the first gold at its Paulsens mine in the Ashburton region. The mine is expected to produce 80 000 ozs per year over its initial five year life and current inferred resource may support a longer life.
- Metex Resources Limited announced in June that following trial mining at the Whisper pit the joint venture partner, Granny Smith Mines Ltd, recommended that development be deferred because of exposure to geologic risks identified during the trial mining operation. Further exploration is aimed at identifying new higher grade resources to reduce the geologic risk.
- The positive results of a feasibility study on the Phillips River gold project caused Tectonic Resources NL to proceed with the project. The study was based on seven open pits in the Kundip area, one in the Trilogy area which were to be followed by three underground mines at Kundip. It is anticipated that the project will have an initial 4.5 year milling life. Output is expected to rise from 48 000 ozs in the first year to a peak of 80 000 ozs in the fourth year of operation.

Iron Ore

Iron (Fe) is a metallic element and which makes up about 5% of the Earth's crust. When pure, iron is a dark, silvery-grey metal that oxidises (rusts) very easily. The principal ores of iron are hematite (Fe_2O_3 —69.9% Fe) and magnetite (Fe_3O_4 —74.2% Fe). Almost all iron ore is used for steelmaking and metallic iron and is most commonly produced from the smelting of iron ore to produce pig iron. Raw iron is alloyed with a variety of elements to strengthen and harden iron to make it useful for construction, automobiles, trucks, trains and train tracks. Other uses for iron and iron ore include in coal washeries and cement manufacturing, fertilisers, magnets and paints.

The Australian iron ore industry is export oriented (over 90% exported) and is dominated by BHP Billiton and Rio Tinto in the Pilbara Region of Western Australia. Other locally significant operations include Koolyanobbing (WA), Cockatoo Island (WA), Talling Peak (WA), Koolanooka (WA), Middleback Ranges (SA), Savage River (Tas), Kara (Tas), Tallawang (NSW) and Breadalbane (NSW).

Resources

In 2005, EDR increased by 12.5% to 16.4 Gt due to the inclusion of Brockman 4, Cape Lambert, Cloud Break, Jack Hills and Frances Creek for the first time and large increases at the Christmas Creek and Southdown deposits. Western Australia has almost all of Australia's EDR with over 90% in the Pilbara district. Magnetite ore currently constitutes 15.6% (2.6 Gt) of Australia's EDR.

Paramarginal demonstrated resources remained unchanged at 0.2 Gt. Subeconomic demonstrated resources decreased 0.6% to 1.8 Gt mainly through a decrease at the Yarrie project. Inferred resources increased by 11.4% to 18.8 Gt due largely to the inclusion of Cape Lambert and Cloud Break for the first time and large increases at Christmas Creek, Claytons Hammer, Mount Nicholas and Marandoo. Western Australia has about 90% of Australia's total identified resources of iron ore with about 85% occurring in the Pilbara district.

Accessible EDR

Almost all EDR is accessible except for the remaining resource at Orebody 23 (18 Mt) in the Newman District and 30% of the Windarling resource, both of which have been quarantined for environmental reasons. The resource life of accessible EDR (16.4 Gt) exceeds 60 years.



Infrastructure at the Orebody 18 mine, Western Australia (BHP Billiton Iron Ore Pty Ltd).

JORC Reserves

About 42% of accessible EDR (6.9 Gt) complies with reporting under the JORC Code's ore reserve categories. The resource life of accessible JORC reserves is about 25 years.

Exploration Expenditure

ABS data indicate that exploration expenditure for iron ore in 2005 totalled \$152.2 million, an increase from \$97.9 million in 2004. About \$149.7 million (over 98%) was expended in Western Australia. Table 3 lists a number of smaller companies that are now exploring for iron ore following a resurgence in demand for this commodity in various forms.

TABLE 3. Small companies (juniors) exploring for iron ore in Australia

Company (by State)	Project	Location	Comment
<i>Western Australia</i>			
Accent Resources NL	Mt Gibson	300 km N Perth	targeting magnetite
Alkane Exploration Ltd	East Pilbara	near Nullagine	targeting Channel Iron Deposits (CID)
Aquila Resources Ltd	Ashburton	Pilbara region	earn interest in Cullen Resources leases
Ausquest Ltd	Rocklea	50 km NW Paraburdoo	targeting CID
Consolidated Minerals Ltd	Mindy Mindy	60 km NW Newman	targeting CID
Fast Scout Ltd	Paulsens East	140 km W Tom Price	targeting hematite conglomerate
FerrAus Ltd mineralisation	Robertson Range	100 km ESE Newman	+58% Fe
Giralia Resources Ltd	West Pilbara	S of Robe River	targeting CID
Helix Resources Ltd	Yalleen	Pilbara region	Aquila/AMCI to earn 70%
Heron Resources Ltd	Bungalbin	near Southern Cross	plus Bandicoot Range
Iron Ore Holdings Ltd	Lamb Creek	Pilbara region	Four CID projects including Lamb Creek
Jupiter Mines Ltd	Beasley River	50 km WSW Tom Price	targeting CID
Leviathan Resources Ltd	Mt Goldsworthy	95 km E Port Hedland	Polaris to earn 70%
Marengo Mining Ltd	Minigwal	280 km NE Kalgoorlie	Magnetite target
Pacific Energy Ltd	Bucklands Hill	7 km S Mesa J	selling to Echelon Resources
Pelican Resources Ltd	Bellary Springs	20 km NE Paraburdoo	targeting CID
Polaris Metals NL	Bullfinch North	50 km NW Southern Cross	Magnetite target; also Evanston
Red Hill Iron Ltd	Red Hill	60 km SW Pannawonica	targeting CID
Reed Resources Ltd	Mt Finnerty	65 km W Koolyanobbing	Iron-enriched BIF
Traka Resources Ltd	Ravensthorpe	near Esperance	Resource Mining to earn 51%
Washington Resources Ltd	Bulla	70 km E Perth at Northam	targeting Banded Iron Formations

Company (by State)	Project	Location	Comment
South Australia			
Adelaide Resources Ltd	Warrambo	Eyre Peninsula	Magnetite target
Centrex Metals Ltd	Wilgerup & others	Eyre Peninsula	Hematite/Magnetite target
Felix Resources Ltd	Hawks Nest	Cooper Pedy region	Hematite/Magnetite resources
Stellar Resources Ltd	Coolybring	Tarcoola region	Magnetite target
Northern Territory			
Compass Resources NL	Browns	Batchelor	Regency Mines has an option for JV
Tennant Creek Gold Ltd	Marrakai	150 km S Darwin	plus Bromil, Hayes Creek South
Tasmania			
Regency Mines plc	Savage River	NW Tasmania	targeting Magnetite
Zinico Resources NL (Zelos)	Nelson Bay River	NW Tasmania	targeting Magnetite
Queensland			
Summit Resources Ltd	Constance Range	300 km N Mt Isa	Siderite/Hematite resources

Production

ABARE reported that Australia's iron ore production in 2005 was 261.4 Mt (231.0 Mt in 2004) with 98% produced in Western Australia. Exports in the same period totalled 239.0 Mt (210.3 Mt in 2004) with a value of \$11 billion. Australia's iron ore production is projected by ABARE to reach 380 Mt by 2010–11.

World Ranking

Australia had some 10% of world EDR of iron ore and is ranked fifth after Ukraine (19%), Russia (15%), Brazil (14%) China (13%). In terms of contained iron, Australia has about 12% of the world's EDR and is ranked third behind Brazil (20%) and Russia (18%).

Australia produces around 17% of the world's iron ore and is ranked third behind China (25%) and Brazil (20%).

Industry Developments

WESTERN AUSTRALIA

Hamersley Iron (100% Rio Tinto): The US\$200 million Yandicoogina expansion from 24 to 36 Mtpa was completed in August 2005. A further expansion at Yandicoogina costing US\$530 million commenced in late 2005 and will increase capacity from 36 to 52 Mtpa by the end of 2007. In April 2005, Rio Tinto committed US\$290 million to further expansion of existing Hamersley Iron mines in the Pilbara Region. The expansion of the Tom Price and Marandoo mines and the construction of new mine capacity at Nammuldi were expected to commence from early 2006 subject to government approvals. Hamersley Iron is currently undertaking a pre-feasibility study on developing a new mine at the Brockman 4 deposit. Construction is planned to commence in 2007 with commissioning in 2009.

At Dampier an expansion project to raise port capacity to 116 Mtpa was completed in late 2005. Approximately US\$690 million will be spent to further expand port facilities to lift shipping capacity from 116 to 140 Mtpa. The expansion is due to commence in early 2006 and is expected to be

completed in late 2007. Another US\$113 million will be spent in additional rolling stock and associated infrastructure. Completion of the rail duplication from Tunkawanna to Rosella Siding is expected in mid-2006.

Robe River Associates (53% Rio Tinto):

The US\$105 million West Angelas expansion to 25 Mtpa was completed in mid-2005. Robe River is considering expanding production at West Angelas from 25 to 35 Mtpa at a cost of \$217 million. Robe is reviewing plans to increase Cape Lambert port capacity to 80 Mtpa. A feasibility study into the development of Mesa A to replace the Mesa J mine is progressing.

BHP Billiton: Rapid Growth Project 2 (RGP2) currently underway includes the development of Orebody 18, purchase of additional rolling stock and a new car dumper at Finucane Island. RGP2 is scheduled to be completed in second half of 2006 and will increase capacity from 110 to 118 Mtpa.

In October 2005 construction commenced on the US 1.3 billion RGP3 which will increase the annual capacity of the Mining Area C project from 22 to 42 Mt from late 2007 and will result in a total annual capacity of 129 Mtpa from BHP Billiton's Pilbara operations. RGP3 includes development of "E" Deposit, an overland conveyor, new crushing and screening facilities and increased port and rail capacity. BHP Billiton is currently undertaking a feasibility study on a US\$1.4 billion expansion called RGP4 which will expand the Newman operations to a total capacity of 152 Mtpa by 2010.

The Yarrie operations will be suspended from September Quarter 2006 for up to two years to allow for the replacement of ageing berth and production infrastructure as part of the RGP3 expansion. An intensive drilling campaign is planned in the Nimingarra and Yarrie area during the shutdown. BHP Billiton is considering the Goldsworthy Extension Project which includes mining at Cattle Gorge, Nimingarra and extensions of Yarrie crustal areas.

Portman Ltd: At Koolyanobbing commissioning of infrastructure for the upgrade from 5 to 8 Mtpa is planned for the first Quarter of 2006. A fourth shed at Esperance and the railway siding projects were completed in late 2005. In the first half of 2005 Cleveland-Cliffs purchased a controlling interest in Portman of slightly over 80%. During 2005 mine production was 5.9 Mt at Koolyanobbing and 1.1 Mt at Cockatoo Island.

Mount Gibson Iron Ltd (MGI): At Talling Peak mine planning has indicated that production can be increased from 2.3 Mtpa to 3.0 Mtpa from early 2006 and continued until at least 2011. The \$15 million Mount Gibson hematite project is expected to commence by mid-2007. Ore will be transported 85 km by road to Perenjori then 240 km by rail to the port of Geraldton. A Bankable Feasibility Study is due to be completed by the end of January 2006 on the Extension Hill magnetite project near Mount Gibson. MGI plan to establish a mine that produces 5 Mtpa of magnetite concentrate (68% Fe) that will be transported to the port of Geraldton by a 280 km slurry pipeline. The Shougang Group has been granted the right to take up a 50% interest in the \$620 million project. Mine development is expected to commence in April 2006 with commissioning of the concentrator in mid-2007. Plans also include shipping concentrate to a new \$80 million 2.5 Mtpa pellet plant intended to be constructed near Nanjing in China.



Project Magnet, Middleback Ranges, South Australia (OneSteel Ltd).

Aztec Resources Ltd: The Bankable Feasibility Study for the brownfields Koolan Island project was released in August 2005 and identified a capital cost of \$108 million for a 4 Mtpa operation. Construction is expected to commence in April 2006 with the first iron ore shipment planned for late 2006. Prior to mining the Main Pit a seawall will be constructed across the mouth of Arbitration Cove.

Hancock Prospecting: In July 2005 Hancock Prospecting and Rio Tinto formed a 50:50 joint venture to develop the Hope Downs deposit. The project will require a spur line of less than 50 km to link up with Pilbara Iron's rail line and will be able to use existing port infrastructure. The JV plans to develop a 30 Mtpa project with capability to deliver savings of up to \$850 million in capital costs and enable Hope Downs to make its first shipments in 2008.

Fortescue Mining Group Ltd (FMG): In August 2005 FMG released the results of the "Infrastructure Definitive Feasibility Study" that incorporates the rail, port and mine facilities. The capital cost for the project with a capacity of 45 Mtpa is \$1.95 billion. The project costing includes a 255 km railway from Cloud Break to Port Hedland, four train sets comprising three locomotives and 200 wagons (\$560 million) and two berths at Anderson Point near Port Hedland (\$800 million). Successful trial mining was undertaken in the December Quarter at the Cloud Break deposit using a Wirtgen surface miner. FMG have begun planning to increase production from an initial 45 to 60 Mtpa. On 1 December 2005 FMG signed the mining State Agreement with the Government of Western Australia which accommodates the initial production target of 45 Mtpa. FMG expects the first shipment of iron ore to occur in late 2007.

Midwest Corporation Ltd: Trucking of iron ore fines stockpiles from the historic Koolanooka mine commenced in early 2006 at a rate of 1.0 Mtpa. Ore is trucked 160 km to the Port of Geraldton and unloaded into a storage facility ready for shipment to overseas customers. The capital cost of the project was \$26 million and included upgrading 20 km of roads from Koolanooka to the Main Roads WA network. A scoping study is expected to be completed in early 2006 on the Koolanooka Magnetite Project which is planned to produce 4.5 Mtpa of concentrate/pellets over 30 years. Midwest plans to complete a pre-feasibility study of the Weld Range Hematite Project 50 km north of Cue during 2006. A 15 to 20 Mtpa direct shipping mine is proposed connected by a 340 km rail line to Oakajee Port near Geraldton. In October 2005 Midwest signed a Joint Venture agreement with Sinosteel Corporation covering scoping, pre-feasibility and bankable feasibility studies for the Weld Range Hematite and Koolanooka Magnetite Projects.

Grange Resources Ltd: A \$13 million Bankable Feasibility Study on the Southdown Project commenced in February 2005 and is expected to be completed in early 2006. Grange is planning to produce 6.6 Mtpa (69% Fe) of magnetite concentrate that will be pumped 90 km via a buried slurry pipeline to the Port of Albany. The concentrate is planned to be loaded onto Capesize vessels and shipped to a proposed iron ore pellet plant located in Kemaman (Malaysia).

Mineralogy Pty Ltd: The \$1.4 billion Fortescue iron ore project consists of a mine based on the George Palmer deposit, an initial 7 Mtpa pellet plant and a port at Cape Preston. Mineralogy has entered into Memorandums of Understanding with Chinese companies which could see a number of projects producing concentrate, pellets and DRI.

Murchison Metals Ltd: Mining is expected to commence in the second Quarter of 2006 on the \$35 million Jack Hills iron ore project at an initial rate of 1.2 Mt increasing to 1.8 Mt in 2007. The direct shipping grade ore will be trucked 540 km by road trains to the **Port of Geraldton** for export. A proposed second stage consists of increasing production up to 25 Mtpa by 2010 and includes the construction of railway and port infrastructure. A pre-feasibility study on the second stage is expected to be completed in early 2006.

Gindalbie Gold Ltd: The Karara Hematite Project is located 260 km east of the Port of Geraldton. Exploration has identified 6 high grade hematite prospects where Gindalbie aim to define a resource and commence mining at a rate of 1.5 Mtpa in 2007. A scoping study that was released in 2005 on the nearby Mount Karara Magnetite Project found that the deposit could support a 4.0 Mtpa operation over 20 years. The concentrate would be transported to Geraldton via a 220 km slurry pipeline for pelletising or direct shipping. A definitive feasibility study is to be undertaken during 2006.

Resource Mining Corporation: Propose to mine 1.5 to 2.0 Mtpa of direct shipping ore at the Argyle Iron Ore Project and truck the product 170 km to Wyndham for export.

Cape Lambert Iron Ore Ltd: Propose to produce 5 to 7 Mtpa of magnetite concentrate from the Cape Lambert Project located between the towns of Karratha, Roebourne and Wickham. The \$300 million project is planned for commencement in late 2009. The company is aiming to complete a Bankable Feasibility Study by late 2006.

Atlas Gold: Plan to commence a scoping study in mid-2006 on the Pardoo Iron Ore Project 75 km east of Port Hedland. Atlas propose to commence development of a 1 to 2 Mtpa direct shipping operation in 2007.

Sherlock Bay Nickel Corporation: The US\$1.0 billion Cane River Project proposes to produce 15.5 Mtpa of a direct shipping iron ore sinter feed product of plus 60% iron consisting of a blend of one part high grade magnetite concentrate from the Balmoral Southern Block (80 km west of Karratha) and two parts Cane River pisolite (150 km south of Balmoral Southern).

Golden West Resources: About 0.5 Mtpa of hematite is planned to be trucked 700 km from the Wiluna West project to Geraldton over four years commencing in 2007.

Geraldton Iron Ore Alliance: In December 2005 Midwest Corporation, Murchison Metals Ltd and Gindalbie Metals Ltd agreed to cooperate to facilitate the development of the iron ore industry in the Geraldton and mid west region.

Port of Geraldton: The Western Australian State Government has committed \$35 million to an upgrade of the port to increase the iron ore shipping capacity to 10 Mtpa. The upgrade includes a new shiploader at Berth 5 which is expected to be completed in late 2007.

SOUTH AUSTRALIA, TASMANIA AND NORTHERN TERRITORY

OneSteel Ltd: In May 2005 the company committed to the \$325 million Project Magnet that involves conversion of the Whyalla Steelworks from a hematite to magnetite ore feedstock. This will reduce steelmaking costs by up to 5% and extend the life of the steelworks from 2020 to beyond 2030. The project includes a mine cut back, magnetite concentrator, a 62 km slurry pipeline and conversion of the pellet plant and is due to be fully operational in the 2007/08 financial year.

Stemcor Holdings Ltd: In early 2005 Ivanhoe Mines Ltd sold the Savage River mine to Stemcor. The production at the open-pit mine is planned to cease in 2007 with pellet production ending in 2009. A scoping study found that it is technically feasible to block cave a large orebody under the North Pit and Stemcor plan to undertake a feasibility study into underground development.

Territory Iron Ltd: Plan to produce 1 to 2 Mtpa from 2007 at Frances Creek located 200 km south of Darwin and 18 km from the new Alice Springs-Darwin railway.

INDUSTRY DEVELOPMENTS—IRON AND STEEL

Operating and proposed Direct Reduced Iron (DRI) and steelworks in Australia include:

- Pig iron is produced in blast furnaces at **Port Kembla** and **Whyalla**.
- Steel is produced at Port Kembla, Whyalla, **Rooty Hill**, **Mayfield** and **Laverton North**.
- In August 2005 BHP Billiton announced that the permanent closure of the Hot Briquetted Iron facilities at the **Boodarie** Iron plant in Port Hedland. Demolition is due to commence early in 2006 and is expected to be completed in late 2008.
- Construction of the \$400 million **Hismelt** DRI processing plant at Kwinana was completed in April 2005. Production is planned to ramp up to design capacity of 0.8 ktpa over three years. Rio Tinto invested approximately \$600 million developing the Hismelt technology between 1982 and 2003. The technology is designed to produce pig iron significantly cheaper than conventional methods by removing the need for coke ovens and/or sintering and pelletising facilities. The Commonwealth Government provided a \$50 million grant to Hismelt for the development of multi-user infrastructure.

- **Westralian Iron Pty Ltd** (associated with **Mt Gibson Iron**) has commenced a feasibility study to determine the viability of producing iron near Dongara. The study will investigate progressively constructing four 500 ktpa modules using the Midrex rotary hearth furnace technology, magnetite from Koolanooka South and coal from near Mingenew.
- **Aviva Corporation:** Commenced a pre-feasibility study into an Ironmaking (0.5 Mtpa) and Cogeneration (50 MW) facility based on the Central West coal deposit near Eneabba (WA).
- **Iluka Resources:** Commenced a pre-feasibility study to investigate one or two ironmaking plants based on the synthetic rutile iron oxide residues at plants in Capel and Geraldton (WA)
- **Ferro West Pty Ltd:** Intends to study the feasibility of a 0.5 to 1.0 Mtpa iron making project based at Yalgoo, east of Geraldton (WA).

Lithium

Lithium (Li) is a silvery grey metal with a density about half that of water. Sons of Gwalia's Greenbushes mine in Western Australia is the world's second largest producer of lithium minerals. Greenbushes products have a range of uses that include production of specialty glasses, ceramics and ceramic glazes, glass bottles. Its ore (predominantly spodumene $\text{Li}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2$) is also a feedstock for the production of lithium carbonate in the chemical industry.

Resources

All of Australia's lithium resources are in Western Australia and the Greenbushes deposit, the world's largest and highest grade spodumene deposit, in the southwest of the state accounts for all EDR.

EDR in 2005 increased slightly to 170 000 t, due mainly to a reassessment of resources. Other resource classifications remained unchanged.

Exploration

There are no statistics available on exploration expenditure for lithium. With continuing world oversupply of lithium, particularly in the form of lithium-rich brines notably from Chile, as well as increased resource definition at Greenbushes, substantial exploration expenditure in Australia is unlikely in the near future.

Production

Chile was the largest producer of lithium minerals in 2004, followed by China and potentially Australia. The supply of lithium carbonate from brine operations in Chile and Argentina, along with increased production in China, is continuing to impact negatively on the price and supply of lithium minerals on the world markets.

World Resources

According to estimates published by the USGS, Chile holds approximately 73% of the world's lithium resources followed by China with 13%, Brazil with 4.6% and Canada with just over 4%. Resource data are not available for some important producing countries including Argentina and Russia. Lithium resources occur in two distinct categories—lithium minerals and lithium-rich brines. Lithium brine resources, now the dominant feedstock for lithium carbonate production, are produced dominantly by Chile. Canada, China and Australia have the most significant resources of lithium minerals.

World production of lithium in 2005 was estimated by GA and USGS data to be 21 300 t of contained lithium, an increase of 37% from 2004. However, information on USA production is withheld by the USGS for commercial reasons. Chile with 39% remained the world's largest producer, followed by Australia (20% for part year), China (13%) and Russia (11%).

Industry Developments

Sons of Gwalia operations remained in receivership in 2005. Production of lithium from Greenbushes continued during this period.

Magnesite

Magnesite (magnesium carbonate) is marketed in three main forms: (1) crude magnesite, primarily for use in chemicals and agriculture; (2) dead-burned magnesia, a durable refractory for use in cement, glass, steel and in metallurgical industries; and (3) caustic calcined magnesia, for use in making oxychloride and oxysulphate cements for flooring and wallboards, mouldings and acoustic tiles, and various environmental and chemical applications.

Resources

EDR of magnesite remained unchanged at 344 Mt in 2005. South Australia has the largest holding of magnesite EDR with a global resource of 579 Mt. About 235 Mt of this resource is classified as EDR, unchanged from 2004.

Queensland has the second largest inventory of magnesite EDR. The bulk of this occurs at Kunwarara (70 km northwest of Rockhampton), where Australian Magnesium Corporation Ltd has an inferred global resource of 1200 Mt of magnesite-bearing material. Within this global resource, which has an inferred resource of 500 Mt of magnesite, the company has identified several high-grade magnesite zones which are classified as EDR. The Kunwarara deposit contains substantial accumulations of very high-density "bone-type" magnesite characterised by nodular and cryptocrystalline structure and low iron-content.

The third largest inventory of EDR is in Tasmania where the Arthur River deposit has an indicated resource of 26 Mt. Magnesite in the deposit typically grades 42.8% MgO and is part of a much larger global resource of 195 Mt in the Arthur-Lyons River area, about 53 km south of Burnie.

Minor EDR occurs in the Winchester deposit (near Batchelor, NT), at Thuddungra (80 km northwest of Young, NSW), and at Bandalup (20 km east of Ravensthorpe, WA)

Subeconomic demonstrated resources of 57 Mt of magnesite remained unchanged from 2004. All of these resources occur in Queensland and Tasmania.

Inferred resources remained steady at 931 Mt with Queensland accounting for 50% of these resources followed by South Australia (31%) and Tasmania (16%).

Accessible EDR

All magnesite EDR is accessible for mining.

JORC Reserves

About 11% of AEDR comprise JORC Code reserves. The remaining represents resources assessed by Geoscience Australia from the measured and indicated categories of industry reported mineral resources, as defined under the Code and other classification systems used by companies not listed on the Australian Stock Exchange. At Australia's 2005 rate of production, magnesite resources in the JORC Code reserves categories are adequate for 64 years.

Exploration

Data relating to exploration expenditure for magnesite are not published by ABS on either a state or national basis.

Production

There was no recorded production of magnesite in 2005. USGS data indicate that Russia (30%), North Korea (20%) and China (17%) were the largest producers of magnesite in 2005.

World Ranking

According to Geoscience Australia and USGS data, Australia has about 5% of the world's EDR of magnesite. Russia, North Korea and China, together, account for nearly 70% of the world's EDR of magnesite. The Kunwarara deposit is the world's largest known resource of cryptocrystalline, nodular magnesite, a high quality ore.

Industry Developments

There were no major developments in Australia's magnesite industry in 2005.

Manganese Ore

Manganese (Mn) is the twelfth most abundant element in the Earth's crust. Some 300 minerals contain manganese, the most common being pyrolusite (MnO_2) and rhodochrosite (MnCO_3). Manganese is the fourth most used metal after iron, aluminium and copper. About 90% manganese ore worldwide is consumed in the steel industry, the majority of which is processed initially into manganese alloys. Manganese is an essential input to steel-making due to its ability to desulphurise, prevent oxidation and improve toughness and hardness. No satisfactory substitute for manganese in steel has been identified due to the relatively low price and outstanding technical benefits. After steel the second most important market for manganese is in dry battery production. It is also used in fertilisers, animal feed and as a colorant.

In Australia there are three operating manganese mines—Groote Eylandt, Bootu Creek (NT) and Woodie Woodie (WA). Bootu Creek commenced operations in late 2005. Manganese ore is processed in plants at Bell Bay (Tas) and Newcastle (NSW).

Resources

In 2005 Australia's EDR of manganese ore increased by 7.1% to 143 Mt with increases in resources at Woodie Woodie and Groote Eylandt. Paramarginal demonstrated resources decreased 17.8% to 23 Mt due reclassification of resources at Bootu Creek and subeconomic demonstrated resources remained unchanged at 167 Mt. Inferred resources increased 15.3% to 155 Mt due increases at Groote Eylandt and Bootu Creek.

Accessible EDR

All manganese ore EDR (143 Mt) is accessible. The resource life is about 18 years on current rates of production of beneficiated manganese ore.

JORC Reserves

Manganese ore JORC reserves are 120 Mt (84% of accessible EDR). The resource life based on JORC reserves and at the current rate of production of beneficiated manganese ore is about 15 years.

Exploration Expenditure

Data relating to exploration expenditure for manganese are not published by ABS on either a state or national basis.

Consolidated Minerals maintained a \$8 million per annum exploration program at Woodie Woodie designed to increase its resource and reserve inventory. Exploration drilling during 2005 intersected 40 m of high-grade manganese at the Canyon Prospect 300 m east of the Mike mine. OM Holdings plan to commence a \$2.0 million 20 000 m drilling program in the June quarter aimed at doubling the current resource base at Bootu Creek. De Grey Mining Ltd has discovered manganese at the Beyondie Project, 160 km south of Newman. Hole BBRC009 returned 4 m @ 21.0% Mn from 16 m.

Production

In 2004 production of manganese ore at Groote Eylandt totalled 2.73 Mt and at Woodie Woodie 0.65 Mt. ABARE report that Australia produced 3.38 Mt of beneficiated manganese ore (2.5 Mt 2003). Exports for 2004 totalled 2.82 Mt (2.1 Mt 2003) valued at \$402 million (\$312 million 2003).

World Ranking

Australia has 10% of the worlds EDR of manganese ore and is ranked fourth behind Ukraine (34%), India (21%) and China (17%). In terms of contained manganese, Australia has 15% of world EDR and is ranked third behind Ukraine (33%) and India (22%).

Australia produces 14% of the world's manganese ore and is ranked third behind China (16%) and South Africa (18%).

Industry Developments

At Grootte Eylandt, GEMCO is aiming to increase the rate at which ore is fed into the concentrator. As a result of a concerted assessment of unscheduled stoppages and operating procedures in 2004–05 improved production resulted in an increase in revenue of \$10.6 million

Consolidated Minerals at Woodie Woodie, 400 km SE of Port Hedland, completed a \$6.5 million expansion of production, which resulted in an increase in production to 1.0 Mtpa by mid-2005. A new crushing circuit, commissioned in late 2005, has enhanced performance in its processing plant. The operation sources ores from multiple open-pits, which are blended to maintain consistent product specifications.

The \$45 million Bootu Creek manganese project, 110 km north of Tennant Creek (NT), commenced mining in late 2005. A 60 km haul road has been constructed to a rail siding on the Alice Springs-Darwin railway. Approximately 600 000 tpa of lump and fines products are planned to be railed 900 km to Darwin's East Arm Port, with initial shipments expected to commence in early 2006.

With rising construction costs and OMG Cawse Nickel's decision not to proceed with integrating the two processing plants, **HiTec Energy Ltd** has deferred plans to produce electrolytic manganese dioxide (EMD) at the Cawse nickel operation north of Kalgoorlie. Compass Resources purchased HiTec's Kalgoorlie assets for the Browns Project in the Northern Territory.

Mineral Sands

The principal components of mineral sands are the titanium minerals—rutile (TiO_2) and ilmenite (FeTiO_3), and zircon (ZrSiO_4). Rutile and ilmenite are mainly used in the production of titanium dioxide pigment with a small portion, less than 4% of total titanium mineral production, typically rutile, used in making titanium sponge metal. Zircon is used as an opacifier for glazes on ceramic tiles, in refractories and for the foundry industry. Recently there has also been some interest in monazite as a source for thorium for possible use in thorium nuclear reactors for electricity generation.

Resources

EDR of ilmenite decreased by 1% to 214.9 Mt in 2005, down from 217.2 Mt in 2004.

About 59% of Australia's EDR of ilmenite is in Western Australia, 25% in Queensland and the rest in New South Wales (7%), Victoria (6%) and South Australia (3%).

A small quantity of ilmenite EDR, about 54 000 t, has been reported from the Northern Territory in 2005.

EDR of rutile (which includes leucoxene in Western Australia) increased marginally by 1.5% from 20.2 Mt in 2004 to 20.5 Mt in 2005. Queensland has the largest share of Australia's rutile EDR with 35% followed by New South Wales with about 22.6%. Western Australia has approximately 20.5% of the resources with Victoria holding 19.0% and South Australia 2.8%. Northern Territory has about 42 000 t of rutile.

Australia's EDR of zircon increased by 9.7% from 30.0 Mt in 2004 to 32.9 Mt in 2005 with Western Australia and Queensland accounting for 68.2% of Australia's zircon EDR. The balance of zircon EDR was distributed among New South Wales (11.1%), Victoria (8.4%) and South Australia (12.1%).

Australia's subeconomic demonstrated resources of ilmenite, rutile and zircon in 2005 amounted to 54.3 Mt (an increase of 6.5%), 13 Mt (+8.3%) and 20.2 Mt (+6.3%), respectively. Over 99% of these resources are recorded in the paramarginal category, and are associated with the WIM deposits in the Murray Basin in Victoria. The WIM deposits also contain 14.38 Mt of leucoxene.

Inferred resources of ilmenite decreased to 116 Mt from 118.9 Mt in 2004. Most of this decrease was in Victoria. Victoria has the largest proportion of Australia's inferred ilmenite resources with 46% followed by New South Wales with 21%, Western Australia 18% and Queensland, with 12%.

Inferred resources of rutile remained unchanged at 29 Mt. Victoria has the largest share of Australia's inferred rutile resources with 53.5% of the Australian total followed by New South Wales (33.7%) and South Australia (6.5%).

Inferred resources of zircon decreased by 9.1% with the largest decreases in South Australia and Western Australia. Victoria is the main holder of zircon inferred resources with 56% of the Australian total, followed by New South Wales (20%), Western Australia (11%) and South Australia (7%).

Accessible EDR

A significant portion of mineral sands EDR is in areas quarantined from mining, which are largely incorporated into national parks. Geoscience Australia estimates that some 17% of ilmenite, 28% of rutile and 25% of zircon EDR is unavailable for mining. Deposits in this category include Moreton Island, Bribie Island and Fraser Island; Cooloola sand mass; Byfield sand mass and Shoalwater Bay area, all in Queensland, and Yuraygir, Bundjalung, Hat Head and Myall Lakes National Parks in New South Wales.

JORC Reserves

Approximately 17% of ilmenite, 17% rutile and 15% zircon of accessible EDR (AEDR) comprise JORC Code reserve. The remaining represents resources assessed by Geoscience Australia from the measured and indicated categories of industry reported mineral resources, as defined under the Code and other classification systems used by companies not listed on the Australian Stock Exchange.

Duration of Resources

At Australia's 2005 rate of production, AEDR of ilmenite, rutile and zircon are sufficient for an average of 89, 84 and 57 years respectively. However, resources in the JORC Code reserves categories are adequate for only 18 years for ilmenite, 19 years for rutile, and 11 years for zircon.

Exploration

According to quarterly ABS figures, expenditure on exploration for mineral sands in 2005 was estimated at \$30.1 million (compared with \$24.7 million in 2004). This represents an increase of about 22% over the previous year.

Production

In 2005, Australia produced 2.03 Mt of ilmenite, 177 000 t of rutile, 55 000 t of leucoxene and 426 000 t of zircon (compared with 1.93 Mt of ilmenite, 162 000 t of rutile, 44 000 t of leucoxene and 442 000 t of zircon in 2004). The bulk of Australia's rutile (168 000 t) and zircon (422 000 t) production is exported compared to about 714 000 t for ilmenite. The remaining ilmenite is upgraded to synthetic rutile containing about 92–94% TiO₂. In 2005, Australia produced 752 000 t of synthetic rutile (compared with 720 000 t in 2004).

World Ranking

According to Geoscience Australia and USGS data, Australia has the world's largest EDR of rutile and zircon with 40%, and 43%, respectively and has the second largest share of the world's ilmenite at 19% behind China (34%). Other major country rankings include India (15%), South Africa (11%) and Norway (6%) for ilmenite; South Africa (16%) and India (15%) for rutile; and South Africa (28%) and Ukraine (8%) for zircon.

In 2005, world production of ilmenite increased by 0.6% to 9.02 Mt, rutile decreased by 5.3 % to 375 000 t, and zircon increased by 0.9% to 1 080 000 t. Australia is the largest producer of rutile with about 47% of the world production followed by South Africa with 31% and Ukraine with 16%. It is the largest producer of ilmenite with 23% followed by South Africa with 20% of the world's production and also the largest producer of zircon with 40% with South Africa second with 31%.

Industry Developments

In 2005, Australia produced 2.03 Mt of ilmenite, 177 000 t of rutile, 55 000 t of leucoxene and 442 000 t of zircon. Companies that produced heavy mineral sands during 2005 were Iluka Resources Ltd, BeMax Resources Ltd, TiWest joint venture, and Doral Mineral Sands Pty Ltd, all in Western Australia and Consolidated Rutile Ltd (Queensland). Production commenced from BeMax's Ginkgo mine in the Murray Basin in New South Wales in December 2005 and from Iluka's Douglas project in Victoria also in the Basin. Other potential greenfields mineral sands projects in Australia include Matilda Minerals Ltd's Andranangoo and the Lethbridge deposits on Melville Island in Northern Territory, Australia Zircon NL's Mindarie project in South Australia and the Coburn project of Gunson Resources Ltd in Western Australia.

Iluka Resources Ltd heavy mineral sand operations in Western Australia are located in two regions. The Mid-West region north of Perth comprise the main mines of Eneabba (two wet concentrators, five mining units) and Gingin (wet concentrator, one mining unit). The Narngulu facility at Geraldton include mineral separation, zircon finishing and synthetic rutile plants and port operations and storage facilities at Geraldton. Full production at the Gin Gin mine site commenced from July 2005, and production from the zircon-rich Adamson deposit at Eneabba started in early 2006. The company has also proposed starting site preparation and construction at Cataby in late 2006 with mining to commence in late 2007. Production of heavy mineral sand commodities from Mid-West region in 2005 amounted to 74 000 t of rutile, 252 000 t of synthetic rutile, 467 000 t of ilmenite, 204 000 t of zircon.

South of Perth is Iluka's South-West region based on mines at Yoganup Extended, Yoganup West (wet concentrator and mining unit at each site), and production commenced at Wagerup in June 2005 (wet concentrator and mining unit). Iluka also propose commencing construction of a mineral sands mine north of Waroona in 2006 with mining to start in early 2007. Production in the Iluka's South-West region amounted to 62 000 t of rutile, 160 000 t of ilmenite and 53 000 t of zircon. Iluka reported production in this region of 13 337 t of the proprietary product Hyti 91, and 11 153 t of Hyti 70.

Iluka Resources Limited's Douglas project in Victoria is based on the resources of three main deposits comprising the Bondi Main, Bondi West and Bondi East. The infrastructure comprises a single mining unit plant, a wet concentrator plant, and a mineral separation plant located at Hamilton to produce the final specification rutile and zircon. Iluka Resources Limited announced in April 2006 that following the completion of commissioning trials, Iluka has taken over from the contractor the operation of the mining unit plant and the wet concentrator plant at its Douglas mineral sands operations in the Murray Basin, Victoria. The construction of the mineral separation plant is expected to be completed in September 2006. By April 2006, approximately 800 000 tonnes of heavy mineral ore has been mined, of which approximately 260 000 tonnes has been processed including for commissioning activities, producing 14 000 tonnes of heavy mineral concentrate. 540 000 tonnes of heavy mineral ore is stockpiled adjacent to the wet concentrator plant. Ilmenite produced will be initially returned to the mine.

Iluka expects the Douglas project to reach full production in 2007 with a combined production level of rutile and zircon of about 180 000 t. In addition to the Douglas project, the company has delineated 27.2 million tonnes of heavy mineral ore in the northern Murray Basin with one group of deposits at Ouyen in northwest Victoria comprising Kulwin, Woonack, Rownack, Rainlover, and Pirro, and another group at Euston in New South Wales comprising Castaway, Kerribee, Earl, Dispersion and Koolaman. During 2006 Iluka will continue with evaluation and detailed planning on development of the northern Murray Basin deposits and pre-feasibility work has commenced on the Kulwin deposit with possible production start up in 2007. The development of Kulwin will involve the construction of an additional mining unit plant and wet concentration plant, with concentrate hauled by truck to Hamilton for treatment at the mineral separation plant.

In 2004 the company discovered the zircon-rutile-ilmenite deposits of Ambrosia and Jacinth in the Eucla Basin in South Australia and in 2005 announced an indicated resource for the two deposits of 7.9 Mt of heavy mineral. In November 2005, Adelaide Resources Ltd and Iluka Resources announced the discovery of the Tripitaka heavy mineral sand deposit in their Colona Joint Venture area, 90 km



The Ginkgo Mine at the Pooncarrie Project showing Amanda II dredge and the floating concentrator being assembled in the bottom of the construction pit, New South Wales (Bemax Resources NL).

southeast of the Jacinth and Ambrosia deposits in South Australia. The joint venturers completed a detailed drilling program during the first half of 2006 to enable the estimation of a mineral resource at the Tripitaka deposit. The Tripitaka discovery was followed by the discovery of the Gulliver's Prospect, about 160 km southeast of Tripitaka and 60 km east of Ceduna in South Australia. The heavy mineral grades are reported to be relatively uniform across the prospect in the range of 1 to 3% with individual samples up to 8% heavy minerals. The mineral assemblage appears to be dominated by ilmenite rather than zircon comprising about 60% altered ilmenite, 21% zircon, 5% leucoxene and 2% rutile. Iluka reported that pre-feasibility work for the Eucla Basin deposits is being undertaken in the context of remote location of the Eucla Basin deposits and major infrastructure requirements for their potential development.

The TiWest JV (Kumba Resources Ltd 50%, Kerr McGee Corp 50%) operates an integrated titanium dioxide project in Western Australia, incorporating a dredging and dry-mining heavy mineral sands operation at Cooljarloo, dry separation and synthetic rutile plants at Chandala and a titanium dioxide pigment plant in Kwinana, which is the largest pigment producer in Australia. Production in 2005 was approximately 440 000 t of ilmenite, 70 000 t of zircon, 32 000 t of rutile, 24 000 t of leucoxene, 222 000 t of synthetic rutile and 106 000 t of TiO₂ pigment. Current reserves for the Cooljarloo operations are 174 Mt of ore averaging 2.8% heavy mineral sands. In November 2005, Kumba Resources bought out minority interest in Ticor Ltd, thereby increasing Kumba's stake in Ticor from 51.54% to 100%.

To the end of 2005, Consolidated Rutile Ltd's operations at the Yarraman and Enterprise mines on North Stradbroke Island produced 71 500 t rutile and 53 389 t zircon, representing a combined improvement of 21 % over the 2004 production figures. The increase was partly due to the introduction of supplementary dry mining operations in late 2003. The ilmenite production increased marginally by 29% to 160 469 t. Commercial production from the Enterprise mine commenced in October 2005. Higher than expected grade and consistent mine productivity through difficult ground at the Yarraman Mine contributed to the strong production performance.

The heavy mineral resources/reserves controlled by BeMax are located in old shorelines in two geological/geographic provinces—the Murray Basin of Victoria and New South Wales and the South West region of Western Australia.

BeMax Resources NL has reported that it has 67.5 Mt of heavy mineral resources, of the company's 81 Mt, over an area of 7000 km², in the Murray Basin—enough resources to sustain mining for up to 60 years. The overall average grade for the total resource is 2.9% heavy minerals containing 53% ilmenite, 17% rutile and 10% zircon.

BeMax's Pooncarie Project is located in the northern part of the Murray Basin of New South Wales, it consist of the Ginkgo and Snapper deposits, and contains in excess of 10 Mt of heavy minerals with a mine life of over 20 years.

Production at the Ginkgo mine commenced in December 2005 and all of the production from the mine is fully sold to global clients. By 31 March 2006, 1.68 Mt of ore had been mined for a heavy mineral concentrate production of 86 363 t. The first truck loads of products left the mine site at end of January for further processing at the Broken Hill mineral separation plant. The gravity circuit to process the zircon/rutile rich non-magnetic concentrate was fully operational by mid February with the leucoxene plant brought on line soon after. The first product railing from Broken Hill to Port Adelaide took place in April and the first shipment of 22 000 t of zircon and rutile rich non-magnetic product was made at end of May 2006 to company's mineral separation plant in Bunbury, Western Australia. In June 2006 the company announced that the commissioning of the Bunbury plant upgrade and expansion has been completed.

In continuing exploration in the Murray Basin, BeMax reported drilling of the Campaspe deposit extended the deposit 4.5 km to the north and two further deposits, Wakool and Coliban, have been identified south of Campaspe which will require follow up drilling.

BeMax's heavy mineral sand resources in South West region of Western Australia in 2005 totalled 13.9 Mt of heavy minerals at an average grade of 9.6% heavy minerals containing 82% ilmenite and 9% zircon. In 2005, BeMax's operations in the region produced 275 153 t of heavy mineral concentrate. Production of heavy mineral commodities comprised 173 790 t of ilmenite, 11 684 t of secondary ilmenite, 3398 t of leucoxene, 20 028 t of zircon and 543 t of rutile. Producing mines in 2005 comprised Ludlow, Tutunup South Mine (commenced operations in February 2006) and Tutunup Mine (shut down in September 2005). Approval for the development of the Gwindinup deposit was received at the end of 2005 which will come on line when operations are completed at Ludlow during 2007. The company's mineral separation plant at Bunbury treats material from its own mines as well as on toll treatment basis for a number of customers. During 2005 the mineral separation plant underwent a \$6 million upgrade to allow it to simultaneously process feedstock from the Western Australian and Murray Basin operations as well as a wider variety of toll treatment feedstock.

Early in 2006, Australia Zircon NL commenced construction mining facilities at its Mindarie deposits, 148 km east northeast of Adelaide, South Australia. Reserves at the deposit amount to 59 Mt at 4.3% heavy minerals.

Australian Zircon NL is also earning an 80% participating interest in its WIM 150 Joint Venture with Austpac Resources NL. Australian Zircon continued with a comprehensive review of all data derived from drilling and assaying undertaken on the WIM 150 fine grained heavy mineral resource in the 1980's. The company also processed a WIM 150 heavy mineral concentrate sample through a two stage wet magnetic separation circuit to recover an acceptable zircon concentrate and a raw ilmenite stream. Primary and secondary ilmenite concentrates were produced from a sample of magnetic concentrate produced at Roche MT from WIM 150 heavy mineral concentrate. Austpac has previously demonstrated that a +95% TiO₂ synthetic rutile can be produced from the fine WIM 150 ilmenite, and that the synthetic rutile product can be agglomerated.

Austpac Resources NL continued the upgrading of its pilot plant at Kooragang Island, Newcastle, to a fully integrated demonstration plant with a nominal capacity of 1500 tpa of high grade synthetic

rutile produced from ilmenite, a possible source for ilmenite being heavy mineral sand deposits in the Murray Basin. The scale-up factor from the demonstration plant to the 30 000 tpa synthetic rutile plant will be less than 25:1. Detailed process data from the demonstration plant will be used to complete the final plant design and obtain capital and operating cost estimates for the 30 000 tpa plant. The company commenced the first stage of the upgrade of its plant using existing cash reserves. Additional funds are being sought to complete the project.

Astron Ltd's Donald project comprises the Donald (WIM 250) and Jackson (WIM 200) heavy mineral sand deposits in the Murray Basin in Victoria. In January 2006 the company reported a total indicated and inferred resource for the project of 693 Mt with a heavy mineral content of 5.1%. Contained within this resource is an indicated and inferred resource of 477 Mt at 1.1% zircon, 1.8% ilmenite, 0.3% rutile and 1.1% leucoxene. A pre-feasibility study was completed in May 2005. The project is planned to be a 7.5 Mtpa mining operation, producing 500 000 tpa of heavy mineral concentrate for export to China. Pending the required regulatory approvals, construction is to commence during the second half of 2007, with first production shipment slated for the first half of 2008.

In April 2006 Olympia Resources NL announced a new heavy mineral sand resource at Yayalup in southwest of Western Australia. The total upgraded heavy mineral resource inventory held by the company now amounts to 128.518 Mt of measured, indicated and inferred tonnes of mineral sand at 3.8% heavy minerals for 4.911 Mt of heavy minerals. The completion of a bankable feasibility study for the Keysbrook mineral sands project was announced by the company in September 2005. The company plans to start mining at the Keysbrook project, south of Perth, in 2007. The company has signed a sales agreement with DuPont to sell all of its titanium production from Keysbrook. A long-term zircon contract for 6000 tpa, representing half of the zircon production from Keysbrook, was signed earlier in the year with a major European zircon miller.

Gunson Resources Limited announced, for their Coburn Project in Western Australia, an indicated resource of 305 Mt with 1.4% heavy minerals with additional 420 Mt of inferred resource at 1.4% heavy minerals. Western Australia state environmental approvals for the project were passed in May 2006 and in early 2006 the company signed a memorandum of understanding with two Chinese customers for over 40% of the proposed 30 000 tpa initial zircon production from Coburn over a five year period.

Matilda Minerals Ltd announced updated reserves of 4.86 Mt at 4.5% heavy minerals for their Tiwi Islands mineral sands project in Northern Territory. The Tiwi Islands are located north of Darwin and comprise the Melville Island in the east and Bathurst in the west. The reserves are contained in three deposits, the Andranangoo and the Lethbridge on the north coast of the Melville Island and the Puwanapi on the west coast of the Bathurst Island. The deposits contain 72 000 t zircon, 42 000 t rutile, 24 000 t leucoxene and 52 000 t ilmenite. In May 2006 the company received environmental assessment approval for the project from the Northern Territory Government and approval for the mining of mineral sands at the Andranangoo and the Lethbridge deposits was granted by the Commonwealth Government in July 2006.

Image Resources NL announced that ground magnetic surveys outlined 36 km of potential heavy mineral strands within their Bidamina project, approximately 100 km north of Perth. Follow up drilling in mid 2006 outlined a broad mineralised zone more than 500 m wide with a best intersection of 12 m at 5.4% heavy minerals from 34 metres.

Image reported that drilling at their joint venture area with Metal Sands Pty Ltd at Cooljarloo, suggest a new style of heavy mineral concentration which may be related to channels developed below the strand line mineralisation. At least two channels have been intersected, which are steep sided, at least 200 m in apparent width, and discordant to the flat-lying mineralised strandlines that occur above them. A further five channels have been identified on the southeastern part of the tenement, some of which straddle the tenement boundary. The scout drilling identified a 200 m-wide mineralised zone including intersections of 12 m at 2.7% heavy minerals from 28 m and 2 m at 9.2% heavy minerals from 16 m.

Nickel

More than 80% of the world's nickel (Ni) production is used in alloys. When alloyed with other elements, nickel imparts toughness, strength, resistance to corrosion, and various other electrical, magnetic and heat resistant properties. About 65% of world nickel output is consumed in the manufacture of stainless steel. Stainless steels are widely used in the chemical industry, consumer products (eg. sinks, cooking utensils, cutlery and white-goods), motor vehicles and the construction industry.

Resources

There was an increase in Australia's EDR of 5.8% in 2005 from 22.6 Mt to 23.9 Mt. The increase was due to ongoing detailed resource definition. Of this amount, about 44% of EDR was in sulphide ores, and the remaining EDR was associated with laterites.

Western Australia remains the largest holder of nickel resources with over 90% of total Australian EDR. Nickel production continued at the operating sulphide mines of BHP Billiton's Leinster and Mt Keith; LionOre Mining International Ltd's Black Swan and Emily Ann; Jubilee Mines NL's Cosmos; Mincor Resources NL's Miitel, Wannaway, and production commenced at Mariners in the first quarter of 2005. Sulphide nickel production continued or commenced at another eight mostly small mines. Mining of lateritic nickel continued from the Minara Resources NL's Murrin Murrin mine and from the OMG's Cawse mine. Despite the continuing production from the sulphide nickel mines, the EDR for sulphide nickel increased from 9.7 Mt to 10.4 Mt in 2005, whereas lateritic nickel increased from 12.9 Mt to 13.5 Mt.

New South Wales is the second largest holder of EDR with 6.6%, followed by Queensland 2.5%, Tasmania 0.3% and Northern Territory at 0.1%. Nickel resources in both New South Wales and Queensland are associated with laterite deposits, whereas EDR in Tasmania and Northern Territory are mostly sulphides.

Subeconomic demonstrated resources, which accounted for about 7.1% of total identified resources, decreased by 0.7 Mt during the review period. The paramarginal resources decreased by 0.5 Mt while the submarginal resources decreased by 0.2 Mt in 2005. Western Australia has 77% of the submarginal resources.

Inferred resources increased by 0.8 Mt (4%) to just over 20 Mt in 2005. Western Australia maintained its dominant share of Australia's inferred resources at around 90% followed by Queensland with 7%.

The ratio of inferred resources to EDR remained unchanged in 2005 compared to the previous year.

Accessible EDR

Currently, all nickel EDR is accessible for mining. At the rate of production in 2005, AEDR of nickel (including both sulphide and laterite) are sufficient for an average of over 120 years.

JORC Reserves

About 29% of AEDR comprise JORC Code reserve. Of this amount, about 32.7% occur in nickel sulphide deposits and the remaining in nickeliferous laterite deposits. The remaining 71% of EDR represents resources assessed by Geoscience Australia from the measured and indicated categories of industry reported mineral resources, as defined under the Code and other classification systems used by companies not listed on the Australian Stock Exchange.

Total JORC Code reserves of nickel are adequate for an average of 37 years at current rates of production.

Exploration

Expenditure on nickel-cobalt exploration for 2005 calendar year, as reported by ABS, was A\$168.1 million, an increase of 42% over 2004. Western Australia attracted most of this expenditure with \$152.2 million. Nickel sulphide and lateritic nickel deposits in the Yilgarn Craton, Western Australia

continued to attract the bulk of the exploration expenditure followed by significant exploration activity in other regions of Western Australia including the Pilbara and Kimberley.

Some of the exploration results of interest in 2004 include the following:

- Underground drilling by Sally Malay Mining Ltd at its Sally Malay deposit encountered significant intersections suggesting extensions to the deposit and included 23 m at 3.15% Ni, 1.22% Cu and 0.16% Co.
- Drilling by Sally Malay Mining Ltd at its Lanfranchi JV project for extensions from the previously mined Schmitz/Skinner/Winner deposits included intersections of 6.78 m at 5.13% Ni from 210.72 m (true thickness 4 m),
- Western Areas NL are concentrating their drilling efforts at Flying Fox in order to prove up additional resources and bring the mine into production by end of 2006. Intersections of high nickel grades included 11.7 m at 7.1% Ni from 965.6 m at T5 and an unusual zone of granite hosted sulphide was intersected at T4 with 13.7 m at 4.6% Ni.
- Exploration drilling by Jubilee Mines NL in 2005 at its Prospero deposit, included intersections of 30.5 m at 7.6% Ni, 19.6 m at 10.3% Ni, and 15.7 m at 8.7% Ni. High-grade massive sulphides were reported by Jubilee from the Tapinos (Anomaly 4) deposit located 3.5 km south of the Cosmos nickel mine and 300 m up-dip (north) of the Prospero deposit. Intersections included some very high grades of 1.13 m at 17.8% Ni and 2.83 M at 15.5% Ni.
- Three kilometres south of the Cosmos mine at Anomaly 9, Jubilee reported an intersection of 28 m at 1.1% Ni from 168 m.
- In November 2005, Jubilee announced a new nickel discovery at its Sinclair prospect in the Bannockburn Project area near Leonora and about 90 km south of its Cosmos nickel operations. Significant intersections included 24 m at 3.73% Ni from 91 m.
- Drilling by Fox Resources Ltd of the Ashlea Lode at the B2 Nickel Project intersected 9.84 m at 1.42% Ni, 1.26% Cu, from 256 m. Drilling at Ruth Well intersected 11 m at 4.3% Ni, 1.5% Cu and 0.13% Co from 55 m.
- Much of the exploration by Mincor Resources NL was directed towards locating extensions to its existing mines of Miitel, Redross and Mariners. As a result of this drilling, the company announced the discovery of the South Miitel deposit that included an intersection of 11.5 m at 2.53% Ni with an estimated true width of 9.4 m. Mincor also announced an agreement with View Resources Ltd to earn a 70% interest in View's Carnilya Hill and associated tenements (excluding existing nickel resources) by spending \$2.5 million on nickel exploration over the next three years.
- Independence Group NL announced the discovery of the McLeay deposit located south of Victor South. The company is also developing an exploration decline towards its Long South target where drill intersections include 3.6 m at 3.3% Ni.
- Ongoing near mine exploration drilling by Allegiance Mining NL intersected significant nickel mineralisation at North Viking including 5 m (3 m true width) at 0.7% Ni and 5 m (3 m true width) at 1.2% Ni at South Viking.
- Results from ongoing drilling of lateritic deposits by Metallica Minerals Ltd in north Queensland included intersections of 21 m at 1.23% Ni from 7 m at Bell Creek South lease and 13 m at 1.23% Ni from 0 m at Minnamoolka, both part of Metallica's NORNICCO project.
- Under a farm-in agreement with View Resources Ltd, Mincor Resources NL restarted exploration at Carnilya Hill in early 2006 and by mid 2006, Mincor announced an intersection of 11 m at 6.95% Ni, located about 200 m down plunge of the existing mine development at Carnilya Hill.

- At the Acra Joint Venture Project with the Pioneer Nickel Ltd, Jubilee is earning 75% interest and drilling in 2005 continued to intersect disseminated nickel sulphides including an intersection of 43 m at 0.45% Ni from 43 m.
- Australian Mines Ltd announced the formation of a joint venture with Pioneer Nickel Ltd to explore for sulphide nickel mineralisation on areas surrounding the Blair nickel mine. Recent drilling at Blair South included 15 m at 1.21% Ni and 0.13% Cu from 102 m.
- Consolidated Minerals Ltd completed a 800 m development/exploration decline from the Beta-Hunt mine to the upper levels of the East Alpha orebody. Consolidated Minerals also reported that drilling at East Alpha to the south and north of the current resource encountered significant mineralisation including 4.3 m at 4.09% Ni, 1.9 m at 2.15% Ni and the latest results in the December quarter, 2005 extended the East Alpha mineralised system to 1.2 km in length. At Munda, a number of holes drilled as part of gold resource definition program also intersected the ultramafic-mafic contact with significant nickel mineralisation, including 11 m at 2.2% Ni from 71 m depth.
- Thundelarra Exploration Ltd announced a drilling intersection at their Copernicus North prospect of 12 m at 1.09% Ni and 0.78% Cu, and 10 m at 1.02% Ni and 0.83% Cu at Copernicus Deeps.
- Nickel Australia Ltd reported an intersection of 16 m at 0.2% Ni, 0.1% Cu, and 0.44g/t PGE (Pd+Pt) at their Monarch prospect near Norseman, Western Australia.

Production

Australia's nickel production increased in 2005 by 1.0% to 189 kt, as reported by ABARE, all from Western Australia. The value of all nickel products exported was A\$3.5 billion. Australia was the world's third-largest producer, accounting for 13% of estimated world nickel output.

World Ranking

Based on figures published by the USGS and modified to incorporate the Australian resources reported here, world EDR of nickel increased by 1.04% to 64.1 Mt in 2005 (61.8 Mt in 2004). Australia's share of world EDR was 37.3% in 2005 (up 0.7% from 2004), and it remained the largest holder of EDR followed by Russia (10.3%), Cuba (8.7%) and Canada (7.0%).

Russia was again the largest producer with 315 kt (21.5%), followed by Canada with 196 kt (13.5%) and Australia with 189 kt (13%). The fourth largest producer was Indonesia with 140 kt (9.6%) and New Caledonia with an output of 122 kt (8.4%).

Industry Developments

ABARE reported that in 2005, world nickel prices averaged US\$14 750 a tonne, 6% higher than the average for 2004. The agency forecasted an average nickel price of US\$16 600 for 2006, 13% higher than the previous year.

Australia has several nickel sulphide mines currently in operation including BHP Billiton's Leinster and Mt Keith, LionOre Mining International Ltd's Black Swan and Emily Ann, Jubilee Mines NL's Cosmos, Mincor Resources NL's Miitel, Redross, Mariners and extraction of remnant ore is continuing at Wannaway, the Independence Gold NL's Long-Victor, and from Consolidated Minerals Ltd's Beta Hunt operation. Production at Sally Malay Mining Ltd's Sally Malay mine has switched to underground mining and the company, in a joint venture with Brilliant Mining Corp. continued mining and delineation of additional ore at the Lanfrachi mine. Sulphide nickel mining also continued from another four small nickel mines and WMC Resources Ltd's concentrator at Kambalda processes ores from third party operators. Two laterite nickel mines were in operation: OM Group's Cawse and Minara Resources NL's Murrin Murrin. All of these operating nickel mines are in Western Australia which also has the nickel smelter at Kalgoorlie, a refinery, at Kwinana. Another refinery is located at Yabulu, Queensland.

In their 2005 US Annual Report (Form 20-F), BHP Billiton reported that their West Australian operations produced 119 291 t of contained nickel-in-concentrate extracted from 14.9 million t of ore processed in the year ended 30 June 2005. Purchased feed from third parties over the same period amounted to 32 202 t of nickel-in-concentrate.

During the year ended 30 June 2005, the Leinster mine production was sourced from the Perserverance underground mine, the 11 Mile Well open-pit and the Harmony open-pit. The Leinster mill has a nominal operating capacity of three million tonnes of ore per year and in the year to 30 June 2005 the mill utilisation was approximately 95% and produced concentrates with a nickel content of about 12%.

The Mt Keith deposit, averaging about 0.52% nickel is mined by open cut and concentrates from the ore contain approximately 23% nickel. The nominal capacity of the Mt Keith concentrator is 11.5 million tonnes of ore per annum and has a current utilisation of about 96%. Metals Exploration Ltd noted in their annual report for 2005 that nickel in concentrate despatched from Mt Keith in 2005 amounted to 38 100 t.

Nickel ore is concentrated at Kambalda, Leinster and Mt Keith and the majority of this concentrate is smelted into nickel matte at the Kalgoorlie Nickel Smelter. The mill and concentrator at Kambalda are fed with third party ore. About 32% of nickel matte was sold to overseas customers and the rest was refined at BHP Billiton's Kwinana Nickel Refinery to produce LME accredited nickel briquettes, nickel powder and other intermediate products such as cobalt-nickel-sulphide.

In August 2005, BHP Billiton approved revised development cost for the Ravensthorpe mine site in Western Australia for US\$1.34 billion and US\$460 million for the expansion of the Yabulu refinery in Queensland. The Ravensthorpe project includes the development of an open cut mine, treatment plant and associated infrastructure and is based on three laterite nickel deposits with a combined proved and probable reserves of 263 Mt at 0.65% Ni and 0.029% Co. The mine will produce up to 220 000 t of mixed nickel-cobalt hydroxide intermediate product containing up to 50 000 t of nickel and 1400 t of cobalt, to be shipped from Esperance to Townsville, in Queensland, for refining at the QNI Yabulu refinery. The metal refining section of the refinery is being expanded to increase refinery production to 76 000 t of nickel and 3500 t cobalt. In their quarterly report for March 2006 the company reported that the Ravensthorpe project was 60% complete and the Yabulu expansion was 47% complete. The first shipment of mixed nickel-cobalt hydroxide from the Ravensthorpe mine is expected to take place in the second quarter of 2007 and nickel metal production from the expanded Yabulu refinery is on schedule for the third quarter of 2007.

LionOre Mining International Limited reported production figures for 2005 of 350,926 t at 0.8% Ni from the Black Swan open pit and 153 473 t at 4.82% Ni from the Silver Swan underground mine. Plant throughput for the year was 503 670 t with a metallurgical recovery of 82.7% and the overall grade was 2%. In October 2005 the company approved the Black Swan Disseminated 2 Project that will expand the existing open pit mine and upgrade the processing plant capacity to 2 150 000 tpa from the current 600 000 tpa. The plant upgrade is scheduled for commissioning in the third quarter of 2006 with full ramp-up in production by end of 2006. The increased production will come from lower grade ore from the open-pit at a rate of 2 000 000 tpa. Nickel production is forecast for 8500 t of payable nickel in 2006 and 13 000 t in 2007.

LionOre's Lake Johnston operations comprise the Emily Ann mine and the Maggie Hays mine, 3 km south of Emily Ann. In January, 2006 LionOre announced the upgrade for Maggie Hays Upgrade (MHU) following the completion of the optimised feasibility study in 2005, which will increase payable nickel production by approximately 20% to over 14 000 tpa by the end of 2006 and increase nickel reserves threefold. The upgrade will enable the mining of the large disseminated nickel sulphide along with the smaller high grade massive sulphides at Maggie Hays using sub-level caving bulk method at a rate of 1.3 mtpa, and an upgrade of the processing plant capacity 1.5 mtpa. The increased production from Maggie Hays will replace the output from Emily Ann, which will cease production by end of 2006. The balance of the upgraded plant capacity (200 000 tpa) is anticipated to be sourced in 2007 from Maggie Hays North Shoot and third party toll treatment.

In April 2004 LionOre purchased the Bulong lateritic nickel processing plant near Kalgoorlie, renamed Avalon, and commenced a feasibility study into converting the plant into a nickel sulphide hydrometallurgical facility utilising its proprietary Activox process. The feasibility studies are looking at a base case mining and treatment operation of 11 mtpa at Honeymoon Well with one downstream processing option being to supply an Activox facility at Avalon capable of producing 45 000 tpa nickel. The study is due to be completed by 2007.

Production from Jubilee Mines NL Cosmos Deep orebody in 2005 amounted to 10 334 t Ni. In mid 2005 the company announced the discovery of the Tapinos deposit (formerly Anomaly 4), 3.5 km south of the Cosmos Mine. The deposit contains some very high grade intersections (eg. 2.83 m at 15.5% Ni) and lies on the same contact position (ultramafic/felsic rock) that hosts Cosmos, Prospero and Alec Mairs deposits. It occurs 300 m below surface and approximately 200 m up-dip of Prospero. By end of 2005 the company announced an inferred resource for the Tapinos deposit of 142 000 t at a grade of 7.4% Ni for contained nickel metal of 10 500 t. The company also commenced the Helene Decline in October 2005 to provide access to the Prospero and Tapinos high grade nickel sulphide deposits. During the first quarter of 2006 the company announced updated measured, indicated and inferred resources for the Prospero deposit totalling 911 500 t at 6.64% Ni with a nickel metal content of 60 500 t. The company has commenced work on a box cut and decline development to access the deposit and a formal feasibility study has also been commenced. The Alec Mairs lower exploration drive was completed during the first quarter of 2006 and will provide exploration access to Alec Mairs and Anomaly 1 deposits. Deep drilling 300 m south of Alec Mairs deposit has delineated another zone of high grade mineralisation called Alec 2.

In early 2006, Western Areas NL completed a feasibility study for its stage two expansion of the nickel mine being developed at Flying Fox. In February 2006 the total resources of the T1 to T5 deposits comprising the Flying Fox mine amounted to 1 168 900 t at an average grade of 7.5% Ni with a nickel content of about 79 400 t. The construction and funding of a 250 000 tpa nickel sulphide concentrator at Cosmic Boy, 20 km south of Flying Fox has been deferred until 2007 when steady state of ore production from T1 is expected. Western Areas reported that early ore production from T Zero deposit is anticipated to commence in December quarter 2006 and will overlap with production from T1, which is scheduled to commence in first half of 2007. Early ore produced from Flying Fox mine will be treated through the Lake Johnson concentrate plant located 90 km east of Flying Fox, as part of an existing offtake agreement with LionOre Mining International Limited. The company's feasibility study on Diggers South deposit is still in progress while the New Morning/Daybreak feasibility study is on hold as Western Areas is currently focussing on getting Flying Fox into production in December quarter of 2006.

Sally Malay Mining Ltd reported that in 2005, its Sally Malay mine produced 7642 t Ni, 3884 t Cu, and 426 t Co. The operation has been moving towards underground mining with the commencement of a portal in September 2004 and development of a decline and establishment of production headings. A total of 43 484 t of ore at 1.15% Ni was mined during the December 2005 quarter. During early in 2006 the underground operation was being ramped up to 600 000–650 000 t of ore per year. Sally Malay holds 75% and is operator of the Lanfranchi JV nickel project. Mining of the remnant ore at Lanfranchi recommenced in January 2005 and decline development to the Helmut South orebody commenced in May 2005 followed by ore delivery in September 2005. Ramp-up to a mining production rate of 12 000 t–15 000 t per month is on track with production of 21 328 t of ore at 2.51% Ni in the December 2005 quarter. Exploration was carried out on the Schmitz/Skinner/Winner trend for extensions of ore from previously mined deposits and an indicated resource of 79 523 t at 4.26% Ni for 3389 t of contained nickel at Schmitz extension has been announced in early 2006. A Canadian company, Brilliant Mining Corp. entered into a letter agreement to acquire all of the issued and outstanding shares of the private company Donegal Resources Pty. Ltd., which indirectly holds a 25% interest in the Lanfranchi JV. Sally Malay also signed a letter of agreement with Platinum Australia Ltd whereby Sally Malay will fund a two stage feasibility study on production of PGE concentrates from the Panton PGE deposit.

The 2005 nickel production from the Radio Hill mine, owned by Fox Resources Limited, amounted to 2205 t Ni and 1404 t Cu. Fox signed a Heads of Agreement with BioHeap Ltd (subsidiary of Titan Resources Ltd) to license the BioHeap proprietary bacterial leaching process and use the process to heap leach disseminated ore from Radio Hill (1 320 000 t at 0.72% Ni, 1.0% Cu) and Sholl (3 000 000 t at 0.61% Ni, 0.71% Cu). Fox commenced metallurgical testwork which will contribute data for a planned bankable feasibility study which has been commenced.

Australian Mines Ltd reported that production from its Blair nickel mine in 2005 amounted to 1380 t of nickel. Drilling and decline development was continued to access deeper parts of the Blair Deeps ore shoots. Recent drill intersections from Blair Deeps included 3.1 m at 13.14% Ni from the E shoot. The company also carried out preliminary metallurgical test work to assess the Anomaly 11 oxide ores for possible heap leach or agitated leach processing.

Mincor Resources NL operated four nickel mines in 2005 south of Kambalda in Western Australia comprising the Miitel, Redross, Mariners and the Wannaway mines. The combined metal in concentrate production for the three mines in 2005 was 12 256 t Ni, 1103 t Co and 234 t Cu. In December 2005 the company announced the discovery of the South Miitel deposit with inferred and indicated resources of 258 000 t at 3.98% Ni with nickel content of 10 250 t. Small scale remnant mining continued at the Wannaway mine.

During 2005, Independence Group NL continued mining and development of its Long and Victor South deposits. Total production for 2005 amounted to 8757 t Ni and 622 t Cu. In mid 2005 the company announced the discovery of the McLeay deposit and a resource (inferred and indicated) of 344 000 t at 6.9% Ni was delineated by end of 2005, the deposit is still open to north, south and east.

Allegiance Mining NL announced results of a feasibility study indicating that the Avebury deposit is economic and envisages a 600 000 tpa throughput to produce 5700 tpa nickel metal in a 20% (plus) nickel concentrate. The study envisages an increased throughput to in excess of 1 000 000 tpa to produce over 10 000 tpa nickel metal in concentrate. As at 31 March 2006, total resources amounted to 12.81 million tonnes of ore averaging 1% Ni with 132 000 t of nickel metal. The resource included total reserves of 4.4 million tonnes with a grade of 1.14% Ni. The company reported that the resource remains open along strike to both east and west and down dip. The Avebury nickel concentrates will be hauled by road 24 km to the Melba Flats base metal concentrate rail loading facility and then by rail to Burnie, on north coast of Tasmania, for export. In April 2006, Allegiance Mining NL executed an agreement with Jinchuan Nickel Group Limited for the sale of approximately US\$1.3 billion worth of nickel-in-concentrates from the Avebury nickel mine. Production is expected in the first half of 2007.

Metallica Minerals Ltd main activities in nickel comprised drilling at the NORNICCO and Lucky Break lateritic deposits to increase the resource base as well as ongoing metallurgical studies in column leach testwork on lateritic nickel deposits from both areas. In early 2006, Metallica announced a doubling of the inferred lateritic nickel resources to 20.75 million tonnes at 0.78% Ni and 0.04% Co for the NORNICCO group of deposits and 1.022 million tonnes at 0.8% Ni and 0.05% Co for the Lucky Break deposits. Metallica's joint venture partner on Lucky Break Project, Metals Finance Corp. delivered a preliminary desktop scoping study based on a throughput of 250 000 t of ore over four years. Subject to successful results from ongoing testwork, the targeted commissioning for the Lucky Break heap leach nickel operation is early 2007. Experience from the proposed feasibility and development of Lucky Break is intended to serve as a major part of the much larger NORNICCO feasibility studies that envisage a 1.5 mtpa heap leach operation planned to produce about 10 000 tpa Ni.

Consolidated Minerals Ltd, through its subsidiary Reliance Mining Ltd, operated the Beta Hunt nickel mine which produced 4317 t Ni in 2005. The company continued decline development and exploration drilling the nearby East Alpha deposit and announced an updated resource of 551 000 t at 4.48% Ni for 24 700 t of contained nickel. Mining of the East Alpha deposit commenced at end of March 2006 and production is planned to increase to 5000 tpa nickel by November 2006. Consolidated Minerals Ltd has also earned a 50% interest in the Munda and Armstrong projects via a JV with Titan Resources Ltd's subsidiary Australian Nickel Mines NL. Reported resources for the Munda deposit amount to

256 000 t at 1.94% Ni while the Armstrong deposit is estimated to have an open pit resource of 137 000 t at 1.73% Ni and an underground mining resource of 475 000 t at 1.98% Ni. Consolidated Minerals Ltd commenced a takeover offer for Titan Resources Ltd in the first half of 2006.

View Resources Ltd reported that the current phase of mining at Carnilya Hill and Zone 29, was completed in mid December 2005 with a total production for the year of 1995 t Ni. The mine was placed on care and maintenance. View entered into a farm-in agreement with Mincor Resources NL who are required to spend \$2.5 million on exploration to earn 70% equity in the Carnilya Hill project.

Australasian Resources Ltd, previously Sherlock Bay Nickel Corporation Limited, continued with feasibility studies, on their Discovery nickel deposit at Sherlock Bay, to evaluate the treatment of low grade disseminated nickel sulphide ore.

On 30 July 2005, Heron Resources Ltd signed a definitive farm-in and joint venture agreement with Inco Limited providing for the potential development of the Kalgoorlie Nickel Project (KNP). The project is based on a laterite nickel resource of 903 Mt grading at 0.74% Ni and 0.05% Co but the initial feasibility programs will focus on siliceous ore, of which some 357 mt at 0.7% Ni is in the Goongarrie-Big Four-Siberia region, the likely KNP plant site. Heron reported that screening studies to date suggest that run-of-mine low grade siliceous nickel mineralisation will upgrade through low cost screening to deliver 1.5% nickel into the plant. One of the main objectives for Inco in its feasibility studies will be to evaluate whether a plant-scale screen upgrade to 1.5% Ni is achievable.

The annual production for 2005 from the Murrin Murrin lateritic nickel plant operated by Minara Resources Limited amounted to 27 783 t of nickel and 1791 t of cobalt. The company stated that one of its main objectives for 2006 is to lift production by achieving greater than 80% planned maintenance across the entire plant.

During 2005 Metals Exploration Ltd carried out 15,061 m of reverse circulation drilling in 151 holes over the Wingellina nickel-cobalt oxide deposit to verify previous drilling results and to enhance the understanding of mineral association and geological controls of the nickel oxide mineralisation. The latest drill data indicates that the Wingellina resource comprise approximately 85% limonitic lithologies with the balance in saprolitic lithologies. The company plans to commence a metallurgical review in 2006 with the objective of proceeding to a prefeasibility study.

The small mining operation at RAV 8 produced 1243 t of nickel and was closed down by Tectonic Resources NL after minable resources were extracted.

Niobium

Niobium (Nb) is used in alloys by steel and aerospace industries and niobium-titanium alloy wire is utilised in the medical sector in magnetic resonance imaging. In Australian, niobium is only recovered as by-product of tantalum mining at the Greenbushes mine (WA).

Resources

Niobium EDR remained unchanged at 194 kt in 2005. Most EDR of niobium is in the Greenbushes pegmatite deposit with minor resources in New South Wales.

Exploration

Data relating to exploration for niobium are not available.

Production

A total of 200 t of niobium in export tantalum products was produced from the Greenbushes deposit in Western Australian during 2005.

World Ranking

World EDR is estimated at 4.4 Mt of which Brazil has 4.3 Mt. Australia has the second largest EDR with 0.2 Mt followed by Canada with 0.1 Mt.

World production in 2005, based on USGS estimates, is 33 900 t Nb of which 29 900 t came from Brazil. Canada produced an estimated 3400 t.

Industry Developments

No major developments were reported in 2005.

Phosphate

Phosphate rock is the major resource mined to produce phosphate fertilisers, which are utilised in cropping, pasture and horticulture production. Phosphorous is also used in animal feed supplements, food preservatives, anti-corrosion agents, cosmetics, fungicides, ceramics, water treatment and metallurgy. The characteristic minerals in phosphate rock are members of the apatite group ($\text{Ca}_5(\text{PO}_4, \pm \text{CO}_3, \pm \text{OH})_3(\text{OH}, \text{F}, \text{Cl})$).

Australia's commercial resources of phosphate are in northwest Queensland (Phosphate Hill, 140 km southeast of Mt Isa) and on the Indian Ocean Territory of Christmas Island. Phosphate Hill is a world-class rock phosphate resource that is close to surface and easy to access and mine. The rock is ideal for the manufacture of high analysis fertilisers for domestic and international use. The first di-ammonium phosphate (DAP) fertiliser utilising Phosphate Hill ore was produced by WMC Resources Limited in late 1999.

Christmas Island is a source of quality rock phosphate, which is exported to the Asia-Pacific and southeast Asian region. Christmas Island rock phosphate products are used widely in the palm oil sector of this region, and sales of higher-grade rock phosphate are made to Australian manufacturers of mono-ammonium phosphate (MAP) fertiliser.

DAP and MAP have different ratios of phosphorous and nitrogen, and have slightly different applications. Both products are generally produced as granules with a diameter of between 2–4 mm. DAP (20% P and 18% N) is used on broad-acre crops such as cereal, legume, fodder, horticultural and row crops, and dairy and newly-established pastures. MAP (22% P and 10% N) assists with early crop growth and enhances phosphorous uptake in broad-acre crops.

Resources

EDR of phosphate rock remained unchanged compared to 2004. All EDR is sedimentary phosphate rock (phosphorites) from Phosphate Hill, which has an average grade of about 24% P_2O_5 . There is no publicly available information on Christmas Island's phosphate resources. Geoscience Australia, however, has reasonably detailed knowledge of this deposit and known resources remaining within the existing mining lease on the island.

Most of Australia's demonstrated resources of phosphate occur in the Georgina Basin and are classified as paramarginal. Two deposits, Swan and Emu, occur within carbonatite at Mount Weld, 26 km southeast of Laverton (WA), where a phosphate-rich zone has formed by the solution and weathering of a primary carbonatite.

The bulk of Australia's inferred phosphate resources are in phosphorites in the Georgina Basin, and these are distributed between Queensland, Western Australia and the Northern Territory.

Exploration

Data relating to exploration for phosphate are not available.

Production

Data on Australian production of fertiliser for calendar year 2005 are unavailable as a consequence of BHP Billiton's acquisition of WMC Resources during the period. From 1 to 30 June 2005, BHP Billiton's share of fertiliser production from Phosphate Hill was 40 507 tonnes of DAP and 33 395 tonnes of MAP.

Phosphate Resources Ltd shipped 678 820 dry tonnes of bulk rock phosphate and 78 193 dry tonnes of bagged dust from Christmas Island in 2004–05. This was a 15% increase compared to the previous financial year's output of 655 474 dry tonnes.

World Ranking

Australia's EDR of phosphate rock comprises less than 1% of the world's total EDR of 18 Gt, which occurs principally as sedimentary marine phosphorites.

Industry Developments

WMC fertilisers' business, Queensland Fertiliser Operation (QFO), became part of BHP Billiton in 2005. Its major production-based operations—phosphate mine and beneficiation, phosphoric acid, ammonia and granulation plants—are at Phosphate Hill. Supporting facilities are located at Mt Isa (sulphuric acid plant) and Townsville (storage and ship handling facilities). Ore reserves at Phosphate Hill are sufficient to support production for more than 30 years.

In August 2005, the QFO business name was changed to Southern Cross Fertilisers Pty Ltd (SFO). In May 2006, BHP Billiton announced it had entered into an agreement for the sale of SFO to Incitec Ltd.

In early 2006, Phosphate Resources Ltd announced that the Federal Government's Department of Environment and Heritage had approved an Environmental Management Plan enabling the company to commence mining over 40 hectares of rock phosphate at the airport extension on Christmas Island. Access to a further 256 hectares on the island, as additional mining leases, is being sought under an Environmental Impact Study process.

Shale Oil

Oil shale is organic-rich shale that yields substantial quantities of oil (shale oil) by heating and distillation. One tonne of oil shale may contain over 200 litres of oil. The organic material in oil shale is kerogen, which can be a precursor to conventional oil reservoirs given appropriate conditions in the crust. Australian oil shale deposits of commercial interest are predominantly in a series of narrow and deep extensional-basins near Gladstone and Mackay in central Queensland. These are thick Tertiary lacustrine (lake-formed) deposits that are relatively easy to mine. They contrast with generally harder carbonate-bearing oil shales (marls) found elsewhere in the world that are more difficult to mine and process.

Resources

Southern Pacific Petroleum's (SPP) oil shale assets were acquired by Queensland Energy Resources Ltd (QERL), a privately owned company, in early 2004. The last systematic review of the in situ mineralisation for these ten oil shale deposits was completed by SPP in 2000 to comply with the JORC Code.

Australia has an estimated 4.6 GL (29 million barrels) of shale oil EDR. This could increase significantly if research and development investigations into the processing of shale oil were to lead to a commercial plant. From 2000 to 2004 SPP developed a demonstration-scale processing plant at the Stuart deposit near Gladstone which produced over 1.5 million barrels of oil using a rotary kiln retort. The shale tonnage processed was small in comparison to the overall resource, so there was no change in the year 2000 reserves estimate at the reported level of precision. Paramarginal and submarginal demonstrated resources are 202.1 GL (1.3 billion barrels) and 3719 GL (23.4 billion barrels) respectively.

Production

Final plant trials at the Stuart demonstration plant were successfully completed in 2004. There was no oil production in 2005. The facility is now on care-and-maintenance in an operable condition. The tests achieved stable production runs at or above 100% of design capacity solid feed rates (6000 t of shale per day) and oil yield (4500 barrels per stream day), while maintaining product quality and adhering to EPA emissions limits.

The oil products from the demonstration plant were Ultra Low Sulphur Naphtha (ULSN) 55–60% and Light Fuel Oil (LFO) 40–45%. The ULSN, which can be used to make petrol, diesel and jet fuel has a sulphur content of less than 1 ppm. To put this into perspective, petrol in Australia previously contained about 500 ppm sulphur. Regulatory guidelines are in place to reduce this to 150 ppm for petrol and to 50 ppm for diesel.

World Ranking

The 2001 survey of energy resources by the World Energy Council reported that Jordan, Australia and Morocco have the largest deposits of 'proved oil shale in place'. The same survey also reported that production of oil from shale for 1999 was recorded in Brazil at 239 ML and Estonia at 185 ML.

Industry Developments

QERL is currently focussing on conducting extensive research and design studies for the next phase of its Queensland oil shale operations based on experience acquired from the Stuart Stage 1 demonstration plant. QERL announced in mid 2004 that the results to date from Stage 1 have demonstrated that large scale oil extraction from the Stuart deposit can be done.

In 2005, QERL made several new box cuts in the Stuart and Condor deposits to obtain fresh representative bulk samples for a series of test runs. Tests included using a pilot gravity-fed 'Paraho' retort system in Colorado with a capacity for treating one tonne of shale per hour, which has no moving parts and for which the shale feed does not have to be as finely crushed as it did for the rotary kiln. By early 2007, QERL hopes to be in a position to decide whether to move to front-end engineering and design for a new demonstration plant capable of producing 4500 barrels of shale oil a day. The location is likely to be at the Stuart deposit because the infrastructure is already in place.

Two independent groups, Xtract Energy and Australian Thermal Solutions (ATS), are appraising the potential of a technology called supercritical solvent hydrogenation. Bench tests indicate the oil yield from shale will be much higher than from conventional retorting techniques. The process, including the heating of the shale, is described as being self sufficient with a minimal need for process water, anoxic and carried out at moderate temperatures in enclosed vessels that do not liberate carbon dioxide. ATS plan to establish a one tonne per hour pilot plant in Townsville using oil shale from Julia Creek (Qld).

In the United States (Colorado), Shell has announced it intends to test an in situ extraction process, which involves heating a subsurface deposit to around 350°C over four years to accelerate natural maturation, then using conventional wells and fracture stimulation to extract the oil and gas.

Tantalum

Demand for tantalum (Ta) has increased steadily since 2002. Australia, through the operations of Sons of Gwalia Ltd, is the world's largest producer of tantalum in the form of tantalum concentrates. The company also controls the world's largest stock of tantalum resources, principally in its holdings at Greenbushes and Wodgina (WA).

Resources

No changes occurred for tantalum in 2005 under the national assessment classification groups.

Exploration

Data relating to exploration for tantalum are not available.

Production

Production data for the Greenbushes and Wodgina mines were not available for 2005. Haddington International Resources produced 211 352 lbs of Ta₂O₅ (79 t Ta) at its Bald Hill deposit.

World Resources and Production

Based on world estimates published by the USGS and modified by Geoscience Australia to take account of recent discoveries, Australia has close to 95% of the world's EDR of tantalum. Canada has the second largest resource base.

World production in 2005, based on USGS estimates modified to account for later Australian data amounted to 1510 t Ta. Production was dominated by Australia, with 840 t in 2005 (about 56% of world output), however this figure is not complete for 2005. According to the USGS, other producers of tantalum metal were Mozambique (260 t), Brazil (215 t), Canada (65 t), Congo (60 t) and Ethiopia (35 t).

Industry Developments

Sons of Gwalia went into receivership in 2004. Operations are continuing on a limited basis under an administrator at both the Greenbushes and Wodgina mines.

Thorium

Thorium oxide (ThO₂) has one of the highest melting points of all oxides (3300°C) and has been used in light bulb elements, lantern mantles, arc-light lamps, welding electrodes and in heat resistant ceramics.

Thorium can also be used as a nuclear fuel, through breeding to U²³³. Several reactor concepts based on thorium fuel cycles are under consideration, but much development work is still required before the thorium fuel cycles can be commercialised. There is interesting research underway on Accelerator-Driven Systems (ADS), which link powerful accelerators—producing neutrons by spallation—to running subcritical nuclear reactors powered by thorium. This research is being promoted as being on track to developing a commercial power generation system in the medium term.

Resources

There are no detailed records on Australia's thorium resources because of the lack of large-scale commercial demand for thorium and a paucity of required data.

Most of the known thorium resources in Australia are held in the monazite component of heavy mineral sand deposits, which are mined for their ilmenite, rutile, leucoxene and zircon content. Monazite is a rare earth-thorium phosphate mineral. Prior to 1996, it was being produced from heavy mineral sand operations and exported for extraction of rare earths. In current heavy mineral sand operations, the monazite content is not always recorded by mining companies in published reports; the monazite is generally dispersed back through the original host sand (to avoid the concentration of radioactivity) when returning the mine site to an agreed land use.

In recent years, new mineral sand deposits have been discovered in inland areas of Australia, in the Murray basin (New South Wales, Victoria and South Australia) and the Eucla Basin (South Australia and Western Australia). Most of the known resources of monazite are in Victorian and Western Australia.

Australia's monazite resources are estimated from available information by Geoscience Australia to be of the order of 4.5 million tonnes. Monazite may contain in excess of 20% thorium. However, assuming an average thorium content in monazite of about 7%, Australia's thorium resources in heavy mineral sand deposits could amount to about 318 000 tonnes.

Apart from heavy mineral sand deposits, thorium can also be present in other geological settings, including carbonatite intrusions and other alkaline complexes, veins and dykes. A significant example

is the Nolans Bore rare earth, phosphate uranium deposit, which is in fluorapatite veins and dykes; this contains about 60 600 tonnes of ThO₂ (53 300 tonnes of Th) in 18.6 million tonnes of indicated and inferred ore grading at 3.1% rare earth oxides, 14% P₂O₅, 0.021% U₃O₈ and 0.326% ThO₂.

As there is no established large scale demand and associated costing information for thorium, there is insufficient information to determine how much of Australia's thorium resources are economic for purposes of electricity power generation in thorium nuclear reactors.

Exploration

There has been no widespread exploration for thorium in Australia apart from two exploration licences that have been reportedly acquired for thorium primarily for thorium exploration in Queensland.

Production

There is no current production of thorium in Australia. Thorium is present in monazite in heavy mineral beach sand deposits including in those that are currently being mined. Prior to 1996, monazite was being produced from heavy mineral sand operations and exported for extraction of rare earths. However, monazite is no longer considered to be a commercially viable source of rare earths because of the cost of disposal of radioactive material containing thorium. In current heavy mineral sand operations in Australia, the monazite is generally dispersed back through the original host sand (to avoid the concentration of radioactivity) which is used in returning the mine site to an agreed land use.

World Ranking

OECD/NEA (in press) has compiled estimates of thorium resources on a country-by-country basis. The OECD/NEA report notes that the estimates are subjective due to variability in the quality of the data, a lot of which is old and incomplete. Table 4 has been derived by Geoscience Australia from information presented in the OECD/NEA analysis; the total identified resources refer to RAR plus Inferred Resources recoverable at less than US\$80/kg Th. Table 4 includes quantitative estimates that have been made of undiscovered thorium resources for some countries.

TABLE 4. Estimated thorium resources by country

Country	Total Identified Thorium Resources (^{'000 t Th}) <USD 80/kg Th	Undiscovered Resources (^{'000 t Th})
Turkey	344	400–500
India	319	Not available
Brazil	221	329–700
United States	400	274
Russian Federation	75	Not available
Greenland	54	32
South Africa	18	130
Australia	371	Not available
Venezuela	300	Not available
Norway	132	132
Egypt	100	280
Canada	44	128
Others	33	81
TOTAL	2411	1786–2257

Sources: Data for Australia compiled by Geoscience Australia; estimates for all other countries are from OECD (in press).

The US Geological Survey (in its annual Mineral Commodity Summaries) has reported 300 000 tonnes of thorium 'reserves' for Australia, but has added the qualification that the monazite would probably not be recovered for its thorium content unless there was demand for the rare earth metals in the monazite.

Tin

Tin (Sn) is used in solders for joining metals and pipes, as a coating for steel cans, and also in metal alloys. The largest single application for tin is in solders, which accounts for about one third of total world consumption. Solders are used in light engineering applications such as plumbing and sheet metal work, in the automobile industry, and in cans for various uses. Another major use for tin is the manufacture of tinplate (steel sheet coated with tin), which accounts for about 27% of world tin consumption. Tinplate is used for containers (cans) of food products, drinks, and also for oils, paints, disinfectants and chemicals.

Resources

Australia's total EDR at December 2005 was 163 kt tin, unchanged from December 2004. Australia's EDR of tin are in the following deposits: Renison Bell, Mount Bischoff (western Tasmania), alluvial deep leads in northeast Tasmania, Greenbushes (WA) and Collingwood (North Qld).

Accessible EDR

All tin EDR are unencumbered and there are no restrictions on mining these deposits.

JORC Reserves

EDR is the sum of JORC Code reserve categories plus measured and indicated resources, which Geoscience Australia considers will be economic over the long term. In 2005, JORC reserves of tin accounted for approximately 39% of AEDR.

Exploration

At the Mt Ramsay tin prospect (western Tas), Malachite Resources drilled a diamond drillhole to test an electro-magnetic anomaly in dolomitic rocks of the Crimson Creek Formation, a geological setting similar to that at the Renison Bell mine, 23 km south of Mt Ramsay. The hole intersected multiple zones of brecciated calc-silicate hornfels rock. Sulphide mineralisation (mainly pyrrhotite) was intersected over 50 m commencing at a down-hole depth of 355 m. The highest tin value was 180 ppm Sn with up to 110 ppm WO_3 . Further ground EM surveys and drilling are planned for this and other anomalies in the Mt Ramsay area.

Malachite Resources continued exploration drilling at the Sheep Station Hill and Newstead tin prospects, 20 km east of Inverell in northern NSW. At Sheep Station Hill prospect, 50 short reverse circulation percussion holes were drilled to test a series of greisen zones hosted by granite. Assay results showed several narrow zones of high grade tin-tungsten mineralisation with several 1 m intervals assaying more than 2% Sn and up to 1% WO_3 within greisen. The average grade of the greisen zones (including mineralisation) intersected was of the order of 0.25% Sn. Four shallow, large diameter diamond holes were also drilled to test greisen veins down to a depth of 25 m below surface. The greisen assays were generally low grade with narrow intersections of mineralisation—one hole intersected 0.9 m averaging 7.18% Sn and 4.0% WO_3 . Overall, the drilling results show the strong nugget effect due to coarse-grained aggregates of cassiterite and wolframite in the greisen veins. The company proposes to undertake large scale bulk sampling to better estimate the average grade of the near surface portions of the greisen veins and to outline areas that could be mined by shallow open cut and selective mining of the veins.

Five holes drilled at the Newstead prospect (4 km southeast of Sheep Station Hill) intersected low grade tin mineralisation in greisen zones (up to 0.17% Sn) together with significant silver values. A hole was drilled to test for alluvial tin within a deep lead below basalt cover rocks and it intersected 1 m of palaeo-colluvium (representing bank material) assaying 0.26% Sn.

Production

Production in 2005 was 2813 t tin in concentrates (800 t in 2004) and 594 t of refined tin ingots (27% more than 2004). Tin concentrates were produced at Renison, Sons of Gwalia (WA) and the first production was recorded from the Collingwood mine (Qld). Refined tin was produced at Sons of Gwalia's smelter (WA). The increase in Australia's mine production followed re-commencement of operations at Renison mine. Total tin exports for 2005 were 2573 t, valued at A\$16 million.

World Ranking

Australia's EDR for tin ranks at ten in the world. The world's major resources of EDR are in China, Malaysia, Indonesia, Peru and Bolivia.

Industry Developments

Bluestone Tin continued its work program on four tin projects that are at various stages of development. These are:

Renison Bell mine, 15 km northeast of Zeehan in Tasmania. Mining and processing re-commenced at Renison in February 2005 after Bluestone Tin had refurbished both the mine and tin concentrator. In October, mining and processing operations were temporarily suspended due to low tin prices. Bluestone Tin reported that in order to achieve operating efficiency, the tin concentrator must operate at or near full capacity. The current status of the Renison underground mine is such that it cannot achieve these operating levels without significant new capital investment to enable several production areas. Total production for 2005 was 2237 t tin in concentrates.

Underground exploration drilling continued at Renison mine to test for extensions of the Federal Fault ore zone and the North Bassett/King Lode. Drilling intersected high grade tin mineralisation and showed there was a change in mineralogy with depth in these zones and significant copper grades were intersected in the tin ore. These high copper zones appear to be associated with cross fault zones. The best drill intersections were 4.0 m averaging 3.23% Cu in the Federal Fault, and 18.65 m averaging 4.55% Cu in the North Basset Lode.

Rentails Project: metallurgical test work continued on the old mine tailings at Renison. The objective of this program is to develop flotation and gravity processes to remove the sulphide minerals from the tailings and then to investigate the use of tin fuming technology to recover tin metal from these concentrates.

Mount Bischoff mine: in January 2005, the company purchased the historical Mount Bischoff mine located 80 km north of Renison mine. Total measured + indicated + inferred resources were estimated by former owners to be 742 000 t averaging 1.23% Sn (9127 t contained tin metal). Bluestone is working to re-establish the open cut mine and it is proposed to truck the ore to the Renison mill for processing.

Collingwood Project, 30 km south of Cooktown in North Queensland. Construction and commissioning of the Collingwood tin concentrator was completed in February 2006. The first production of concentrates commenced in January 2006 and first shipments were despatched in February. Refurbishment of the decline adit was completed and stope development progressed. In 2005, the mine produced 12 100 tonnes of ore grading 0.88% Sn.

Greenbushes mine (Sons of Gwalia Ltd) produced 594 tonnes refined tin ingots for 2005. Greenbushes is the world's largest hardrock tantalum mine. Tin occurs in association with tantalum minerals and is recovered as a by-product (smelted ingots) during ore processing at site.

Van Dieman Mines continued work to evaluate deep lead alluvial tin deposits in north-east Tasmania. These deposits extend from the Blue Tier granite in the south through to the northeast coast of Tasmania and extend off-shore into Ringarooma Bay. During the 1960s and 1970s a number of companies delineated significant resources of alluvial tin in the Scotia, Central Ringarooma, Great Northern Plains and offshore deposits. During 2005, mining leases were granted over the company's

Scotia and Endurance resource areas. A pilot plant was installed to produce bulk samples of tin concentrate and rough sapphire for sorting and grading. Results from the bulk samples will be used to finalise plans for full-scale alluvial mining and processing proposed to commence in the latter part of 2006.

Tungsten

Tungsten (W) metal and its alloys are amongst the hardest of all metals. It occurs as wolframite ((Fe,Mn)WO₄) and scheelite (CaWO₄). Tungsten carbide has a hardness approaching that of diamond and is used for cutting and wear-resistant materials primarily in the metalworking, mining, oil drilling and construction industries. Tungsten alloys are also used in electrodes, filaments (light bulbs), wires and other components for electrical, heating, lighting, and welding applications.

Resources

EDR at December 2005 is 4.6 kt WO₃. China has the world's largest resources of tungsten with approximately 68% of world resources. Other nations with large resources include Canada (8%) and Russia (7%).

Exploration

There was little or no exploration for tungsten in Australia between 1980 and the end of 2004. Tungsten prices rose substantially in 2004 and 2005, with the price more than doubling in 2005. In response to these rises, a number of tungsten exploration companies listed on the Australian Stock Exchange during 2005.

Between May 2005 and March 2006, King Island Scheelite Ltd drilled 39 diamond holes at the **King Island** tungsten deposit to better define the known resources, to explore for extensions of the deposit, and to provide sample material for metallurgical test work. The company completed an estimate of the resources for a planned open pit mining operation using the recent drilling together with the results from 593 holes drilled by the previous owner. Total Indicated and Inferred Resources down to a vertical depth of 308 m below sea level reported by the company are 13.4 Mt averaging 0.64% WO₃. A mining feasibility study is scheduled to be completed by mid-2006.

Tasmania Mines Ltd commenced exploration drilling at the **L5** scheelite project, 1.5 km from the Kara mine and milling plant near Burnie, northern Tasmania. Low grade scheelite mineralisation was intersected in a magnetite-pyroxene skarn within folded Ordovician limestone which is in contact with Devonian granite.

In November, Vital Metals commenced exploration drilling at the **Watershed** project, 25 km north-east of Mt Carbine mine in far north Queensland. Watershed has an Inferred Resource of 13.9 Mt averaging 0.35% WO₃. Four large diameter holes were drilled to obtain large sample material for ore sorting and conventional mineral dressing test work.

Queensland Ores Ltd completed a drilling program comprising 36 diamond holes and 15 reverse circulation holes at the **Wolfram Camp** tungsten-molybdenum project, 90 km west of Cairns, North Queensland. Wolframite and molybdenite mineralisation occur in high grade quartz-rich pipes and also as disseminated lower grade mineralisation surrounding these pipes. Mineralisation is within granite and is adjacent to the margins of the granitic body where it intrudes sediments.

Based on the results of this drilling and drill sampling completed by previous owners, the resources were estimated to be: Measured plus Indicated Resources 237 000 t averaging 0.45% WO₃ 0.23% MoS₂ and Inferred Resources 318 000 t averaging 0.5% WO₃ 0.2% MoS₂. The company proposes to continue exploration drilling in 2006 and to complete a feasibility study to investigate development of open cut operations to mine the deposit. Previous production from the Wolfram Camp field, which commenced in the 1890s and continued intermittently until the 1980s, was based on the extraction of high grade mineralisation (>5% combined wolframite and molybdenite) associated with the quartz pipes. Queensland Ores proposes to mine disseminated lower grade mineralisation surrounding these pipes.

Segue Resources has commenced exploration at its **Coronet Hill** tungsten prospect, 60 km east of Pine Creek (NT).

Production

Australia's only producing tungsten mine in 2005 was the Kara scheelite mine (northern Tasmania), which produced 15 t of scheelite concentrates averaging 55.7% WO₃, representing 8.4 t contained WO₃.

Mine production of tungsten in Australia fell sharply in 1982 with the closure of the King Island scheelite mine. Minor production of scheelite (and magnetite) continued at the Kara mine from several scheelite-magnetite skarns.

Industry Developments

World production has been dominated by China, which produced more than 80% of primary tungsten output in recent years. Other large producers are Russia and Austria. In 2005 the Chinese Government took steps to regulate production and control the release of its tungsten on to the world market. During the past decade there have been increases in domestic consumption of tungsten in China. The lack of supplies of tungsten concentrates from China, together with increased demand in China and elsewhere, have resulted in higher prices over the last two years.

Uranium

Uranium (U) has two major peaceful uses: as the fuel in nuclear power reactors to generate electricity; and in the manufacture of radioisotopes for medical applications. Approximately 16% of the world's electricity is currently generated by the use of uranium in nuclear reactors. At January 2005, some 440 commercial nuclear power reactors with a total net capacity of 369.2 gigawatts (electrical) were operating in 30 countries; a further 27 new reactors were under construction. During 2003 and 2004, 11 reactors were permanently shut down. Most of the growth in nuclear capacity is forecast to occur in China, Japan, India and South Korea. A total of 16 countries generate more than 25% of their total electricity requirements from nuclear reactors. Australia has no significant national demand for uranium and all mine production is exported under nuclear safeguards agreements with importing countries.

There has been a progressive increase in spot market prices since late 2003 and there were continued sharp rises in prices during 2005. Spot market prices rose from US\$20/lb U₃O₈ in January 2005 to US\$36 by the end of the year and to US\$44 by June 2006. The main reason for these rises was reduction in supplies of uranium from secondary sources, particularly material supplied from the blending down of highly enriched uranium in military stockpiles. In addition, the improved outlook for nuclear power worldwide has also influenced market prices. Concerns about climate change arising from increased greenhouse gas emissions has meant that governments in many countries are taking a renewed interest in nuclear power, a fuel which produces minimal greenhouse gasses. Developing countries such as China and India are planning major expansions of nuclear power capacity and will become significant importers of uranium within the near future. Rises in crude oil prices in recent years have also impacted on spot market prices of uranium.

Resources

Geoscience Australia prepares estimates of Australia's uranium resources within categories defined by the OECD Nuclear Energy Agency (OECD/NEA) and the International Atomic Energy Agency (IAEA). The estimates in each category are for resources of recoverable uranium after losses due to mining and milling have been deducted. In Table 1, these estimates are reported under the corresponding resource categories of the national classification scheme. The resource categories of both schemes are correlated in Table 5.

TABLE 5. Correlation of resource classification schemes for uranium

National Scheme	NEA/IAEA Scheme	Tonnes U recoverable
Economic Demonstrated Resources	Reasonably Assured Resources (RAR) recoverable at less than US\$40/ kg U	716 000
Paramarginal Demonstrated Resources	RAR recoverable at US\$40–80/ kg U	16 000
Submarginal Demonstrated Resources	RAR recoverable at US\$80–130/ kg U	16 000
Economic Inferred Resources	Inferred Resources (IR) recoverable at less than US\$40/ kg U	378 000
Subeconomic Inferred Resources	IR recoverable at US\$40–130/ kg U	65 000

EDR were estimated to be 716 000 t U, an increase of 15 000 t U compared to the previous year. This is due to reclassification of resources at the Valhalla, Skal and Andersons deposits (in the Mt Isa region) from higher cost categories into RAR recoverable at less than US\$40/kg U.

Australia had an additional 378 000 t U in Inferred Resources recoverable at costs of <US\$40/kg U —by far the world’s largest resources in this category. These Inferred Resources are mainly in the south-eastern part of the Olympic Dam deposit, where drilling is currently defining large tonnages of additional resources.

Almost all of Australia’s EDR are within the following six deposits:

- Olympic Dam (SA), which is the world’s largest uranium deposit
- Ranger, Jabiluka, Koongarra in the Alligator Rivers region (NT)
- Kintyre and Yeelirrie (WA).

Accessible EDR

Approximately 22% of uranium EDR is inaccessible for mining. All uranium deposits in Western Australia and Queensland are classified as inaccessible resources as their governments have policies in place that ban uranium mining. For South Australia, all EDR are considered to be accessible as these resources are in deposits that are currently being mined (Olympic Dam, Beverley) and the Honeymoon deposit (mining lease and export permits granted). In the Northern Territory, inaccessible resources include those deposits in the Alligator Rivers region where the mining leases are too small to accommodate the proposed mine and treatment plant facilities and water retention ponds. These lease areas are within the Kakadu National Park and cannot be increased in size. Applications for new uranium mines in the Northern Territory are assessed by the Commonwealth Minister for Industry, Tourism and Resources.

JORC Reserves

EDR is the sum of JORC Code reserve categories plus those resources in measured and indicated categories, which Geoscience Australia considers will be economic over the long term. In 2005, JORC reserves of 441 000 t U accounted for 78% of AEDR.

World Ranking

Australia has the world’s largest resources of uranium in RAR recoverable at <US\$40/kg U (equates to EDR), with 36% of world resources in this category (at December 2005). Other countries with large resources include Canada (15%), Kazakhstan (14%), Niger (9%) and Brazil (7%) (Source: OECD/NEA & IAEA).

Olympic Dam is the world’s largest deposit of low cost uranium. Based on ore reserves and mineral resources reported by BHP Billiton as at June 2005, Geoscience Australia estimated that the deposit contains 503 300 t U in RAR recoverable at <US\$40/kg U. This represents almost 26% of the world’s total resources in this category.

Exploration

There was a resurgence in uranium exploration in Australia in 2005 with expenditure of \$41.09 million—this represented a three-fold increase in expenditure compared with the previous year of \$13.96 million. In constant 2005A\$ terms, expenditure in 2005 was the highest annual expenditure on uranium exploration in Australia since 1988.

During 2005, a number of new junior uranium exploration companies were listed on the Australian Stock Exchange. The number of companies actively exploring for uranium increased from five at the start of 2004 to more than 34 by late 2005.

The proportions of total expenditure in each jurisdiction were: South Australia 42%, Northern Territory 37%, Queensland 15% and Western Australia 6%. The combined expenditures in South Australia and Northern Territory accounted for almost 80% of Australia's total.

Main areas (in terms of expenditure) were (Figure 2):

- South Australia: Gawler Craton-Stuart Shelf region; Tertiary palaeochannel sediments of the Frome Embayment; and palaeochannels overlying the Gawler Craton
- Northern Territory: Alligator Rivers region and Western Arnhem Land, Ngalia Basin (including Napperby project in Tertiary sediments overlying the Ngalia Basin)
- Queensland: Mt Isa province.

SOUTH AUSTRALIA

Gawler Craton-Stuart Shelf was the region of highest uranium exploration expenditure in Australia during 2005. Exploration focussed on the search for Olympic Dam style copper-uranium-gold mineralization in Proterozoic metasediments of the Gawler Craton. Most of the uranium exploration was in the general region of the Olympic Dam and Prominent Hill deposits.

BHP Billiton continued a major drilling program to explore for extensions of the **Olympic Dam** deposit to the south. This was the second year of the program and is part of the study to investigate the feasibility of a major expansion in production at Olympic Dam. Up to eighteen diamond drilling rigs operated concurrently in this area. As in previous years, 25% of total exploration was attributed to uranium and this amounted to \$9.1 million and 53 600 m of drilling (pre-collar percussion and diamond drilling). This proportion was used because uranium generates 25% of the total revenue annually from Olympic Dam operations.

This drilling has discovered major extensions (and additional resources) to the south-eastern portion of the deposit, however it remains open to the south. Revised estimates of ore reserves and mineral resources will be reported in BHP Billiton's 2005–06 annual report which is to be released in September. Drilling has tested the mineralised zone to a depth of 1 km below surface and it remains open at depth. The company proposes to drill several deep exploration holes to test the mineralisation down to a depth of 2.5 km below surface. The first of these holes was completed by June 2006.

Oxiana Minerals continued drilling at the **Prominent Hill** copper-gold-uranium deposit as part of the feasibility studied for the project. The geological setting and style of mineralization are similar to the Olympic Dam deposit, approximately 150 km to the south east. Average uranium grades for the resources are 100 ppm U (compared to 400 ppm U for Olympic Dam).



Uranium exploration at the Beverley in-situ leach mine, South Australia (Heathgate Resources Ltd).

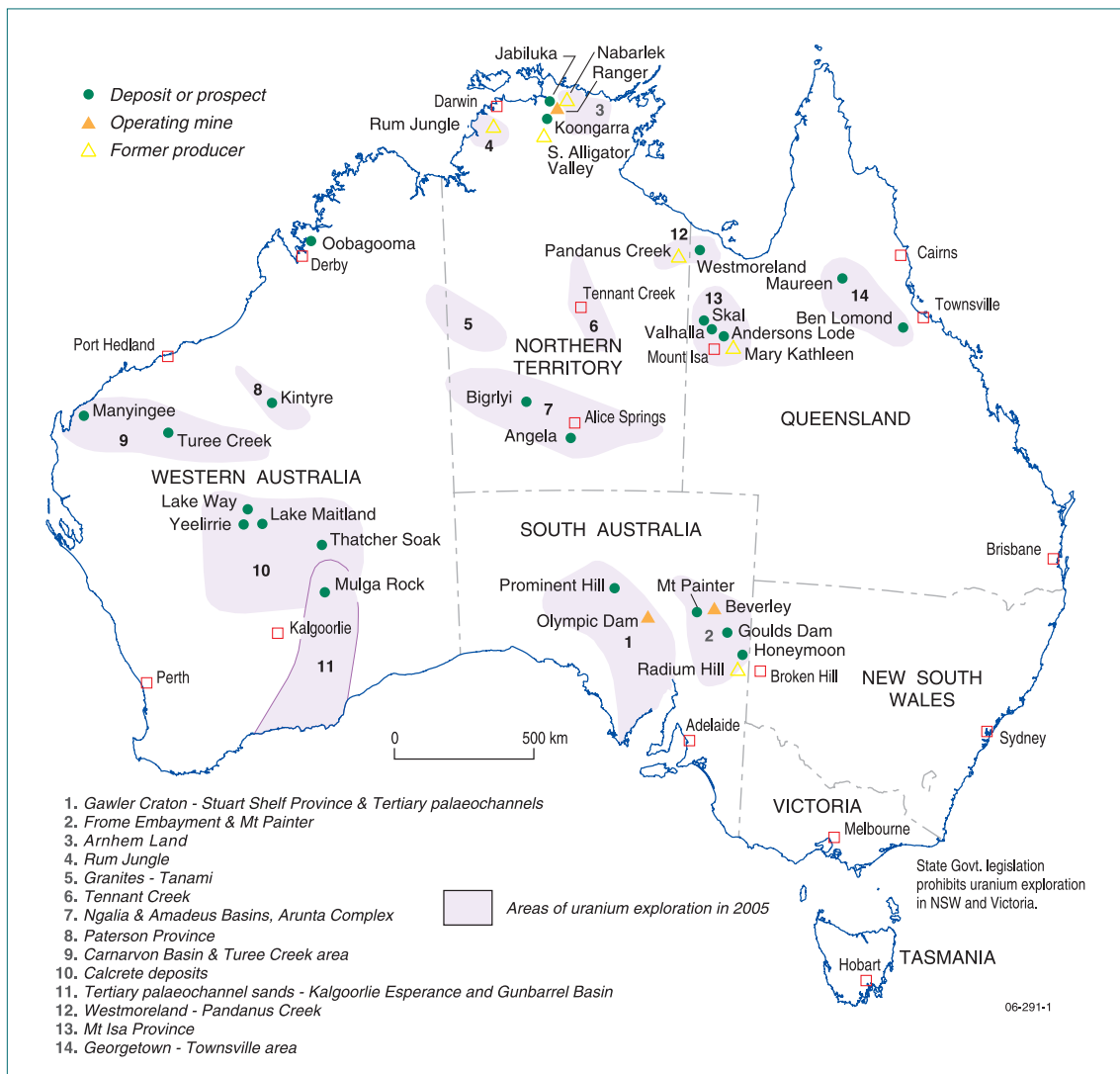
The company plans to complete the feasibility studies by the end of 2006.

Frome Embayment: There was a marked increase in exploration within the Frome Embayment during the year with more than 6 companies actively exploring for sandstone-hosted uranium deposits in Tertiary palaeochannel sediments. Exploration focussed on: palaeochannels to the south and east of the Beverley deposit; the Yarramba palaeochannel in the vicinity of the Honeymoon deposit, and the Billeroo palaeochannel in the vicinity of Goulds Dam deposit. The results from airborne electromagnetic surveys were used to define the extent of buried palaeochannels and exploration drilling by both Heathgate Resources and SXR Uranium One Inc. was directed at target areas within these palaeochannels. Airborne magnetic surveys were also flown and the results provided information on the geology of the underlying basement rocks.

In April 2005, reconnaissance drilling by the Alliance Resources/Quasar Resources joint venture led to the discovery of the **Beverley 4 Mile** deposit located 5–10 km west of the Beverley mine. The deposit is several hundred metres to the east of outcropping Proterozoic basement rocks of the Mount Painter Inlier (North Flinders Ranges).

Mineralisation is hosted by carbonaceous sands of the Eocene Eyre Formation and occurs at, or slightly above a regional disconformity between the Early Cretaceous Bulldog Shale and overlying Eyre Formation (Alliance Resources report to Australian Stock Exchange, 2005). Mineralisation also occurs where these sands unconformably overlie weathered Proterozoic basement. The Eyre Formation is the host sands for uranium deposits at Honeymoon and Goulds Dam in the southern portions of the Frome Embayment.

FIGURE 2: Areas of uranium exploration within Australia in 2005.



By early 2006, more than 65 holes (rotary mud drilling) had been drilled at Beverley 4 Mile. The known extent of the mineralization is currently 1.6 km by 1.2 km; however the full extent of the mineralisation has not been tested. Drilling to date has identified two zones at Beverley 4 Mile deposit:

- Eastern zone with mineralization at depths of 170 m to 180 m, within carbonaceous gravels and sands immediately above the Proterozoic basement
- Western zone with mineralization at shallower depths (130 m plus) within carbonaceous silty sands some 20 m above the basement.

Both zones appear to be controlled by basement faulting. The better intersections to date include 13.5 m averaging 0.44% eU₃O₈ in the western zone; and 5.5 m averaging 0.40% eU₃O₈ in the eastern zone.

Heathgate Resources/Giralia Resources continued exploration drilling at the **Deep South zone**, which is 3 km south of the Beverley mine. Deep South zone was discovered in 2004 and is within sands similar to the main Beverley deposit. Airborne electromagnetic and magnetic surveys over these tenements outlined buried palaeochannel sands similar to those which host the Beverley deposit. A program of 37 rotary mud drill holes were completed in the early part of the year and anomalous radioactivity was recorded in 21 of these—four holes recorded significant intersections with grades above 0.03% U₃O₈. Resource estimates for this zone have not been reported to date.

Mount Painter Inlier: Several companies continued exploration for uranium mineralisation in hematite-rich granitic breccias within the Mount Painter Inlier, North Flinders Ranges. Marathon Resources re-calculated the resources for the Mount Gee deposit and reported 57 Mt of Inferred Resources averaging 0.06% U₃O₈ with 33 000 t contained U₃O₈. The re-calculation was based on data from drilling carried out by previous title holders. Marathon also commenced a drilling program at Mount Gee.

Marathon drilled the Hodgkinson deposit and the best intersection reported was 23 m averaging 0.15% U₃O₈ between 58 and 81 m depth within hematite granite breccias.

Eyre Peninsula: Several companies explored for unconformity-related mineralisation in Proterozoic rocks of the Gawler Craton in the Eyre Peninsula region. The regional geology of the Eyre Peninsula region is similar to that in the Alligator Rivers region (NT) and small uranium prospects (eg. Ben Boy) are known in Proterozoic rocks.

Tertiary palaeochannels overlying Gawler Craton: Exploration was undertaken for uranium in Tertiary palaeochannels sediments overlying the Gawler Craton. Exploration focussed on the known mineralisation within the Warrior, Narlaby and Wynbring Palaeochannels. These palaeochannel sands possibly correlate with the basal sands of the Eucla Basin.

Olary region: After a hiatus of more than two decades, exploration re-commenced in the Olary region for uranium mineralisation in Mesoproterozoic granites of the Curnamona Province. Most of this activity focussed on the search for extensions of the Crocker Well and Mount Victoria deposits.

NORTHERN TERRITORY

Alligator Rivers region and Western Arnhem Land: Exploration focussed on the search for unconformity-related deposits in metasediments of the Cahill Formation. Energy Resources of Australia Ltd continued drilling to the east of the **Ranger No. 3 Orebody** to explore for extensions of the deposit. The company also carried out airborne geophysical surveys over parts of the Ranger Project Area and proposes to drill several of the anomalies in 2006.

In western Arnhem Land, Cameco Australia Ltd (and joint venture partners) continued exploration and drilling to search for mineralization in basement rocks below a thick cover of Kombolgie Sandstone. Bullion Minerals Ltd commenced exploration in south-western Arnhem Land in the Mount Evalyn area (southeast of Koongarra).

Rum Jungle: Compass Resources discovered additional zones of uranium mineralisation in the Rum Jungle area, during their 2005 drilling campaign. The company holds large tenements that cover the

old uranium mining areas at Rum Jungle and the adjacent Browns copper-cobalt-nickel deposit. In 2005, Compass completed 157 exploration drill holes on uranium and base metals prospects within the tenements.

Significant additional zones of uranium mineralisation were intersected at the **Mt Fitch** and **Rum Jungle East** prospects. A considerable amount of data is available from old drilling completed at these prospects during the 1950s and 1960s by Territory Enterprises Pty Ltd on behalf of the Australian Atomic Energy Commission.

Twenty-two holes were completed at the **Mt Fitch** prospect in 2005. The drilling intersected wide zones of low to moderate grade uranium mineralisation within which there are narrow zones of higher grade, eg. hole 05MF02 intersected 21 m averaging 0.10% U_3O_8 which included a 12 m zone assaying 0.15% U_3O_8 . The holes were drilled near the western margin of an area originally tested in the late 1960s by Territory Enterprises Pty Ltd. Based on the results of drilling by Territory Enterprises, Mt Fitch deposit has 1500 tonnes contained U_3O_8 with average grade of mineralisation being 0.042% U_3O_8 .

Rum Jungle East prospect is a zone of uranium mineralisation between the previously mined Whites and Dysons open pits. Two holes drilled in this prospect intersected a 10 m wide mineralised zone averaging 0.02% U_3O_8 . Compass stated the drilling results show that mineralisation extends between the two old open cuts.

In May 2006, Compass Resources received NT Government approvals to mine the Browns copper-cobalt-nickel deposit. Revenues from mining will be used to fund on-going exploration in the Rum Jungle area

Arunta Complex: Arafura Resources carried out mapping and exploration at the **Nolans Bore** rare earth-phosphate-uranium deposit in the eastern Reynolds Ranges, 135 km north-west of Alice Springs. The deposit is a stockwork of large veins of carbonatite that intrude granite gneiss of the Arunta Complex. The company completed a drilling program at the deposit in late 2005 and reported total resource of 5.81 Mt averaging 3.9% rare-earth oxides, 0.31% U_3O_8 and 16.5% P_2O_5 . Exploration also commenced in the Jervois region 265 km north-east of Alice Springs.

Ngalia Basin: Energy Metals was granted exploration tenements over a large area of the northern part of the Ngalia Basin. Regional exploration focussed on the search for sandstone-hosted uranium deposits within the Mount Eclipse sandstone. The company commenced a re-evaluation of the available exploration and old drilling data for the **Biglryi** and **Walbiri** deposits.

Deep Yellow Ltd completed a drilling program (569 holes with each hole about 10 m deep) to define the resources at the **Napperby** deposit, 150 km north-east of Alice Springs. Mineralisation is in calcrete sediments along Tertiary drainage channels overlying the Ngalia Basin. In November, the company reported to the Australian Stock Exchange that it was not possible to use the drill hole data to calculate a JORC compliant resource estimate for the project because of poor recoveries of sample material from the drilling through the mineralised zone. Average recoveries were less than 50% (Deep Yellow, Nov. 2005).

Exploration commenced for sandstone-hosted deposits in the northern section of the **Amadeus Basin**.

WESTERN AUSTRALIA

State Government policies prohibit uranium mining from tenements granted after 2001. Despite this, uranium exploration re-commenced in WA in 2005 following a period of five years during which there was no exploration activity. Most of the expenditure in 2005 went towards acquiring tenements over known uranium deposits (mainly calcrete-hosted deposits), and reviewing the available exploration and drilling data for these deposits. During the year, drilling was undertaken at only one project—the Lake Maitland calcrete deposit.

Calcrete deposits: Most of the exploration activity focussed on reviewing the existing exploration data and previous drilling (completed in the late 1970s) into these deposit. Uranium deposits occur in Tertiary calcrete sediments along drainage channels and in delta sediments where these channels enter playa lakes.

Nova Energy Ltd acquired the **Lake Way** and nearby **Centipede** calcrete deposits. Studies were commenced to investigate the feasibility of developing a mining operation and a processing plant to treat ore from both deposits.

Report Ltd completed a program of air-core drill holes at the **Lake Maitland** calcrete deposit, located 130 km south east of Wiluna. The deposit has total Indicated and Inferred resources of 15.2 Mt averaging 0.052% U_3O_8 (7900 t contained U_3O_8). This estimate is based on drilling carried out by previous owners in the late 1970s. The mineralised zone is 1 to 3 m thick and approximately 6 km long and extends into the westerly-extending arms of the playa lake. The drilling program was designed to increase the drilling density within the known mineralisation and explore for extensions. Extensions of the mineralisation on the western edge of the deposit were intersected.

Paterson Province: Exploration for unconformity-related mineralization in the Paterson Province re-commenced in 2005. No work was undertaken at the Kintyre deposit.

Carnarvon Basin: Scimitar Resources Ltd explored for sandstone type uranium deposits within the Cretaceous sediments of the Carnarvon Basin (Birdrong Sandstone) where they lap onto basement rocks of the Gascoyne Complex. This area hosts **Manyingee** (owned by Palladin Resources) and the small **Bennetts Well** deposits.

Tertiary palaeochannel sands: Bullion Minerals investigated Tertiary palaeochannels sands on the margins of the Gunbarrel Basin, particularly in the general region of the **Mulga Rock** deposit. The company commenced exploration for mineralisation within Tertiary palaeochannel sands in the area between Kalgoorlie and Esperance. These sediments overlie basement granitic rocks of the Yilgarn Craton. The last period of uranium exploration in this area was during the late 1970s.

QUEENSLAND

Queensland Government policies do not permit the development of uranium mines.

Mt Isa Province: Summit Resources continued drilling at **Valhalla**, **Skal**, **Andersons**, **Bikini** and **Mirrioola** uranium-vanadium deposits in the Mt Isa region. Drilling intersected mineralisation within hematite feldspar breccias at all three deposits. The better intersections included: Valhalla—10 m @ 0.28% U_3O_8 0.22% V_2O_5 ; Skal—17 m @ 0.12% U_3O_8 0.07% V_2O_5 ; Andersons—28 m @ 0.22% U_3O_8 0.27% V_2O_5 . These deposits had been drilled previously by Queensland Mines Ltd during the 1960s and Summit's drilling has discovered large extensions of the mineralisation. Summit commenced preliminary feasibility studies at Valhalla deposit. The company also drilled the **Tjilpa**, **Wawai** and **Watta** deposits.

Westmoreland-Pandanus Creek-Calvert Hills region: Laramide Resources (a Canadian exploration company) purchased the **Westmoreland** deposits and acquired tenements over the surrounding area. These deposits are hosted by the Proterozoic Westmoreland conglomerate and were extensively drilled by CRA Exploration/Mt Isa Mines joint venture during the 1960s; by Metallgesellschaft and Queensland Mines during the 1980s; and by Rio Tinto Exploration during the mid 1990s.

Georgetown-Townville region: Preliminary re-evaluation of previous exploration data and drilling results for the **Ben Lomond**, **Oasis** and **Lynd** deposits was undertaken during the year. These deposits are associated with caldera collapse structures within Palaeozoic acid volcanics which extend in a belt from Townsville to Georgetown.

Production

Production in 2005 came from Australia's three uranium mines: Ranger (5906 t U_3O_8), Olympic Dam (4335 t U_3O_8) and Beverley in situ leach operations (977 t U_3O_8) for a record total production of 11 218 t U_3O_8 (9512 t U), 6% higher than for 2004. Australia, with approximately 23% of world uranium production in 2005, is the world's second largest producer after Canada (28%). While there are a number of undeveloped deposits in Western Australia, Northern Territory, South Australia and Queensland, uranium mining is only possible in the Northern Territory and South Australia.

Exports

Exports in 2005 were a record 12 360 t U_3O_8 (10 481 t U) valued at A\$573 million. Exports of Australian uranium are controlled by stringent bilateral safeguards agreements, which ensure that Australia's uranium is used only for electricity generation and that it is not diverted to any military purposes. The importing country must be a signatory to International Atomic Energy Agency safeguards arrangements and must also have signed an agreement with the Australian government to adhere to Australian safeguards obligations for exporting uranium.

Australian mining companies supply uranium under long-term contracts to electricity utilities in United States, Japan, European Union (United Kingdom, France, Germany, Spain, Sweden, Belgium, and Finland), South Korea and Canada.

Industry Developments

OLYMPIC DAM

In August 2005, BHP Billiton acquired all of the issued shares in WMC Resources Ltd and is now the 100% owner and operator of the Olympic Dam project. BHP Billiton is investigating the feasibility of a major expansion of the Olympic Dam operations that would quadruple production capacity from current levels of 4400 t U_3O_8 per annum to approximately 15 000 t per annum. Production capacity for copper would increase to 500 000 t per annum and gold to 500 000 ounces.

The company proposes to develop a large-scale open cut operation to mine the southern portion of the deposit. It is proposed to mine 40 Mt ore per year which would comprise 35 Mt/year from the open pit and 5 Mt/year from the existing underground operations. Current rates of mining and milling are approximately 10 Mt ore per year.

The expansion project faces major infrastructure considerations with water, energy and transport requirements expected to increase in line with increases in production. The Federal and State Governments have imposed a limit on the volume of groundwater that can be extracted from the Great Artesian Basin aquifers for use in the Olympic Dam operations and the nearby township of Roxby Downs. The company is considering options for future water supplies—one of which is to develop a sea water desalination plant on Spencer Gulf, South Australia at an estimated cost of A\$300 million.

Total Measured + Indicated + Inferred Resources for the Olympic Dam deposit at 30 June 2005 was 3970 Mt averaging 0.4 kg/t U_3O_8 which represents 1.465 Mt contained U_3O_8 . This is an increase of 19% over the total as at December 2003. Much of this increase is in the category of Inferred Resources.

RANGER MINE

In 2005, Ranger mine completed 25 years of continuous mining and milling operations and production was a record level of 5906 t U_3O_8 for the year, 15% higher than for the previous year. A total of 2.19 Mt of ore grading 0.274% U_3O_8 was mined from the Ranger No. 3 Orebody open cut during the year.

The company reported that Total Reserves and Resources increased by 21 000 t contained U_3O_8 compared with the corresponding figure at December 2004—this increase included production for the year. These increases were due to a reduction in the cut-off grade from 0.12% U_3O_8 to 0.08% U_3O_8 .



Pulse columns at uranium processing plant, Olympic Dam, South Australia (BHP Billiton Ltd).

The additional reserves and resources will increase the life of the operation by three years. Mining is expected to cease in 2008 and milling from stockpiled ore will continue until 2014 (ERA Ltd Annual Report 2005).

BEVERLEY

Heathgate Resources reported that exploration drilling in recent years has identified new zones of uranium mineralisation extending to the east of the Beverley deposit and also additional mineralisation in an area to the south known as Deep South.

BILATERAL SAFEGUARD AGREEMENTS WITH CHINA

In August 2005, the Australian Government commenced negotiations with the Chinese Government on nuclear safeguards agreements for exports of Australian uranium to China. In April 2006, the Prime Minister announced that the Australian Government had signed a Nuclear Transfer Agreement and a Nuclear Cooperation Agreement with the Chinese Government. These agreements establish strict safeguards arrangements and conditions to ensure Australian uranium supplied to China, and any collaborative programs in applications of nuclear technology, is used exclusively for peaceful purposes.

China currently uses around 1000 t of uranium annually which is supplied from domestic mining operations. It is proposing a major expansion in nuclear energy output and has a need to import uranium from about 2010. For security of supply reasons, China is seeking supplies from Australia, Canada and Kazakhstan.

Vanadium

Vanadium (V) is used in metal alloys with iron to produce high strength steel, which has a wide range of uses including structural applications such as reinforcing bars in building and construction; gas and oil pipelines; tool steel; axles and crankshafts for the automobile industry, and aircraft jet engines.

Non steel uses include super alloys, welding magnets and alloys used in nuclear engineering and superconductors. Vanadium chemicals and catalysts are used in the manufacture of sulphuric acid, and desulphurisation of sour gas and oil.

Vanadium is sold in a number of forms; either as an oxide as vanadium pentoxide (V_2O_5), or less commonly as vanadium trioxide (V_2O_3), or as an alloy of iron and vanadium commonly as FeV80 (80% contained vanadium) or FeV50.

Mine production accounts for only approximately 20% of annual world production of vanadium, the majority of world production (80%) is a by-product from reprocessing of steel slags, oil refining, and the uranium enrichment industry.

While there are a number of vanadium deposits in Australia, Windimurra (75 km southeast of Mount Magnet, WA), has been the only deposit mined in recent years.

Resources

Australia has no EDR of vanadium. Following closure of the Windimurra mine and processing plant the large resources for this deposit have been reclassified as paramarginal.

Significant tonnages of vanadium are classified at subeconomic paramarginal and submarginal resources within deposits in the Yilgarn (Windimurra, Gabanintha) and Pilbara regions (Balla Balla, Don Well) of Western Australia.

Exploration

After seven years of inactivity, renewed interest in exploration for vanadium has been initiated by Precious Metals Australia with a drilling program north of the Windimurra mine in late 2005 and early 2006. A total of 20 reverse circulation holes for 1134 m were drilled (refer section on Industry Developments for results of exploration).

Production

Vanadium was not mined nor produced in Australia during 2005. Most of the world's mine vanadium production during the period was from South Africa (42%), China (34%), and Russia (21%).

Industry Developments

In 2005, Precious Metals Australia Ltd (PMA) acquired full ownership of the Windimurra mine (from its previous owner and joint venture partner). The mine is currently on care-and-maintenance. PMA propose to reopen the mine in late 2007, following a 12 month construction period. A pre-feasibility study, including a review of options for redevelopment of the mine, was completed in February 2006.

The mine and processing plant operated from 2000 to 2003, treating 7 Mt of ore to produce approximately 14 000 t V₂O₅. Following cessation of operations (March 2003), much of the plant and equipment was demolished and removed by the previous owner. Major fixed plant items, however, such as the rotary kiln remained and were included in PMA's acquisition.

Vanadium mineralisation occurs within a shallow-dipping magnetite-rich horizon on the eastern side of a large gabbroic intrusion known as the Windimurra complex. This has a strike length of over 25 km, of which 7 km has been tested by exploration drilling. Much of the horizon is weathered to a depth of approximately of 40 m.

In the first new drilling for almost seven years PMA completed a drilling program to test the magnetite horizon north of the existing pit in January/February 2006. A total of 20 reverse circulation holes for 1134 m were drilled, the results of which have extended drilled strike length of the deposit by nearly 50% (1950 m) from the existing reserve. Grades of up to 1.45% V₂O₅ plus up to 48% Fe and up to 28% TiO₂ were encountered, with the best intersection being 15 m at 0.82% V₂O₅ from 3 m depth. Economic mineralisation extends to surface with a mineable width of 150 m. The resource remains open at depth and is continuous north and south.

The resources based on the latest drilling results and announced by PMA are as follows. Measured and indicated Resource (including the Proven Reserve) 129.75 Mt at 0.46% V₂O₅. This comprises 74 Mt of oxidised and 55.75 Mt of unoxidised material. Combined resources in all categories are 147.75 Mt at 0.46% V₂O₅ (an increase of 47% over the previous estimate at December 2005).

In April 2005, Aurox Resources signed an option agreement to purchase 100% of the **Balla Balla** vanadium-titanium-iron ore project, situated midway between Karratha and Port Hedland near the West Pilbara coast. Balla Balla is a titaniferous magnetite segregated zone within a large basic/ultramafic intrusion. It contains resources over a 16 km strike length. From re-assessment of the mineral resources during the year, the company reported total measured, indicated and inferred resources of 110 million tonnes averaging 0.76% V₂O₅. The deposit is Australia's largest identified resource (in terms of contained V₂O₅). Aurox considers that it can be mined by low cost open cut methods and a bankable feasibility study for the proposed mining project is scheduled to be completed in late 2006.

Zinc, Lead, Silver

Zinc (Zn) is the 23rd most abundant element in the earth's crust. The construction and appliance manufacturing industries use large amounts of zinc, mainly as coatings on steel beams, sheet steel and vehicle panels in the automotive industry. It is also used in alloy die cast products, zinc pigments, zinc salts, zinc oxide as additives to rubber and for zinc chemicals in agriculture, and for wrought or rolled zinc products.

The widespread occurrence, relatively simple extraction, and combination of desirable properties have made lead (Pb) useful to humans since at least 5000 BC. In deposits mined today, lead (in the form of galena, PbS) is usually associated with zinc, silver and commonly copper, and is extracted as a co-product of these metals. More than half of the lead utilised today comes from recycling, rather than mining. The largest use is in batteries for vehicles and communications. Less important uses include cable sheathing, solder, casting alloys, chemical compounds, ammunition, glass in TV and computer

screens for radiation protection, and ceramics. New uses for lead could be in large storage batteries used for load-levelling of electrical power and in electric vehicles.

The relative scarcity, attractive appearance and malleability of silver (Ag) makes it suitable for use in jewellery, ornaments and silverware. Its extensive use in coins throughout history has declined over the last forty years. In Australia, the 1966 fifty-cent piece was the last coin in general use to contain silver (80% silver, 20% copper). Silver is mined and produced mainly as a co-product of copper, lead, zinc, and to a lesser extent, gold. Today, photographic paper and film, followed by the electronics and jewellery/tableware industries are the most important users of silver. Demand for silver as an anti-bacterial agent is likely to double over the next few years as its use increases in water treatment (as an ioniser with copper in domestic swimming pools) and for biocide and bacteriostatic activity in plastic and textiles formulations. Silver based biocides are also being tested as a replacement for arsenic based preservatives in wood treatment.

Resources

Australia's total resources of zinc, lead and silver increased in 2004. Total identified resources of zinc increased by almost 10 Mt to 89.3 Mt of contained zinc; lead from 55.2 Mt to 56.8 Mt of contained lead; and silver from 107.3 kt to 109 kt of contained silver.

Zinc

EDR of zinc at close to 42 Mt is the world's largest holding, accounting for over 18% of global EDR. Queensland's EDR is the largest, remaining steady at 26.1, however, its share decreased slightly to 62%. The Northern Territory again had the second largest EDR, increasing to 10.8 Mt, and its share of national EDR was 26% compared to 23% in 2004. New South Wales had the third largest EDR with 2.4 Mt (2.7 Mt in 2004). This decrease was primarily due to depletion of resources through production. Western Australia's EDR remained steady at 1.48 Mt, while Victoria remained unchanged at 0.39 Mt. Tasmania's EDR fell to 0.33 Mt (0.43 Mt in 2004) due to production depleting resources.

Of Australia's EDR of zinc, 53% occurs in JORC code ore reserves categories, compared to a high of almost 65% in 2002. The national EDR/production ratio is 30.6 but the ore reserve production ratio is only 16.1.

Paramarginal demonstrated resources of zinc fell from 8.5 Mt to 8.2 Mt along with submarginal demonstrated resources, which declined marginally from 14.9 Mt to 14.1 Mt over the year. These variations are attributed to relatively small changes in most states and the Northern Territory.

Total inferred zinc resources remained unchanged.

Lead

EDR of lead increased by 4% in 2005 to 23.8 Mt, which constituted over 40% of total identified resources. Australia also contains the largest share of world EDR at over 30%. Queensland retained the top ranking with its EDR remaining steady at 14.18 Mt in 2005, however its share of national EDR fell to 57%. The Northern Territory increased slightly from 5.25 Mt to 5.76 Mt EDR, or 27% of the national total. New South Wales recorded a slight decrease in EDR from 1.6 Mt in 2004 to 1.48 Mt in 2005, due to depletion of resources through production at Broken Hill and Elura. EDR in Western Australia increased from 1.8 Mt to 2.18 Mt in 2005 due to reclassification of the Magellan resource. Tasmania's EDR fell by 0.02 Mt to 0.09 Mt due to depletion of resources through production.

Of Australia's EDR of lead, 44% occurs in JORC code ore reserves categories (43% in 2004). The national EDR/production ratio is 31 but if the ore reserve/production ratio is used it is 14.

Australia's paramarginal demonstrated resources of lead are 3.1 Mt (2.9 Mt in 2004), which is 5.3% of total identified resources. Submarginal demonstrated resources totalled 8.8 Mt (9.3 in 2004) or 15.3% of total identified resources. These global variations are attributed to relatively small changes in most states and the Northern Territory in both categories.

Total inferred lead resources increased from 21.6 Mt in 2004 to 21.9 Mt in 2005.

Silver

EDR for silver increased to 44 kt in 2005 from 41.4 in 2004. Queensland has the highest inventory, which is steady at 29.7 kt. Its share of the total EDR fell from 73% to under 62% in 2005. The decrease was mainly a result of resource depletion at Cannington, along with reclassification of resources. South Australia has the second largest EDR with 5.5 kt (2.5 kt in 2004) with a substantial increase coming from reclassification of the Olympic Dam resource and addition to the Angas resource. The Northern Territory increased its EDR from 4.5 kt to 5 kt and has the third largest EDR with its share of national EDR at 11.2% compared to 10.9% in 2004. New South Wales marginally decreased its EDR from 2.3 kt to 2.2 kt, while Western Australia decreased from 1.2 kt to 1.1 kt in 2005. Tasmania's EDR fell marginally from 0.41 Mt to 0.32 due to depletion of resources from production at **Rosebery**, and Victoria remained unchanged at 0.28 kt.

Of Australia's EDR of silver, 60% (26.2 kt) occurs in JORC code ore reserves categories. The national EDR/production ratio is 18.3 but if the ore reserve /production ratio is used it becomes 10.9.

Paramarginal demonstrated resources of silver decreased to 15.3 kt from 17.6 kt in 2004 and submarginal demonstrated resources also fell to 14.8 kt from 16.9 kt over the year. These variations are attributable to reclassification of resources at Mt Isa and George Fisher in Queensland and Olympic Dam in South Australia.

Total inferred silver resources decreased from 33.5 kt in 2004 to 32.3 kt in 2005.

Exploration

In 2005, exploration spending on zinc-lead-silver was \$46.5 million, \$13.1 million (39%) higher than in 2004. The 2005 expenditure was about 15% of total base metal expenditure of \$320 million compared to 16% in 2004.

Abra Mining completed the first phase of diamond drilling at its wholly-owned Mulgul base metal prospect, 220 km north of Meekatharra in Western Australia. Four drillholes tested between 100 m and 200 m to the south and south west of previous drilling and all intersected 250 vertical m of mineralisation with results from the four holes including 110 m at 3.66% lead, 1.02% zinc and 0.08% copper from 378 m and 68 m at 7.29% lead, 0.14% zinc and 0.23% copper.

TasGold Ltd's drilling in south-west Tasmania yielded high-grade base and precious metal intersection at Wart Hill, a 7 m mineralised zone returning 7.8% Zn, 4.4% Pb, 78g/t Ag and 0.4g/t Au in semi-massive to massive sulphides 35 m vertically below surface.

Production

Australia's mine production of zinc, lead and silver totalled 1.367 Mt, 767 000 t and 2407 t respectively. Production was higher for each commodity compared to 2004, with zinc up 33 000 t, lead 90 000 t and silver 170 t. In production, Australia ranks second for zinc and lead after China and fourth for silver after Peru, China and Mexico. Cannington (Qld) is the world's largest and lowest cost producer of silver and lead, with almost 288 kt of lead and 43.9 Mozs of silver in 2005. Century (Qld) had the largest zinc output at 501 kt.

World Ranking

Australia has the world's largest EDR of zinc (18%) and lead (32%) and second largest of silver (16%) behind Poland (18%).

Industry Developments

Terramin Australia more than doubled the reserve estimate for its Angas zinc project, 46 km south east of Adelaide in South Australia. The 140% increase (to 2.2 million tonnes), is based on a cut-off grade of 4% Zn for the project.

Kagara Zinc also more than doubled the total inventory of zinc, copper and gold resources at its Mt Garnet project (Qld). Resources increased to 28.4 Mt from the previously reported 11.6 Mt following

drilling campaigns at the Mungana and Balcooma deposits, both of which are key future production centres for the Mt Garnet operations.

In the Northern Territory a new estimate for oxide and sulphide ore at **Compass Resources'** Browns project south of Darwin resulted in an increase of 29% contained lead and 17% copper. Measured, indicated and inferred resource at Browns now total 40 Mt @ 0.5% Cu, 4.52% Pb, 0.11% Co, 0.09% Ni and 13g/t silver.

Oxiana Ltd entered into an agreement from 1 July 2005 to acquire the Golden Grove base metal operation (WA) from **Newmont Mining Corporation** at a cost of \$265 million.

Ivernia Inc entered into an agreement with **Sentient Global Resources Fund** to acquire its 49% interest in the Magellan lead mine (WA) for C\$100 million. On completion of the transaction, Ivernia will have 100% ownership of the Magellan mine's 2.2 billion pounds of in situ lead reserves. Ivernia forecasts 2006 production of about 220 million pounds of lead in concentrate. Mining from the Cano pit at Magellan and commissioning of the lead processing plant commenced in January 2005.

Exploration of the Menninnie Dam zinc, lead and silver deposit (SA) is the subject of an agreement between **Zinifex Australia Limited** and **Terramin Australia Limited**, the deposit's owner. Under the agreement, Zinifex may earn up to a 70% interest in the project by spending up to \$8 million in a number of stages. Subsequent to that agreement, Zinifex acquired a 20% interest in Terramin's wholly-owned zinc, copper and lead subsidiary, Menninnie Metals to pursue the development of new base metals projects in South Australia.

Energy services company **Sempra Energy** has taken a strategic stake in Terramin Australia's proposed 400 000 tpa Angus lead and zinc project in South Australia.

Triako Resources, Platsearch, Eaglehawk Geological Consulting and **Sipa Resources** signed a joint venture agreement with **Teck Cominco** regarding the Stephens-Centennial zinc/lead/silver project at Broken Hill, NSW. The agreement includes a 500 metre deep drillhole to test a defined gravity target before mid 2006 and a geochemical sampling program (using a portable Niton XRF analyser at 20 000 sample sites) to be completed before the end of 2006. The Stephens-Centennial tenement covers 213 km² of highly prospective Broken Hill Group rocks, which is centrally located in the Broken Hill Block, between 5 and 20 km west and northwest of Broken Hill's line of lode.

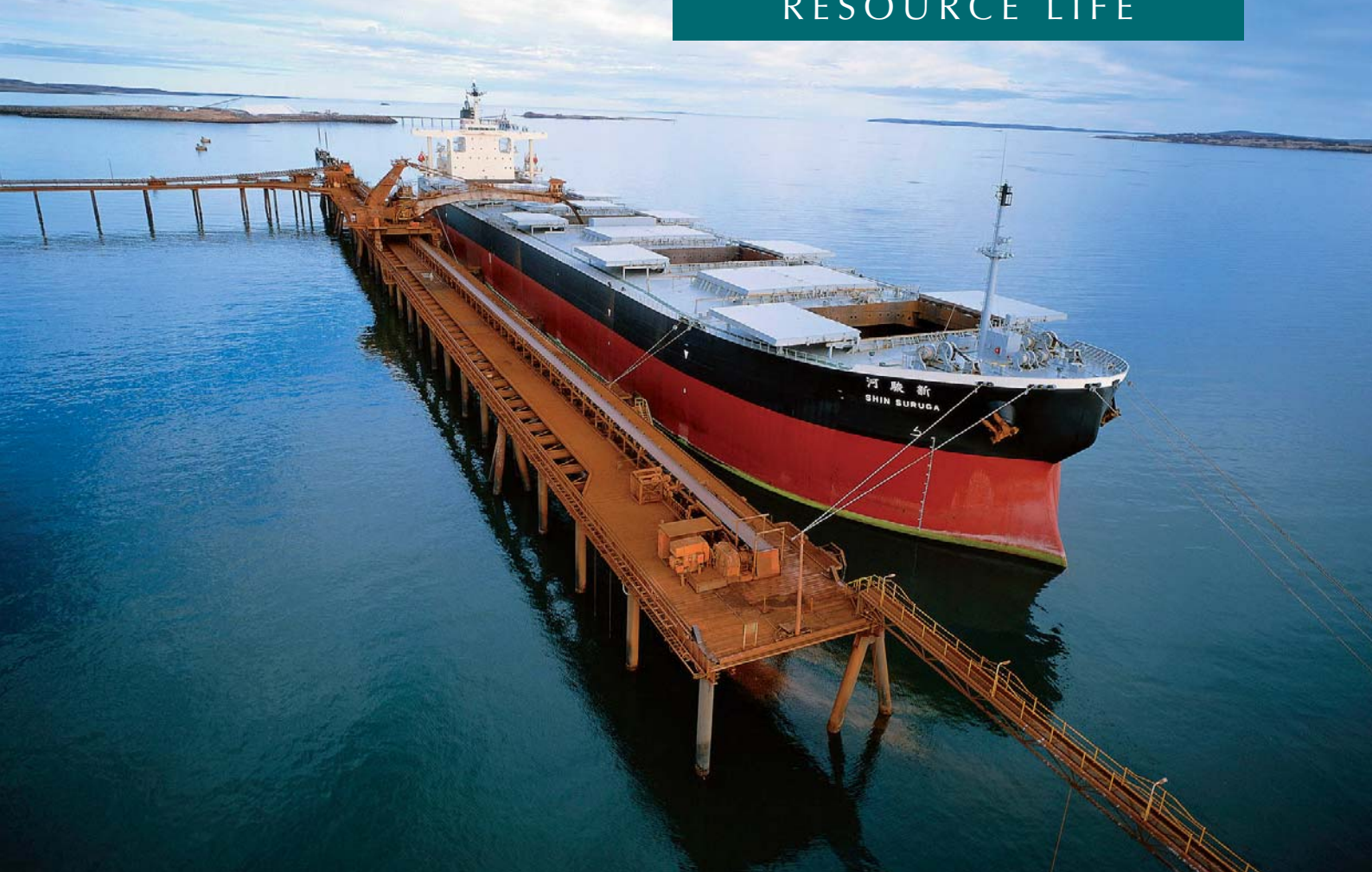
CBH Resources reported an increased resource at its Sulphur Springs zinc-copper deposit in Western Australia based on open pit cut-off grades. The resource estimate increased to 13.8 million tonnes @ 3.7% zinc, 1.4% copper, 21g/t silver (or 6.4% zinc equivalent).

Within this is a large, higher-grade component of 8.5 million tonnes @ 5.2% zinc, 1.9% copper, 25g/t silver (or 9.0% zinc equivalent).

Base metal miner **Kagara Zinc** progressed development of a third production centre at its Mt Garnet base metal operations in north Queensland with the commencement of an exploration decline to access the Mungana deposit. It also announced a substantial upgrade to the base metal resource at Mungana. The new resource, which is now more than 90% in the indicated category, is 2.85 million tonnes grading 12.6% zinc, 2.7% copper, 2.4% lead, 190g/t silver and 1.2g/t gold.

An upgraded resource of 820 000 tonnes with grades of 6.8% zinc, 1.7% lead and 17g/t silver has been announced for the Main Lode at **Prairie Downs Metals'** base metal project, 60 km south west of Newman in the Pilbara region of Western Australia.

PRODUCTION AND RESOURCE LIFE



Loading iron ore on East Intercourse Island, Western Australia (Pilbara Iron Pty Ltd).

Production and Resource Life

Australia's production of major and other selected mineral resources, concentrates and metals for calendar year 2005 are presented in Table 6. The data, published by the Australian Bureau of Agricultural and Resource Economics (ABARE) on a quarterly basis, show that mineral commodity production increased significantly for diamond (up 49%), manganese ores and concentrates (15%), iron ore and pellets (12%), lead ores and concentrates (11%), rutile concentrates (9%), copper ores and concentrates (8%), uranium (6%), and black coal (4%). Mineral commodity production that declined included refined gold (down 8%), iron and steel (8%), refined copper (4%), refined zinc (3%), zircon concentrates (3%), and refined lead (1%).

ABARE reported that Australia's export earnings from mineral resources rose to \$78.5 billion (including petroleum of \$11 billion) in 2005, an increase of \$20 billion or 35% compared with 2004. This stronger performance mainly reflected higher prices for many of the major mineral resources (iron ore, coal, copper, zinc), largely as a result of increased demand from China. Based on ABS survey data new capital expenditure in 2005–06, in real terms (ie 2005–06 dollars), in the mining and metal products industries was \$14.2 billion, the highest on record. This gives an indication, in aggregate terms of the pace and scale of developments in the minerals and energy sector, and was 79% higher than the average annual expenditure for the past 25 years (\$7.9 billion).

To sustain such growth and contribution to national economic performance in the medium and longer terms depends on new resources being discovered and developed for production at rates sufficient to meet demand. To facilitate assessment of the future supply capability of identified resources, ratios of AEDR to current mine production are provided in the commodity reviews above, as an indicator of resource life. It is important to note that these 'duration indicators' can change rapidly with significant changes in rates of production. Iron ore, for example, shows how resource life can change markedly over a relatively short period. Increased production in response to growing demand from Asia is a major factor contributing to a 50% reduction in the duration of iron ore resources from 125 years in 1995 to around 60 years in 2005.

AEDR of other mineral commodities can sustain current rates of mine production on average for the following approximate periods (years): brown coal 450, nickel 125, black coal 100, ilmenite 90, rutile 85, bauxite 75, zircon 55, copper 45 and manganese ore 40.

Resource life duration for gold (about 20 years at current rates of production), lead and zinc (both around 30 years), and diamond (less than 10 years) are amongst the lowest. Increases in the price of gold have contributed to rising expenditure on exploration for this commodity since 1980. However, despite a progressive increase in EDR of gold since the mid-1980s, there is still a need for ongoing successful exploration in the short and medium terms to ensure sufficient available resources to maintain gold as one of Australia's main exports.

There is a need for significant new discoveries of lead and zinc just to maintain production at current levels beyond the next 25 years, when almost all existing base metal mines will have closed. In this regard the focus is on discovery and development of new high quality, metallurgically attractive lead-zinc deposits.

TABLE 6. Australian production and exports of selected mineral products 2005.

Commodity	Production	Exports	Export value \$ million
Aluminium			
Bauxite (Mt)	60.0	5.3	117
Alumina (Mt)	17.7	14.4	4648
Aluminium (Mt)	1.9	1.6	4024
Coal			
Black raw (Mt)	398		
Black saleable (Mt)	307	234	21 825
Brown (Mt 2004–05)	67		
Copper			
Ores and concentrates (kt)	2726	1608	2505
Refined primary (kt)	430	315	1533
Diamond (Mc)			
	30.7	30.7	678
Gold			
Mine production (t)	263		
Refined (t) (a)	341	305	5692
Iron and Steel			
Ore and Pellets (Mt)	262	239	11 064
Iron and steel (Mt)	7.8	2.3	1752
Lead			
Ores and concentrates (kt)	1088	512	628
Refined (kt)	229	245	311
Bullion (kt)	159	165	252
Manganese			
Ores and concentrates (kt)	3.9	2.9	468
Mineral sands			
Ilmenite concentrates (kt)	2034	714	71
Rutile concentrates (kt)	177	168	131
Synthetic rutile (kt)	752	520	335
Titanium dioxide pigment (kt)	203	174	423
Zircon concentrates (kt)	426	422	356
Nickel			
Concentrate (kt Ni)	189		
Refined (kt)	236 (b)	212	3529 (c)
Uranium (kt U ₃ O ₈)			
	11.2	12.4	573
Zinc			
Ores and concentrates (kt)	2535	1893	967
Refined (kt)	457	462	794

Notes for Table 5

Source: Australian Mineral Statistics, ABARE, March quarter 2006

 t = tonnes; kt = 10³t; Mt = 10⁶t; Mc = 10⁶ carats

- (a) Includes primary and secondary gold of Australian and overseas origin
- (b) Sum of products in the Intermediate nickel, <99% Ni and >99% Ni categories
- (c) Sum of all nickel product export values.

EXPLORATION



Processing plant for Beverley in-situ leach uranium operation, South Australia (Heathgate Resources Ltd). Recent exploration has found new sandstone-uranium deposits in this area.

Expenditure

Mineral exploration expenditure for a range of commodities is collected quarterly by ABS. The following discussion is based on the survey data for 2004–05 (year ended 30 June 2005) and calendar year 2005. Differentiation of exploration spending into commodity groups prior to 1980 is based largely on a breakdown of ABS totals by Geoscience Australia.

Financial Year 2004–05

Australian mineral exploration spending in 2004–05 rose by 7.4% to \$1028.3 million which was the highest financial year current dollar spending since 1997–98. In constant 2004–05 dollars spending was at its highest since 1997–98 (Figures 3 & 4).

FIGURE 3. Australian mineral exploration expenditures by commodity in constant 2004–05 dollars (Based on ABS data deflated by Consumer Price Index series)

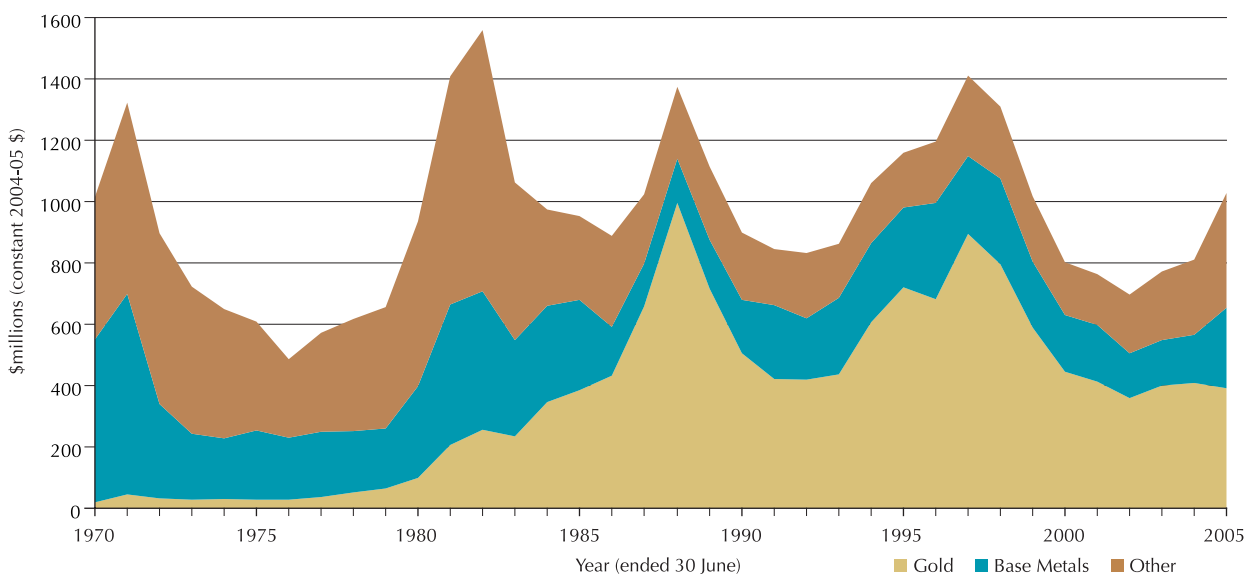
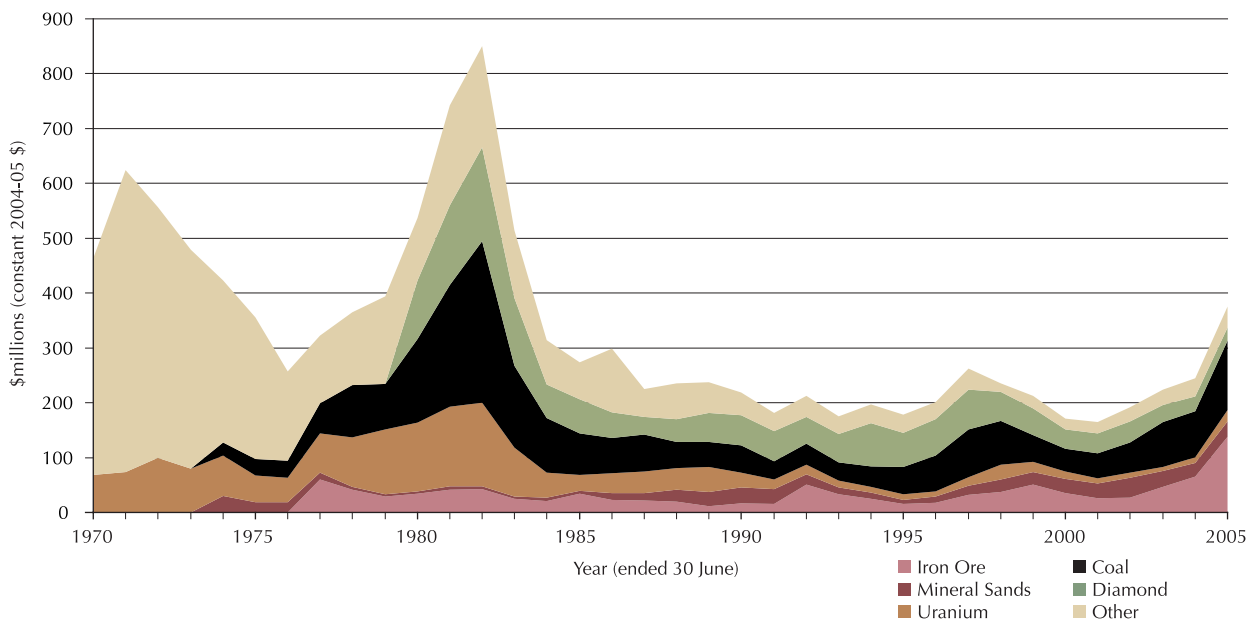


FIGURE 4. Australian mineral exploration expenditures excluding gold and base metals, in constant 2004–05 dollars (Based on ABS data deflated by Consumer Price Index series)

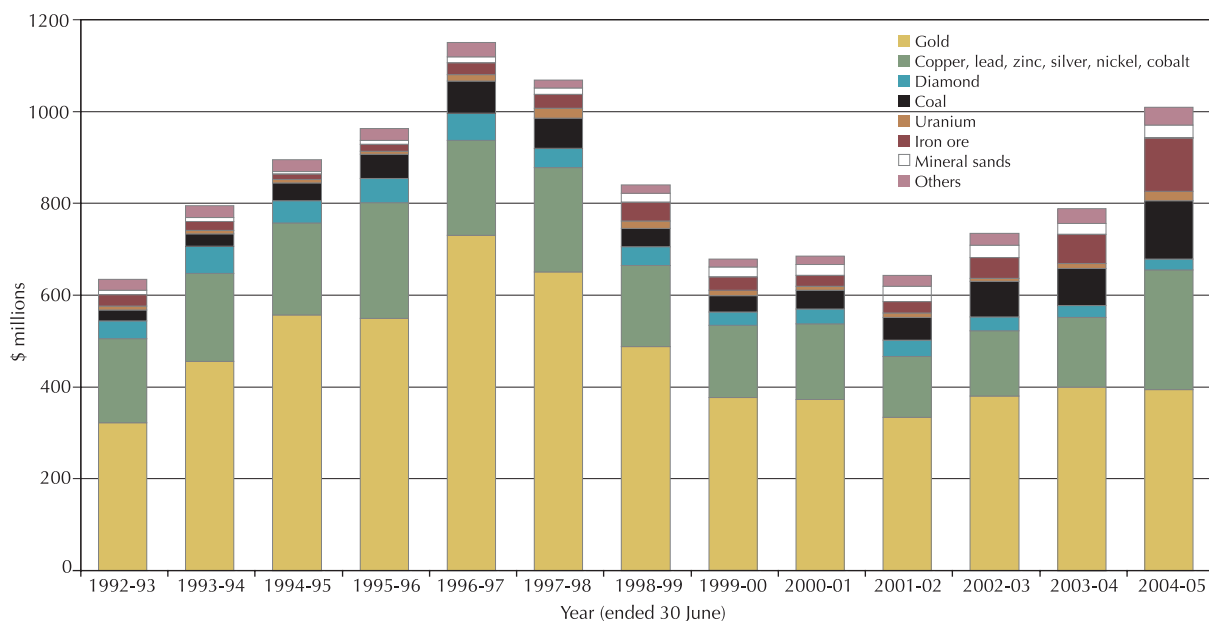


Although gold continued to dominate exploration spending at \$391.7 million it attracted \$6.4 million less than in 2003–04 (Figure 3). Strong growth in exploration was recorded for all other commodity groups except diamond where a reduction of 8% saw spending fall to \$23.7 million. Very strong growth was recorded in spending on exploration for uranium which rose by 97% to \$20.7 million, iron ore by 116% to \$138 million, base metals by 72% to \$261.1 million and coal which rose by 55.6% to \$126.8 million. Mineral sands exploration spending recovered after the fall recorded in 2003–04 with a 16% increase to \$27.6 million.

The reduction in spending on gold exploration occurred despite gold prices being strong throughout the period. High prices and high and expected growing demand for base metals, particularly the expected requirements of the Chinese economy contributed to the growth in base metals exploration which occurred partly at the expense of gold.

The strong performance by the base metals was driven by exploration for copper and nickel both of which rose by 88% over their 2003–04 levels. Copper exploration rose by \$33.5 million to \$71.4 million while nickel increased by \$74.4 million to \$158.6 million. Zinc lead silver exploration had only a small (\$1.5 million) increase in 2004–05 but spending in the second half of calendar year 2005 compared to the equivalent period in 2004 almost doubled to \$30.9 million.

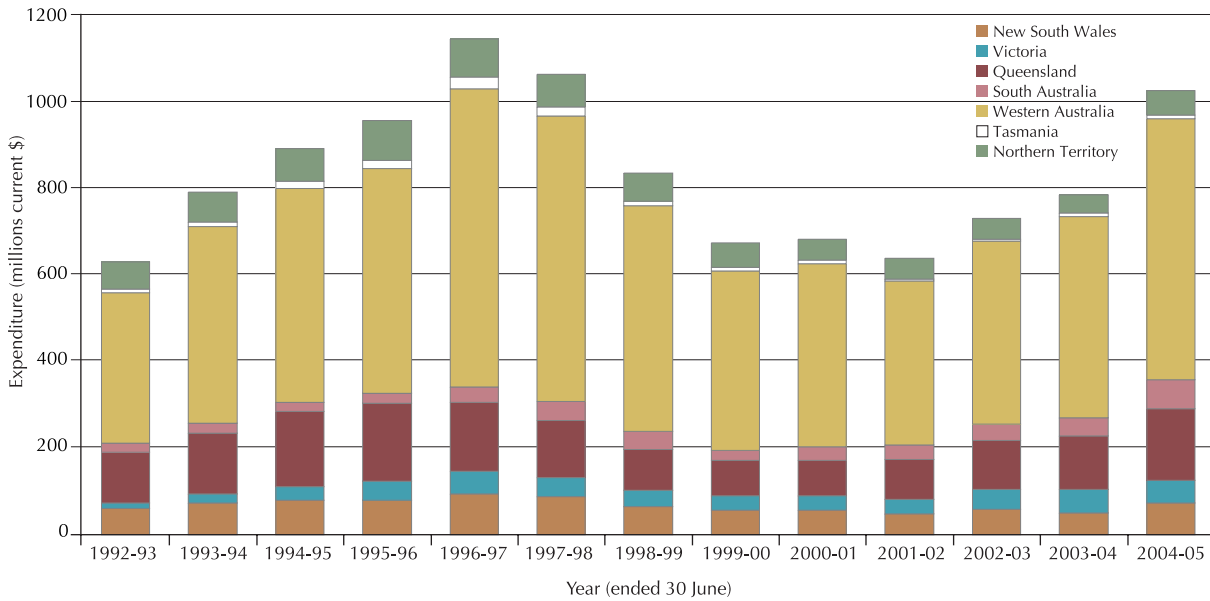
FIGURE 5. Australian mineral exploration spending by commodity (Source: ABS)



In current dollars, gold was the dominant commodity sort in 2004–05 but the level of spending fell (Figure 5). Base metals however showed strong growth to reach a record level of expenditure. Spending on iron ore exploration was the highest recorded for the period for which data are available and was more than double the next highest annual expenditure. Coal exploration grew strongly surpassing the previous high expenditure in 1982. Diamond exploration fell again and was close to the lowest level for the period for which data are available.

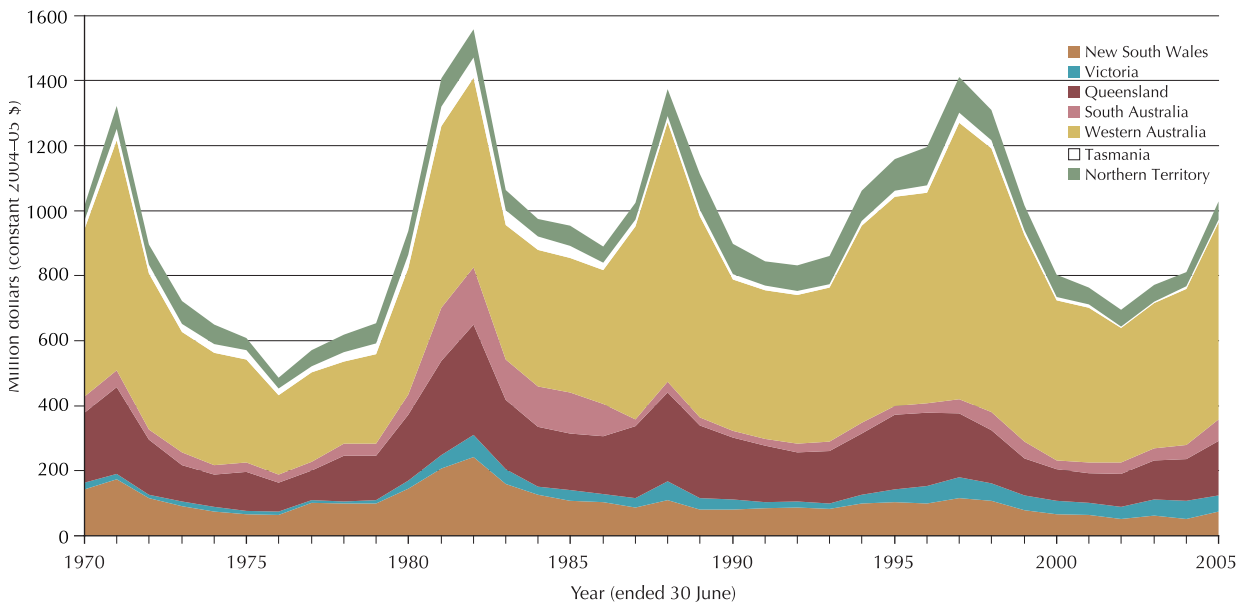
All States except Victoria recorded increases in mineral exploration expenditure in 2004–05. Western Australia continued to dominate with \$606 million, 58.9% of total Australian mineral exploration expenditure in 2004–05 (Figure 6). Queensland with \$166.4 million, an increase of \$41.2 million, was the second largest State with 16.2% of the national total. A spending increase of 7.2% was sufficient for New South Wales to recapture third position with a total of \$73.6 million. Expenditure in South Australia rose by over 60% to \$66.9 million while the Northern Territory had an increase of 31% to \$55.6 million. Tasmania continued to build on the growth recorded in 2003–04 with an increase of 9% to \$8.3 million. In Victoria, a small reduction (less than 4%) was recorded as expenditure totalled \$51.5 million.

FIGURE 6. Australian mineral exploration spending by State (Source: ABS)



In constant 2004–05 dollar terms, all jurisdictions except Victoria had exploration spending that was at its highest level for a number of years (Figure 7). In Victoria there was a reduction of 6% to \$51.5 million which was still the State’s second highest year since 1997–98.

FIGURE 7. Australian mineral exploration expenditures by State in constant 2004–05 dollars (Based on ABS data deflated by Consumer Price Index series)



Calendar Year 2005

On a calendar year basis, spending in 2005 rose by 24% to \$1136 million.

Strong growth in the calendar year resulted from substantial increases in spending in each quarter. This growth reflects strong growth in price for many commodities on the back of anticipated strong and growing demand, particularly from China.

While gold remained the predominant target in calendar year 2005 its share of total spending fell to just under 34%. Gold exploration spending totalled \$384 million in the year, a reduction of almost \$34 million (Table 6). The base metal group had a substantial increase in its share of total spending to 28%—\$320 million, an increase of \$113 million.

TABLE 7. Australian mineral exploration spending by commodity 2004 and 2005
 (Source ABS)

Commodity	Exploration Spending (\$ million)		Change (\$ million)	Proportion of Australian Total Exploration Spending		Change % points
	2004	2005		2004	2005	
Gold	414.0	384.1	-29.9	45.0	33.8	-11.2
Copper	55.8	105.8	50.0	6.1	9.3	3.3
Zinc, lead, silver	33.4	46.5	13.1	3.6	4.1	0.5
Nickel, cobalt	118.2	168.1	49.9	12.8	14.8	2.0
Base Metals	207.4	320.4	113.0	22.5	28.2	5.7
Diamond	25.4	22.8	-2.6	2.8	2.0	-0.8
Coal	96.9	145.6	48.7	10.5	12.8	2.3
Iron Ore	97.9	152.2	54.3	10.6	13.4	2.8
Mineral Sands	24.7	30.1	5.4	2.7	2.6	-0.0
Uranium	14.8	37.7	22.9	1.6	3.3	1.7
Others	38.4	43.2	4.8	3.5	3.8	0.3

This growth is uneven across the base metals with copper and nickel, each rising by \$50 million, being the major contributors. Combined, copper and nickel accounted for 24% of Australia's total mineral exploration spending. Exploration for zinc, lead, silver rose by only \$13 million (39%) but its share of national spending rose only marginally to 4.1%. Iron ore exploration rose by \$54.3 million to \$152.2 million and its share of total spending increased to 13.4%. Coal and uranium exploration both saw strong growth in exploration spending with uranium spending rising by \$22.9 million to \$37.7 million.

All States and the Northern Territory recorded increases in calendar year 2005. Western Australia remained dominant with an increase of \$73.9 million in 2005 to \$613.8 million. This growth was, however, insufficient for the State to maintain its share of national spending which fell to 54% from 58.6% in 2004 (Table 2). Queensland also recorded a slight fall in its share of total spending. South Australia recorded a strong dollar increase in spending and increased its share of national spending to 8.8%.

TABLE 8. Australian mineral exploration spending by State 2004 and 2005 (Source: ABS)

Commodity	Exploration Spending (\$ million)		Change (\$ million)	Proportion of Australian Total Exploration Spending		Change % points
	2004	2005		2004	2005	
Western Australia	539.9	613.8	73.9	58.6	54.0	-4.6
Queensland	154.1	184.9	30.8	16.7	16.3	-0.5
New South Wales	59.7	91.3	31.6	6.5	8.0	1.6
Northern Territory	49.7	68.6	18.9	5.4	6.0	0.6
Victoria	52.4	65.5	13.1	5.7	5.8	0.1
South Australia	55.5	99.4	43.9	6.0	8.8	2.7
Tasmania	8.2	12.7	4.5	0.9	1.1	0.2

Exploration Stage

ABS reports statistics on spending on exploration for new deposits and for the further delineation and/or extension of known mineralisation that has resources delineated. Spending is classified as being for the search for new deposits until there has been a JORC resource estimate of any classification prepared. Subsequent spending on exploring that mineralisation would be classified as further delineation or extension of a deposit.

Nationally 37% of exploration spending was directed at the search for new deposits slightly lower than the 39% in 2004. Western Australia had the highest proportion of exploration in this category of any jurisdiction with 44.9% of its spending in it and New South Wales had the lowest at 21.9%. This share of exploration directed to the search for new deposits is in line with the Metals Economics Group (MEG) world survey of non-ferrous minerals exploration budgets for 2005 which found that 37% of the budget for exploration in Australia was for grassroots exploration.

Exploration Drilling

In 2004–05 ABS reported that exploration drilling totalled 6.78 million metres, an increase of 1.1 million metres (19%) from 2003–04. Of the 2004–05 total, 2.78 million metres (41%) was on the search for new deposits.

Drilling in calendar year 2005 was, at 6.668 million metres, 2.3% higher than in 2004.

Exploration Outcomes

The increase in exploration activity saw a strong growth in the number of reported intersections of mineralisation and several new discoveries. The more significant announcements during the year included:

- Discovery of the Carrapateena copper-gold mineralisation in the Gawler Craton, South Australia.
- Release of a new, increased, resource estimate for the Prominent Hill deposit in South Australia.
- A first indication of the size of the Trident gold discovery, Western Australia.
- Discovery of additional mineral sands deposits (eg. Tripitaka) in the Eucla Basin, South Australia.

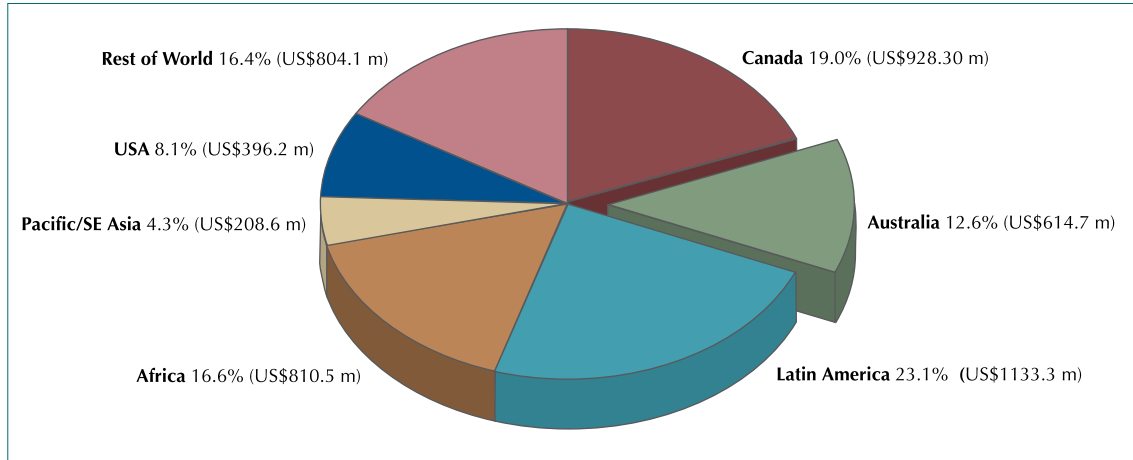
Responding to world demand there was substantial activity in the iron ore sector with new resources and drilling results released for many smaller deposits and prospects that had previously been too small for commercial interest.

Details of exploration for individual commodities are reported under the review of resources for each commodity in this review.

World Exploration

The MEG survey for 2005 reported an increase of 38% to an estimated total budget of US\$5.1 billion (Figure 8) just under the previous high of US\$5.2 billion. Of the respondent's budgets, US\$614.7 million was directed to exploration in Australia and this was the highest budget since 1998 but Australia's share of world budgets fell again to 12.6%. According to the survey, 58.6% of the 2005 exploration budgets for Australian-based companies was for exploration in Australia. The survey included 308 companies with non-ferrous exploration budgets of more than US\$100 000 that were exploring in Australia, an increase of 21 over 2004. Of the total, 37 were overseas based companies, one more than in 2004. Budgets for Australian non-ferrous mineral exploration were directed to gold (US\$331.4 million), base metals (US\$214.1 million) and diamonds (US\$22.5 million).

FIGURE 8. Distribution of world non-ferrous mineral exploration budgets, 2005 (Source: Metals Economics Group)



Outlook for Exploration

Both world and domestic mineral exploration levels grew strongly in 2005 and mergers and acquisitions of mining companies were again minimal. The higher metal prices, particularly for the base metals and the sustained higher gold price levels remain conducive to greater exploration activity in 2006. The outlook for the Chinese economy will continue to play an important role in the outlook for exploration, particularly the demand for base metals, iron ore and coal

Overall, the outlook for exploration is sound and improvements in levels of exploration can be expected unless there is a sharp reversal of the expected economic performance of key countries or metal prices collapse.

Offshore Mineral Exploration in Commonwealth Waters

The Commonwealth Offshore Minerals Act 1994 provides the statutory framework for the exploration for, and the production of minerals, other than petroleum on Australia's continental shelf three nautical miles beyond the territorial baseline of the states and territories. The administration is shared between the Commonwealth and the States and the Northern Territory. The Joint Authority consists of the relevant Commonwealth minister and State/NT minister and is responsible for major decisions relating to titles, such as grants, refusals, etc. The State/NT minister is called the Designated Authority and is responsible for the normal day-to-day administration of the Commonwealth legislation.

Applications for a mineral exploration licence (MEL) are made to the Designated Authority with an application fee of \$3000. The application must be made in the approved manner and specify details such as:

- block numbers (maximum 500 per application)
- proposed exploration program
- amount of money allocated to each part of the program
- technical qualifications of the applicant and employees
- financial resources.

The initial term of a MEL is four years and it may be renewed for three two-year periods subject to satisfactory performance of licence conditions. There is a mandatory reduction of 50% of the licence area on renewal of an offshore MEL. However, it is possible to apply for an extension of term if activities have been significantly interrupted or stopped by circumstances beyond the control of the licence holder.

As at May 2006, a total of 74 offshore MEL applications had been received since February 1990. Currently there are two active licences, T-2-MEL, in Ringarooma Bay in north east Tasmania and WA-31-MEL in the Joseph Bonaparte Gulf in northwest Australia. In Ringarooma Bay Van Dieman Mines plc is investigating the viability of mining the onshore and offshore deposits. In 2005 Van Dieman were granted an onshore licence to mine tin and sapphire and the company intends to employ about 20 people and produce about 1000 tpa of tin concentrate and sapphires. During 2005 four offshore MEL applications were received in an area NW of Ringarooma Bay and SW of Flinders Island. In the Joseph Bonaparte Gulf four MEL applications have been submitted including two from Bonaparte Diamond Mines NL. Bonaparte initially intends to target areas where prospective gravels lie on or close to the seabed and with minimal thickness of overburden. In mid-2005 Bonaparte undertook a first phase sampling program in State waters at the mouth of the Ord River. No diamonds were recovered however previous exploration has discovered gem quality diamonds in State waters off the Ord and Berkeley Rivers.

A joint project to compile the first offshore minerals map of Australia's marine jurisdiction is being undertaken by Geoscience Australia, CSIRO's Wealth from Oceans National Research Flagship and Division of Exploration and Mining and the State/Northern Territory Geological Surveys. The map will be released August 2006. Drivers for this initiative include: Australia having the largest marine jurisdiction in the world, if its November 2004 lodgement with the United Nations Commission on the Limits of the Continental Shelf is ratified; a need to address the issue of marine mineral potential in the New Australia for strategic and longer term resource planning; and anticipated increasing interest by the minerals industry in marine resources and geologically prospective terrains in offshore areas.

Appendix 1

Abbreviations and Acronyms

ABARE Australian Bureau of Agricultural and Resource Economics	ML million litres
ABS Australian Bureau of Statistics	MIbs million pounds
A\$ Australian dollar (where not stated, assume Australian currency)	mm millimetre
AEDR accessible economic demonstrated resources	Moz million ounces
AIMR Australia's Identified Mineral Resources	Mt million tonnes
BRS Bureau of Resource Sciences	Mtpa million tonnes per annum
c carat	MW megawatt
cpt carats per tonne	na not available
C\$ Canadian dollar	NSW New South Wales
CSIRO Commonwealth Scientific and Industrial Research Organisation	NT Northern Territory
EAR-1 estimated additional resources—category 1	OECD/NEA Organisation for Economic Cooperation and Development/Nuclear Energy Agency
EDR economic demonstrated resources	oz ounces
GIS geographical information system	PDR paramarginal demonstrated resources
g grams	PGM platinum-group metals
g/t grams per tonne	ppm parts per million
GL gigalitre	Qld Queensland
Gt gigatonne	RAB rotary air blast
IAEA International Atomic Energy Agency	RAR reasonably assured resources
JORC Joint Ore Reserve Committee Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves	RC reverse circulation
kg kilogram	SA South Australia
km kilometre	SDR subeconomic demonstrated resources
kt kilotonne (thousand tonnes)	t tonne
ktpa kilotonne per annum	Tas. Tasmania
L litre	tpa tonnes per annum
lbs pounds	U uranium
m metre	U₃O₈ uranium oxide
m³ cubic metre	USA United States of America
Mc million carats	USGS United States Geological Survey
MEL mineral exploration licence	US\$ United States of America dollar
	Vic. Victoria
	WA Western Australia
	\$1 m million dollars

Appendix 2

National Classification System for Identified Mineral Resources

INTRODUCTION

Australia's mineral resources are an important component of its wealth, and knowledge of the location, quantity and quality of such resources—including estimates of resources yet to be discovered—is an essential prerequisite of formulating sound policies on resources, land-access, land-use and conservation. Results of resource assessment can be used also to set priorities for exploration and mineral potential is an important input to decisions where alternative land uses are being considered.

In 1975, the then Bureau of Mineral Resources, Geology and Geophysics (BMR) adopted, with minor changes (BMR 1976), the McKelvey resource classification system used by the US Bureau of Mines and USGS (USBM/USGS 1980). Subsequently informal guidelines for using the system's definitions were developed and used by BMR for several years, until the whole system and its application was reviewed in the light of accumulated experience. The results of that review were published (BMR 1984) as the refined BMR mineral resource classification system for national resource assessment.

The principles of the McKelvey system were retained, as were most of the definitions used by BMR in its original system, although minor changes were made to some. Guidelines on applying the system were established, and adopted. It was decided that the term 'reserves' would not be used for regional or national aggregates of resources, so as to avoid the confusion arising from its use with different meanings in other contexts, particularly for commercial reporting for individual deposits.

Several editions of an industry code for reporting resources in individual deposits have been published, the most recent being the 2004 edition entitled *Australasian Code for Reporting Mineral Resources and Ore Reserves*, commonly referred to as the JORC Code. This is a report by a Joint Committee of the Australasian Institute of Mining and Metallurgy, the Australian Institute of Geoscientists, and the Minerals Council of Australia.

The modified McKelvey system and JORC Code are compatible, and data reported for individual deposits by mining companies are used by Geoscience Australia in the preparation of its national assessments of Australia's mineral resources

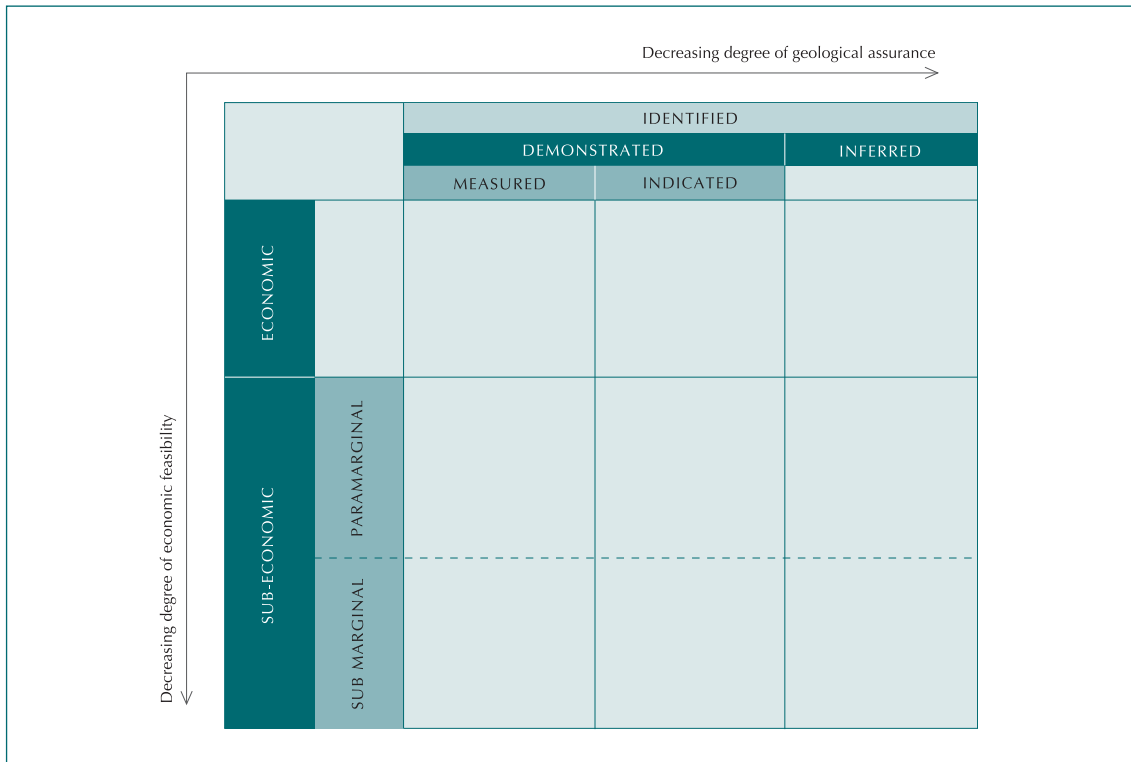
CLASSIFICATION PRINCIPLES

Geoscience Australia 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 (eg. petroleum, coal, and uranium as energy sources).

The modified McKelvey system for classifying identified mineral resources is illustrated below.



TERMINOLOGY AND DEFINITIONS

Resource: A concentration of naturally occurring solid, liquid, or gaseous materials in or on the Earth’s crust and in such form that its economic extraction is presently or potentially (within a 20–25 year timeframe) feasible (see guideline i).

CATEGORIES OF RESOURCES BASED ON DEGREE OF ASSURANCE OF OCCURRENCE

Identified (Mineral) Resource: Specific bodies of mineral-bearing material whose location, quantity, and quality are known from specific measurements or estimates from geological evidence. Identified resources include economic and subeconomic components. To reflect degrees of geological assurance, identified resources can be divided into the following categories:

Measured: Resources for which tonnage is computed from dimensions revealed in outcrops, trenches, workings, and drillholes, and for which the grade is computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely, and the geological character is so well defined, that size, shape, and mineral content are well established.

Indicated: Resources for which tonnage and grade are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than for resources in the measured category, is high enough to assume continuity between points of observation.

Demonstrated: A collective term for the sum of measured and indicated resources.

Inferred: Resources for which quantitative estimates are based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition for which there is geological evidence. This evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geological evidence of their presence. Estimates of inferred resources should be stated separately and not combined in a single total with measured or indicated resources (see guideline ii).

CATEGORIES OF RESOURCES BASED ON ECONOMIC CONSIDERATIONS

Economic: This term implies that, at the time of determination, profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty (see guideline iii).

Subeconomic: This term refers to those resources which do not meet the criteria of economic; subeconomic resources include paramarginal and submarginal categories.

Paramarginal: That part of subeconomic resources which, at the time of determination, almost satisfies the criteria for economic. The main characteristics of this category are economic uncertainty and/or failure (albeit just) to meet the criteria which define economic. Included are resources which would be producible given postulated changes in economic or technologic factors.

Submarginal: That part of subeconomic resources that would require a substantially higher commodity price or some major cost-reducing advance in technology, to render them economic.

GEOSCIENCE AUSTRALIA GUIDELINES FOR CLASSIFYING MINERAL RESOURCES

- (i) Use of the term 'resources' is restricted to material, the extraction of which is generally judged to be potentially economically viable in an arbitrary time frame of about 20 to 25 years. The term includes, where appropriate, material such as tailings and slags. The definition does not intend to imply that exploitation of any such material will take place in that time span, but only that its possibility might reasonably be considered. This guideline attempts to establish a lower limit to what is worth assessing. It should be applied on a commodity by commodity basis to take account of prevailing and prospective technologies. Material falling outside the category of resource should be referred to as 'occurrences'. Unless otherwise stated, the classification system refers to in situ resources. However, it is possible and in fact desirable to also show recoverable quantities of resources in each category.
- (ii) By definition, inferred resources are classified as such for want of adequate knowledge and therefore it may not be feasible to differentiate between economic and subeconomic inferred resources. Where inferred resources are shown as 'undifferentiated', the amount known or judged to be economic may be indicated. Such judgements must take careful account of the commodity being assessed and its mode of occurrence as these factors will have a bearing on the reliability of estimates made. Specifically, grade estimates can be more reliably made for concordant sedimentary and biological deposits than for discordant epigenetic deposits (King et al. 1982, p. 8).
- (iii) The definition of 'economic' is based on the important assumption that markets exist for the commodity concerned. All deposits which are judged to be exploitable economically at the time of assessment, whether or not exploitation is commercially practical, are included in the economic resources category. It is also assumed that producers or potential producers will receive the 'going market price' for their production. The classification is therefore based on the concept of what is judged to be economic rather than what is considered to be commercial at any particular time.

The information required to make detailed assessments of economic viability of a particular deposit is commercially sensitive (eg. a company's costs and required internal rate of return), and these data may not be available to Geoscience Australia. Furthermore, as corporate strategies are likely to be different, individual companies will have different criteria for what is considered

to be 'economic'. Thus to standardise the approach for national or regional resource assessments, the following mineral deposits/situations are accepted by Geoscience Australia, as a general guide, to be economic:

- (a) the resources (published or unpublished) of operating enterprises, whether or not such operations are sustained by long- or short-term, direct or indirect, government subsidies;
- (b) resources in a deposit which is being developed for production (ie. where there is a corporate commitment to production);
- (c) undeveloped resources which are judged to be economic on the basis of a financial analysis using actual, estimated, or assumed variables—viz., the tax rate, capital and operating costs, discount rate (such as reflects the long-term bond rate), commodity prices, and depreciation schedules; the values for the economic variables used in an assessment must be realistic for the circumstances prevailing at the time of the assessment;
- (d) resources at mines on care-and-maintenance meeting the criteria outlined in (c) above.
- (iv) The term 'Recoverable resources' is used when allowance has been made for mining as well as processing losses. 'Mineable resources' is used when allowance has been made for mining losses only. For coal, different terms are used—'Recoverable coal resources' is used when allowance has been made for mining losses only. 'Saleable coal' is used when allowance has been made for mining as well as processing losses.
- (v) Some minerals derive their economic viability from their co-product or by-product relationships with other minerals. Such relationships and assumptions must be clearly explained in footnotes or in accompanying text.
- (vi) National aggregates of resource estimates should be rounded to the appropriate last significant digit, so as not to create false impressions of accuracy.

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Appendix 3

Staff and Commodity Responsibilities: AIMR 2006 and Related Projects

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