

AUSTRALIA

By Geoscience Australia, Canberra

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Australia continues to be a major supplier of mineral and energy products to the world's markets. According to the Australian Bureau of Agricultural and Resource Economics (ABARE), exports of mineral resources returned A\$52.5 billion to the Australian economy in 2003. This was 48% of total merchandise exports and 38% of total Australian goods and services exports.

Mineral exploration expenditure rose by 8.6% to A\$736.3 million in 2003, according to the Australian Bureau of Statistics. ABS also reported that exploration drilling rose to 5.3 million metres, an increase of 13% compared with 2002.

Australia is a major producer of a range of mineral products including bauxite, coal (black and brown), copper, diamond, gold, iron ore, lead, lithium, manganese, nickel, silver, tantalum, titanium minerals, uranium, zinc and zircon. It is the largest producer of bauxite, industrial diamond, lead, tantalum, titanium minerals and zircon.

Although small in world terms, Australia has an important petroleum sector, which makes a significant contribution to the national economy.

Sources and definitions

Commentary in this review is based on publicly available announcements and reports by companies. Information on mineral exploration spending is based on statistical data published by the Australian Bureau of Statistics in its quarterly series *Mineral and Petroleum Exploration Publication Series 8412.0*. Production and trade statistics and forecasts are based on various editions of the Australian Bureau of Agricultural and Resource Economics quarterly series *Australian Commodities forecasts and issues* and *Australian Mineral Statistics*. Information on Australia's world ranking for production and resources are largely based on data published by the US Geological Survey in its *Mineral Commodity Summaries 2004*.

Economic Demonstrated Resources (EDR) are those resources that are very well known geologically and that have been assessed as being likely to be profitably mined over the life of the resource. Formal definitions of the terms constituting EDR can be found in Geoscience Australia's *Australia's Identified Mineral Resources*. The 2003 edition of this review can be found on the Geoscience Australia website:

http://www.ga.gov.au/image_cache/GA3310.pdf

Unless noted otherwise all currency is expressed in Australian dollars. The Australian dollar appreciated markedly against both the US dollar and the Euro in 2003, rising from US\$0.56 in January to US\$0.75 in December and from €0.5403 to €0.5963 over the same period.

Exploration

Australian mineral exploration expenditure rose by 8.6% to A\$736.3 million in 2003, according to the ABS. Western Australia was the main destination attracting A\$432.9 million, an increase of 9.5% on 2002. Other increases were: New South Wales up 5.2% to A\$54.9 million, Victoria up 27.8% to A\$50.1 million, Queensland up 15.1% to A\$116.4 million and Tasmania up 10.0% to A\$4.4 million. Spending fell in South Australia by 2.7% to A\$35.9 million and the Northern Territory by 15.7% to A\$41.5 million.

Gold dominated exploration spending (50.8%) and totalled A\$373.7 million, an increase of 5.2%. Nickel-cobalt, iron ore and coal exploration recorded strong growth with increases of 28.9% (to A\$70.5 million), 40.8% (to A\$52.1 million) and 38.4% (to A\$84.7 million) respectively. Copper exploration fell by 18.6% (to A\$34.5 million) and zinc, lead and silver exploration by 17.7% (to A\$29.7 million). Mineral sands exploration fell by 14.3% to A\$26.3 million and diamond exploration was down by 15.3% to A\$27.6 million.

ABS reported that exploration drilling totalled 5.3 million metres in 2003 an increase of 600,000 m (13%) compared with 2002.

The Metals Economics Group's (MEG) world survey of non-ferrous mineral exploration budgets for 2003 reported an increase of 26% to an estimated total budget of US\$2.4 billion. For exploration in Australia, budgets of respondents to the MEG survey rose by 11% to US\$339.3 million. Despite this increase, Australia's share of the world budget fell to 15.5% from 17.6% in 2002. According to the MEG data, 61% of 2003 exploration budgets for Australian-based companies was directed to exploration in Australia. The MEG survey included 233 companies with exploration budgets of more than US\$100 000 that were exploring in Australia, an increase of 12 over 2002. Budgets for Australian exploration were directed mainly to gold (US\$209.3 million), base metals (US\$83.5 million) and diamonds (US\$15.9 million). Australian grassroots exploration budgets were dominated by the search for gold (55% of total budgets).

There was an increase of almost 50% to 38 in the number of successful minerals initial public offerings (IPOs) on the Australian Stock Exchange in 2003. Capital raisings via IPOs, mainly for exploration in Australia, totalled A\$206 million at an average of A\$5.4 million per IPO. Joint ventures with majors continued to be used as a means of funding exploration in leases held by junior companies.

Highlights of Australian mineral exploration in 2003 including key drill intersections are given in a review of activity prepared by Geoscience Australia (http://www.ga.gov.au/image_cache/GA3690.pdf).

The Australian and State/Northern Territory Governments continued geoscience programmes in support of mineral exploration with new data, products and geoscience initiatives in 2003. Geoscience Australia continued a A\$12 million Federal Government programme in collaboration with the States and the Northern Territory under the National Geoscience Accord. It launched a system for online delivery of geophysical data, including magnetics, radiometrics, gravity and DEM, via the Internet using the new Geophysical Archive Data Delivery System. Data provided via the Internet are free.

In the Northern Territory, a new four-year geoscience initiative to aid exploration, costing A\$15.2 million, commenced and a major diamond exploration database was launched. The Queensland Government continued a four-year, A\$9.2 million geoscience initiative and released an exploration geochemistry database with over 1.4 million data-points. South Australia continued its Targeted Exploration Initiative SA 2020 and released new geophysical maps and compilations based on reprocessed open file data for over 3 million line km. New South Wales continued the A\$30 million Exploration NSW geoscience initiative and presented airborne gravity data from the Broken Hill Falcon™ survey flown in February.

Western Australia released, on CD, a new 1:100,000 scale geology database of the world-class Eastern Goldfields region which incorporates a new GIS viewer, with the capacity to export customised maps to Word documents. The Victorian Initiative for Minerals & Petroleum (VIMP) continued, with investment of A\$29.5 million over ten years in the acquisition of modern geoscientific data. Tasmania's online geological and mineral exploration knowledge base (TIGER) was implemented. Also a 3-D geological model of western Tasmania was released and forms the basis for a new understanding of the tectonic and metallogenic evolution of Tasmania. It is designed to aid exploration between 250 m and 1,000 m below surface.

Commodities

A summary of the production and exports of selected mineral commodities is shown in end table.

Aluminium

Australia's aluminium industry is a large integrated industry of mining, refining and smelting, which is of major economic importance nationally and globally. Its economic demonstrated resources (EDR) of bauxite (4,800 Mt) provide a world-class resource base for the industry, which comprises five bauxite mines, six refineries, six primary aluminium smelters, twelve extrusion and four rolled product (sheet, plate and foil) mills. The industry ranks among the world's lowest-cost producers of bauxite, alumina and aluminium, and is the largest producer and exporter of bauxite and alumina. Over 16,000 people

are employed directly by the industry in all Australian States and the Northern Territory.

In 2003, production totalled 55.6 Mt of bauxite, 16.5 Mt of alumina and 1.9 Mt of aluminium (ingot metal). Compared with 2002, these represented increases of 2.7% 0.9% and 1.1% respectively. Very little Australian bauxite is exported and although ABARE does not report tonnage exported they do detail exports valued at A\$180 million which was 5% higher than in 2002. Alumina exports rose by 0.7 Mt (5.2%) in 2003 but aluminium exports fell slightly. Despite the significant increase in alumina exports the value of shipments fell by A\$90 million (2.4%) and the value of aluminium exports fell by A\$419 million (almost 11%) due mainly to a stronger Australian dollar. In total, bauxite, alumina and aluminium exports in 2003 were worth A\$7267 million, or 7% of total Australian merchandise export earnings. This placed the aluminium industry behind petroleum and coal as the third-largest export industry. ABARE predicts that production of primary aluminium, alumina and bauxite will rise to meet increasing global demand over the next five years and forecasts production of all to increase in 2004 with primary aluminium rising by nearly 33%, alumina by 24% and bauxite by 26% in 2009.

Development of, and production in, the aluminium industry in Australia continued strongly in 2003. Expansion of the Weipa bauxite mine in Queensland is under way to increase production capacity to 16.5 Mt/y, mostly to supply the new Comalco alumina refinery. Construction of the US\$750 million facility at Gladstone, Qld, is on schedule and initial shipments from the 1.4 Mt/y plant are expected in 2005. In June 2003, Comalco signed a long-term supply agreement with Norsk Hydro, under which the Norwegian industrial group will buy 500,000 t/y of alumina for more than 20 years to feed its aluminium smelters in Australia and elsewhere.

In late 2003, Alcan Gove Pty Ltd completed an Environmental Impact Statement (EIS) for its proposed A\$1.5 billion expansion of the Gove alumina refinery in the Northern Territory. The expansion would increase alumina production capacity from 2 Mt/y to around 3.5 Mt/y and convert all of Alcan Gove's bauxite output into alumina. Submission of the EIS to the Northern Territory Government in early 2004 is to be followed by further community consultation during the public comment period.

In Australia, Alcoa Worldwide Alumina and Chemicals (AWAC – owned by Alcoa Inc 60% and Alumina Ltd 40% and created in late 2002 when WMC Ltd's alumina assets were demerged from its other businesses), operates as Alcoa of Australia (AoA). AWAC has integrated mining and refining operations in Western Australia and aluminium smelting interests in Victoria (Point Henry smelter 100% ownership and Portland smelter 55% controlling interest). In 2003, the refineries produced approximately 7.9 Mt of alumina and the smelters a record 545,000 t of aluminium. AoA received the Society of Ecological Restoration International (SERI) Model Project Award — the SERI Award for Outstanding Contribution to the Field of Ecological Restoration. The prestigious award recognised effort in returning the plant

species richness of Jarrah forest in rehabilitated bauxite mines in Western Australia to a level equal to that of the surrounding native forest.

Coal

Although coal mining occurred in all Australian states in 2003, New South Wales and Queensland produced over 96% of all black coal (anthracite, bituminous and sub-bituminous coals) and Victoria produced all the brown coal (lignite). Australia's EDR of black coal is 39,500 Mt, which is about 5% of total world EDR making Australia's holdings the sixth largest in the world. EDR of brown coal is 37,500 Mt, which gives Australia the second-largest holding in the world and accounts for 20% of world EDR.

Expenditure figures published by ABS for coal exploration showed an increase of 38.4% to A\$84.7 million in 2003 of which A\$59.9 million was spent in Queensland. ABS does not provide detailed information on spending in other states but there was exploration in New South Wales, Victoria, South Australia and Western Australia.

Australia's coal production and exports have risen strongly over the past two decades and production of black coal increased in 2003. Output of saleable black coal at 280.7 Mt was 2.7% higher than in 2002 and was 7% of world output, making Australia the world's fourth-largest producer. Brown coal production was restricted to Victoria and reached 67 Mt in 2003, 8% of total world output. Australia was the world's third-largest producer of brown coal. ABARE has forecast Australia's saleable black coal production to rise to 343.5 Mt by 2008-09 of which 267.7 Mt will be exported.

Black coal was Australia's leading mineral export in 2003 generating revenue of A\$10.9 billion – 10% of Australia's total merchandise export revenue. However, this was a fall of 15.5% compared with 2002, despite an increase in tonnage shipped of 14.7 Mt (5.5%) owing to the combined impact of lower prices and the appreciating Australian dollar.

Development activity in the coal industry continued strongly in during the year.

Queensland: Pacific Coal's A\$460 million Hail Creek open-pit mine was opened in late-2003 and is to produce 5.5 Mt/y of hard coking coal for export. Pacific Coal also increased capacity at the Meandu open-pit mine from 5 to 7 Mt/y to supply additional coal to the Tarong and Tarong North power stations.

The BHP Billiton - Mitsubishi Alliance (BMA) started construction of the Broadmeadow punch longwall underground mine at Goonyella. The US\$67 million mine will produce up to 3.6 Mt/y of coking coal from late 2005. BMA plans to develop a new 14 Mt/y coal-handling and processing facility at the Blackwater mine.

At Newlands, Xstrata Coal commenced construction of the 8 Mt/y Northern underground punch longwall mine to replace the Southern underground mine.

Construction continued at Anglo Coal's new underground longwall coking-coal mine, the Grasstree Colliery and production is scheduled for 2005. Anglo Coal is also developing the Oak Park open-pit mine to replace production from the German Creek East mine.

MacArthur Coal's 1.6 Mt/y Moorvale open-pit mine commenced operations in 2003 and work started on Peabody Energy's A\$195 million Eaglefield open-cut project.

New South Wales: BHP Billiton's US\$410 million Mount Arthur open-pit mine commenced coal deliveries in January 2003. The mine will be able to produce up to 15 Mt/y of raw thermal coal when full production is achieved in 2006. BHP Billiton also continued construction of the US\$170 million Dendrobium mine, which will produce 5.2 Mt/y of coking coal from mid-2005.

Coal and Allied received approval to develop its Warkworth Extension, which will extend the life of the Warkworth project to 2020. The development will integrate the Warkworth and Mount Thorley operations.

Xstrata Coal's Beltana punch longwall underground mine commenced production in August at a rate of 5 Mt/y to replace output from the now closed South Bulga mine. Xstrata also started the integration of the Ravensworth East and Mount Owen mines in the second half of 2003.

Construction of Centennial Coal's A\$185 million Mandalong project and Austral Coal's A\$135 million Tahmoor North project continued, with longwall operations scheduled to start in 2005 and 2004 respectively. Construction of White Mining's A\$110 million Ashton open pit started in September, with production to commence in 2004. Gloucester Coal's Bowens Road North mine replaced the depleted Stratford mine during the year, and operations commenced at its Duralie mine.

Western Australia, South Australia and Tasmania: At Collie, in Western Australia, the thermal coal producers Griffin Coal and Wesfarmers are both proposing to construct a 300 MW mine mouth power station. In South Australia, NRG Flinders is planning an expansion of thermal coal production from 3 to 3.8 Mt/y using the current equipment. During the year a new open-pit thermal-coal mine opened at Cullenswood near St Marys in Tasmania.

Victoria: The Hazelwood, Yallourn and Loy Yang mines in the Latrobe Valley produce over 98% of Australia's brown coal. At Yallourn, satellite-guided bulldozers replaced bucketwheel coal dredgers. Australian Power and Energy, Loy Yang Power and HRL are all proposing to develop power stations and/or gas-to-liquids projects utilising new technology to meet stringent Victorian Government greenhouse gas emissions targets.

Copper

Major Australian copper mining and smelting operations are at Olympic Dam (South Australia) and Mt Isa (Queensland), with smaller projects in New South Wales, Queensland, Western Australia and Tasmania. Australia's EDR of copper is 32.8 Mt giving it the world's third-largest holding of copper EDR with 10% of the total.

Spending on exploration for copper fell by 18.6% in 2003 to A\$34.5 million. Although there was exploration for copper in all states and the Northern Territory, data published by ABS only allows South Australian spending of A\$11.7 million – 34% of all copper exploration in Australia – to be identified. The South Australian exploration was directed mainly to the search for Olympic Dam style mineralisation in the Gawler Craton. It includes the resource definition drilling at Prominent Hill where intersections, including 41 m averaging 6.06% Cu, have been located structurally above a previous gold intersection of 57 m at 7.7 g/t.

Other significant exploration results reported during 2003 include:

- Triako Resources Ltd at its Iodide South prospect at Mineral Hill, NSW: 8.2 m at 12.4% Cu and 1.2 g/t Au; 14.6 m at 1.5% Cu and 6.2 g/t Au; and 5.6 m at 1.4% Cu and 3.2 g/t Au.
- Newcrest Mining Ltd identified a large porphyry-style system at Gooley's North prospect east of its Cadia operation, NSW, with an intersection of 743.4 m at 0.17 g/t Au and 0.10% Cu.
- Cloncurry Mining Co reported an inferred resource of 875,000 t at 1.65% Cu and 1.0 g/t Au at the Kangaroo Rat prospect near Cloncurry, Qld. Drill results include: 9 m at 4.6% Cu and 0.98 g/t Au; 6 m at 3.1% Cu and 2.1 g/t Au; and 11.2 m at 2.14% Cu and 1.4 g/t Au.
- Also near Cloncurry, Matrix Metals reported a high-grade zone at its Greenmount deposit, with an intersection of 9.2 m at 5.67% Cu recorded. Greenmount has a measured and indicated oxide resource of 7.4 Mt at a grade of 1% Cu.

Mine production of copper in 2003 was 2.5 Mt of copper ores and concentrates which contained 869,000 t of copper. These were 2.6% and 1.6% lower than in 2002. Apart from Olympic Dam and Mt Isa, other significant copper operations are at Northparkes and Cadia-Ridgeway (New South Wales), Golden Grove (Western Australia), Ernest Henry, Osborne and Mt Gordon (Queensland) and Mt Lyell (Tasmania). As a producer, Australia ranks fourth, with 10% of world output, after Chile, the US and Indonesia. ABARE has forecast that mine output of copper will reach 1.08 Mt in 2008-09.

Australia's exports of copper concentrates and refined copper were valued at A\$2.02 billion in 2003, 1.9% of the value of total merchandise exports.

Copper output in 2003 from WMC Resources' Olympic Dam mine, which has the world's eighth-largest copper reserves, was down 10% on 2002, to 160,080 t of refined copper as a result of planned major maintenance and subsequent problems at the smelter and in the sulphuric acid plant.

Production recovered in the March quarter of 2004, to nearly 48,000 t of copper and is scheduled to increase further, reaching approximately 235,000 t/y of copper when the newly commissioned copper SX plants are at full capacity. In May 2004, WMC Resources Ltd announced a A\$50 million feasibility study into options to expand production further and to develop a preferred life-of-mine plan by 2006. Early studies have shown that Olympic Dam could produce up to 350,000 t/y copper by extending underground mining and in excess of 500,000 t/y copper by developing an open-pit mine on the southern orebody as an addition to existing underground operations. This option would then be the subject of a final feasibility study.

Xstrata Plc reported that 2003 production was impacted by difficult mining conditions during the first half of the year, with annual mine production down by some 7% on 2002. A significant increase in underground development at both the X41 and Enterprise mines is aimed at countering anticipated falling grades by increased production in 2004.

In a further boost for the base metals sector in Western Australia, Straits Resources announced that it would develop the Whim Creek deposit near Port Hedland, with first production from the open pit expected in late-2004. Straits will use the plant and equipment from its former Girilambone mine in New South Wales. It is expected that over 50,000 t of copper will be produced over a four-year operational life.

Tritton Resources announced a decision to develop the Tritton copper project, near Girilambone, in New South Wales, which will be based on a total resource of 14 Mt at 2.7% Cu. The operation will initially mine 660,000 t/y of ore rising to 900,000 t/y in the fifth and following years. Mining will be mainly by underground methods but with some ore supplied from a small open pit. Development costs for the project are expected to be about A\$38.5 million.

Diamond

Australia produced 31.03 Mct of diamond in 2003, making it the world's largest producer of diamond by weight. Australia is the largest producer of industrial-grade diamond and the second-largest producer of gem/near gem diamond. Botswana, a close second in terms of diamond production by weight, is the leading diamond producer by value, with Australia ranked 8th.

Australia's EDR of gem/near gem diamonds is 67.4 Mct and industrial diamonds 70.0 Mct. Australia's EDR of industrial diamond is ranked 3rd in the world, with 16% of world EDR.

ABS data indicate that expenditure on diamond exploration in Australia in 2003 was A\$27.6 million, down 15% on 2002. Exploration was concentrated in Western Australia, notably the Kimberley region, the Northern Territory and South Australia.

During the year, Striker Resources NL announced that it had acquired Ashton Mining's exploration tenements around the Merlin mine and had identified drill-ready targets close to the mine. Striker also reported that bulk sampling of its Seppelt 2 pipe in the North Kimberley region had indicated a grade of about 2 ct/t.

The bulk of Australian production was from the Argyle mine in the Kimberley region of Western Australia which produced 30.91 Mct of mostly industrial and cheap gem quality diamonds. Argyle production was down nearly 8% on 2002 and reflected the mining of lower-grade material in the Northern Bowl and the cessation of mining of alluvial diamonds in late 2002. A total of 9.79 Mt of ore was mined from the Argyle AK1 pipe giving an average grade of 3.16 ct/t, comparable with 2002 figures (3.19 ct/t). A 2.2 km exploratory decline to 300 m depth is being developed to test the Argyle orebody at depth below the open pit as part of a full feasibility study costing A\$70 million to assess the viability of underground mining after the open-pit reserves run out in 2008. A decision on the underground mine development option is expected in 2005.

Mining at Merlin in the Northern Territory ceased in the second quarter of 2003, ending five years of operations. A total of 62,000 ct were mined at Merlin in 2003. Trial mining commenced in December 1998 and a total of 468,000 ct was produced, mostly from the four southern pipes – Excalibur, Launfal, Palomides and Sacamore. The diamonds were mostly of gem quality with an average value of US\$100/ct, and included the largest diamond found to date in Australia, a 104.73 ct gem named Jungiila Bunajina after the traditional owners of the region. Following an unsuccessful tendering process to sell the Merlin deposit, Rio Tinto Ltd undertook closure and rehabilitation of the mine in the second half of 2003.

Mining continued at Ellendale in the West Kimberley region where Kimberley Diamond Co Ltd is producing high value (average value around US\$200/ct) fancy yellow gem diamonds from the top several metres of the Ellendale 9 pipe. A total of 57,000 ct was produced in 2003. Production is scheduled to increase in the second half of 2004 with the commissioning of a larger (2.2 Mt/y) plant. Recent large-diameter drilling and sampling has upgraded the resource at Ellendale 9, 4 and the satellite pipe to 90 Mt at 6.2 ct/100 t.

Gold

Gold resources occur, and are mined, in all Australian states and the Northern Territory. Australia's EDR of gold is 5,415 t, the third largest in the world after South Africa and the US.

Australian exploration spending in 2003 was dominated by the search for gold, with annual expenditure increasing by 5% to A\$373.7 million, which was 51% of total exploration spending. Although Western Australia dominated exploration by attracting A\$260.1 million (70%), work was carried out in the other regions, all with encouraging results.

The following selected highlights are indicative of the year's activity:

- Alkane Exploration Ltd at its Wyoming prospect, NSW yielded intersections at Wyoming One including 129 m at 3.85 g/t Au from 48 m; 15 m at 11.92 g/t Au from 105 m; and 99 m at 4.3 g/t Au from 258 m. At Wyoming Three: 7 m at 5.17 g/t Au from 47 m; and 10 m at 8.35 g/t Au from 48 m. Alkane released an initial resource estimate for Wyoming One and Wyoming Three of 6.38 Mt at 2.43 g/t Au for a contained 498,000 oz.
- Exploration by Newcrest Mining Ltd below the Ridgeway mine (Ridgeway Deeps) and in the Cadia Far East area, NSW, continues to expand the resource potential of the Cadia Valley operations as illustrated, for example, by the Ridgeway Deeps intersection of 408 m (not true width) at 2.98 g/t Au and 0.71% Cu.
- At the Malbec prospect, 1 km west of its Chariot mine near Tennant Creek, NT, Giants Reef Mining Ltd announced significant gold intersections including: 15 m at 7.83 g/t Au between 9m and 24 m; 1 m at 10.95 g/t Au from 49 m; and 1 m at 14.36 g/t Au from 54 m.
- Strategic Minerals Corp NL reported high-grade intersections from the Explorer prospect, part of its Woolgar project, Qld, including 8 m at 10.7 g/t Au from 113 m and 11 m at 14.7 g/t Au from 82 m.
- At Prominent Hill, SA, Minotaur Resources Ltd continued to report good intersections including 130 m at 1.41% Cu and 0.43 g/t Au, and 162 m at 1.03% Cu and 0.46 g/t Au. Late in the year further intersections reported included 103 m at 2.52% Cu and 1.1 g/t Au, and 133 m at 1.72% Cu and 1.4 g/t Au. This drilling confirmed the presence of two copper-bearing breccias in the western part of the deposit of which the southern is of higher grade and wider than the northern.
- Helix Resources Ltd reported encouraging intersections from the Tunkillia project, SA, including: 29 m at 4.3 g/t Au; 2 m at 29.7 g/t Au; and 2 m at 27.8 g/t Au from one hole in the Area 223 North area. Helix later announced a resource estimate of 10.5 Mt at 2.15 g/t Au and 5.5 g/t Ag for Tunkillia.
- Drilling by AngloGold Ltd identified the Carey Shear, a repetition of the Sunrise Shear Zone, at a depth of approximately 900 m under the Sunrise Dam mine. The hole also intersected 10 m at 53.6 g/t Au at a downhole depth of 1,350 m.
- Wide zones of gold mineralisation were reported by De Grey Mining Ltd from reconnaissance drilling at the Indee Turner River gold project, 70 km southwest of Port Hedland, WA. Among the intersections were: 32 m at 8.40 g/t Au; 26 m at 8.39 g/t Au; and 40 m at 4.34 g/t Au at the Wingina Well prospect.

Australian gold production reported by ABARE for 2003 was 284 t similar to output from the US. This level of production makes Australia and the US the second-largest producers in the world after South Africa, with about 11% of world output. The Super Pit at Kalgoorlie in Western Australia was the largest producer with an output of nearly 0.9 Moz. ABARE's longer-term outlook is for gold production to rise to 345 t/y in 2008-09.

Newcrest Mining Ltd is well advanced on the development of its new gold-copper operation at Telfer, WA, which currently has an expected life of 24 years. The A\$976 million Stage One project will include development of the open pit, construction of the concentrator and other necessary infrastructure. The A\$215 million Stage Two will be the underground mine development. Over the life of the mine annual output is expected to be 0.8 Moz of gold and 28,000 t copper. By the end of 2003, construction was on schedule and budget.

Barrick Gold's Cowal project, near West Wyalong, NSW, with a reserve of 66.4 Mt at 1.18 g/t Au (2.8 Moz), has received approval to proceed to develop the open-pit project. Production is expected to average 270,000 oz/y over the first decade. The company was granted a mining lease in June 2003 and work is on target for the first production in 2006.

Giants Reef Mining poured the first gold from its Chariot project near Tennant Creek, NT. The operation will mine 125,000 t/y of ore and produce around 60,000 oz/y of gold at cash costs of around A\$230/oz, with current reserves giving it a four-year mine life. Also in the Northern Territory, Renison Consolidated Mines NL reported that the first gold from its Quest 29 mine near Pine Creek was poured in September 2003.

Newcrest Mining Ltd and Sedimentary Holdings Ltd signed the mining joint venture documents allowing the start of construction of the Cracow gold project 2 km west of Cracow, Qld. The capital cost of the project is A\$89 million, and the first gold production is expected in December 2004.

Dominion Mining Ltd announced that it will proceed with the development of an underground mine at its Challenger gold project in the Gawler Craton, SA, where open cut production commenced in 2002. Subject to gaining regulatory approvals development is scheduled for March 2004, with the first ore to be reached in September 2004.

Perseverance Corp Ltd completed a bankable feasibility study into the development and mining of the sulphide resources at Fosterville near Bendigo, Vic. The A\$75 million project will include open-pit and underground mines and a treatment plant with an annual capacity to mine and treat 800,000 t of refractory ore. Production is planned to start in the December quarter 2004.

The Laverton Exploration JV (Metex Resources Ltd and Granny Smith Mines Ltd, a wholly-owned subsidiary of Placer Dome Asia Pacific Ltd) announced that it would undertake a trial mining programme at the Whisper deposit near Laverton, WA. The programme aims to extract 100,000 t of ore at a grade of 3.1 g/t Au, to be processed through the Granny Smith plant.

Iron ore

In Australia, over 97% of iron-ore production occurs in the Hamersley Basin of Western Australia. Small production also comes from elsewhere in Western

Australia, Tasmania and South Australia. Australia's EDR of iron ore is 12,400 Mt which is about 9% of world EDR. Australia has the fourth-largest iron-ore holding in the world. Australia also produces iron and steel, and in 2003 output totalled 9.7 Mt.

Expenditure figures for iron-ore exploration reported by ABS rose to A\$52.1 million, an increase of 40.8% compared with 2002. Detailed data on spending are not available from ABS but almost all is likely to have been spent in Western Australia and there were low levels of exploration in Northern Territory, Tasmania and South Australia.

Production of iron ore was strong, totalling 212 Mt in 2003, which was 18% of world output and making Australia the world's third-largest producer. ABARE forecasts that iron-ore production will reach 267 Mt/y in 2009.

Iron ore was a major contributor to Australia's export income in 2003 with, 87.3 Mt valued at A\$5.1 billion exported. In addition, Australia exported 3.8 Mt of iron and steel, which generated revenue of A\$1.8 billion. The combined iron ore and iron and steel exports accounted for 6.3% of Australia's total merchandise export revenue.

Hamersley Iron Pty Ltd's Yandicoogina mine was expanded from 20 Mt to 24 Mt/y and the Brockman No2 mine was reopened after capacity was increased to 8 Mt/y. Hamersley announced plans to spend A\$1.25 billion expanding capacity at the port of Dampier (74 Mt to 116 Mt/y), the Yandicoogina mine (24 Mt to 36 Mt/y) and upgrading its rail network.

Hamersley started construction of the A\$420 million Hismelt DRI processing plant at Kwinana in Western Australia. When commissioned in late-2004 the plant will process 1.3 Mt/y of high-phosphorous iron ore to produce 800,000 t/y of 96% Fe content pig iron.

Rio Tinto Ltd and Robe River Associates agreed to ship ore from Rio's wholly-owned Yandicoogina mine through Robe's Cape Lambert port facilities, with the first shipment in October 2003. Robe River will undertake an expansion costing US\$105 million at the West Angelas mine to increase annual capacity from 20 Mt to 25 Mt by mid-2005.

BHP Billiton Ltd's Mining Area C (MAC) project in the Hamersley Basin came on stream at a cost of US\$213 million and ahead of schedule. MAC production is scheduled to rise to 15 Mt/y by 2005. BHP Billiton's Products and Capacity Expansion (PACE) project continued on schedule for commissioning in the first half of 2004. The US\$351 million project will expand annual capacity of the rail and port facilities in the Pilbara region from 85 Mt to 100 Mt.

Portman Ltd's A\$20.3 million Koolyanobbing expansion project commenced in late 2003 and involves the development of mines at Windarling and Mount

Jackson, WA, with the first ore scheduled to be delivered in March 2004. The Koolyanobbing project has an expected life of 13 years at an annual production of 5 Mt.

Mount Gibson Iron Ltd's Tallering Peak mine in Western Australia began production in October 2003 at a rate of 1.6 Mt/y and railing of ore to Geraldton is to commence in early 2004. Developments included a A\$100 million dredging of Geraldton harbour to accommodate Panamax vessels.

In 2003, Aztec Resources Ltd announced a resource of 25 Mt at 67% Fe at Koolan Island in Yampi Sound, WA, and plans to complete a feasibility study in 2004. The Fortescue Mining Group Ltd proposes to spend A\$1.2 billion constructing common access infrastructure in the Pilbara region, including a 400 km rail line and loading berths at Port Hedland.

The company also plans to develop a 20 Mt/y mining operation based on the Mount Nicholas, Tongololo Creek, Mount Lewin and Mindy Mindy deposits. In 2004, Midwest Corp Ltd plans to develop a 1.0 Mt/y direct shipping ore mine based on high-grade resources at Koolanooka and Blue Hills, WA.

In South Australia, OneSteel Ltd signed a six-year contract with Henry Walker Eltin for mining, crushing and train loading services and a five-year ore beneficiation project for the Middleback Range operation. The project will process 9 Mt of low-grade ore to produce 5 Mt of useable high-grade ore, and is scheduled for commissioning in mid-2004. At Savage River, Tas, Ivanhoe Mines Ltd expects current open-pit mining operations to finish at the end of 2007 and pellet production to end in 2009.

Lithium

All of Australia's lithium resources are contained in hard-rock ore as the mineral spodumene ($\text{Li}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2$) and all occur in Western Australia in the Greenbushes deposit south of Perth. The EDR is about 169,000 t of contained lithium, all of which is accessible. Australia has about 4% of the world's EDR of lithium. ABS does not publish data on exploration for lithium but given the world oversupply of lithium resources, particularly in the form of lithium-rich brines in Chile, it is very unlikely that there will be any substantial exploration for lithium in Australia in the near future.

Sons of Gwalia Ltd remained the world's largest producer of lithium minerals (spodumene) in 2003 when production rose by almost 10% to 120,536 t.

Manganese ore

Manganese ore was mined in the Northern Territory and Western Australia in 2003. Production reached 2.55 Mt, 12% of world output, making Australia the third-largest producer in the world. Australian production is from two mines – Groote Eylandt in the Northern Territory and Woodie Woodie in Western Australia. Australia's EDR of manganese ore, at 124 Mt, is 13% of world EDR and Australia has the third-largest EDR in the world.

In 2003, Australian exports of manganese ore totalled 2.14 Mt valued at A\$312 million. ABS does not provide information on exploration spending for manganese ore.

HiTec Energy Ltd is proposing to construct an electrolytic manganese dioxide plant in the Kalgoorlie region of Western Australia. During 2003, Consolidated Minerals Ltd developed an optimised mine plan at Woodie Woodie that ensures a ten-year mine life.

Mineral sands

The three main minerals mined from Australian mineral sands deposits are the titanium-bearing minerals rutile and ilmenite and the zirconium-bearing mineral zircon. Production in 2003 was from Western Australia, Queensland and Victoria.

Australia's EDR of ilmenite is 198.2 Mt of which 63% is in Western Australia, 26% in Queensland and the rest in New South Wales and Victoria. Australia accounts for about 32% (the largest holding) of the world's EDR of ilmenite.

Combined, Queensland and Western Australia hold over 70% of Australia's 23.5 Mt EDR of rutile, which, at 47% of world EDR, is the world's largest.

EDR of zircon is 29.5 Mt, with Western Australia and Queensland holding just over 80%. In world terms, Australia's EDR is 41% of the total and is the largest holding by any country.

Although Australia has substantial EDR of mineral sands, Geoscience Australia estimates that some 18% of ilmenite, 24% of rutile and 28% of zircon EDR is unavailable for mining. They are in areas quarantined from mining that are largely incorporated into national parks. 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.

ABS reported expenditure on exploration for mineral sands in 2003 of A\$26.3 million, 14.3% less than in the record year of 2002. Detailed data are not published by ABS, however, it is likely that most of the expenditure was in the Murray Basin which covers parts of New South Wales, Victoria and South Australia.

In 2003, Australia produced 2.01 Mt of ilmenite, 173,000 t of rutile, 58,000 t of leucoxene and 462,000 t of zircon. Almost all Australia's rutile and zircon production is exported, but over half the ilmenite production is upgraded to synthetic rutile containing 92-94% TiO₂.

Australia was the world's leading producer of ilmenite (28% of world output), rutile (53%) and zircon (46%) in 2003.

Iluka Resources Ltd operated six open-pit mines at Eneabba and Capel and two synthetic rutile plants and a zircon finishing plant at Geraldton, WA. 2003 production was 69,922 t of rutile, 471,000 t of synthetic rutile, 1.03 Mt of ilmenite, 311,000 t of zircon, and 13,702 t of the proprietary product Hiti91. The company is the second-biggest titanium dioxide feedstock producer in the world behind Rio Tinto, and is the largest zircon producer. Production generally rose in 2003 as a result of better mineral processing rates, increased mining tonnages and higher synthetic rutile kiln availability. However, rutile production fell, mainly because of falling rutile grades from the Eneabba operations. A A\$2 million project to modify the synthetic rutile acid-leaching process and increase production of synthetic rutile by 12,000 t/y was completed.

The TiWest JV (Kerr McGee Corp 50%, Ticor Ltd 50%) is the world's largest integrated titanium dioxide project, 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, all in Western Australia. 2003 production was 23.15 Mt at 3.2% heavy minerals which yielded 433,000 t of ilmenite, 80,000 t of zircon, 340,000 t of rutile, 310,000 t of leucoxene, 194,000 t of synthetic rutile and 94,700 t of TiO₂ pigment. Current reserves for the Cooljarloo operations are 170.7 Mt of ore averaging 3.1% heavy mineral sands.

Production of rutile and zircon at Consolidated Rutile Ltd's (CRL) dry mill fell by 19% in 2003 owing to difficult mining conditions at the Yarraman mine and a three-month shutdown of the Yarraman dredge for repairs. To offset this, supplementary dry mining began in the existing Yarraman dredge mine path, feeding ore via a dry-mining slurry unit to the floating concentrator. CRL approved plans to upgrade the Ibis dredge plant, which will include the construction and installation of a thickener to manage higher clay levels in order to maintain current production levels.

In October, CRL announced the signing of a MOU with Austpac Resources NL covering the supply of ilmenite from CRL's operations to Austpac's proposed synthetic rutile plant. Under the MOU, CRL will supply 70,000 t/y of ilmenite, subject to a successful independent bankable feasibility study for the proposed plant, Austpac obtaining finance and the construction and commissioning by Austpac of a 30,000 t/y plant based on its proprietary synthetic rutile technology.

Murray Basin Titanium Pty Ltd, a 50:50 JV between Sons of Gwalia Ltd and RZM Pty Ltd, operated the Wemen mine near Mildura, Vic, to produce 28,239 t of rutile, 10,841 t of zircon and 50,984 t of ilmenite in the year to June 30, 2003. A review of the operation showed that, in the short term, the economics could be enhanced by processing ore at Cable Sands' Bunbury mineral separation plant in Western Australia. Consequently, the Mildura plant was placed on care-and-maintenance pending the outcome of an ongoing feasibility study for Phase 2 of the Murray Basin Development programme.

Southern Titanium NL expanded the scope of its feasibility studies on the Mindarie project, 120 km north of Adelaide, SA, to incorporate newly discovered strandlines. The Mindarie deposits contain one of the world's highest ratios of premium-grade zircon to titanium minerals. The project's resource base in September 2003 was 327.4 Mt for 8.3 Mt of heavy minerals. The company plans to mine 69 Mt/y of ore to yield 35,000 t of premium zircon, 8,200 t of rutile, 7,200 t of leucoxene and 72,000 t of ilmenite over a mine life of 12.5 years. An off-take agreement with DECOMetal International Trading GmbH was signed covering all planned output

BeMax Resources NL (BeMax) completed a definitive feasibility study and received all approvals from the New South Wales Government for the development of the Ginkgo deposit, near Pooncarie. The operation is expected to produce 450,000 t/y of heavy mineral concentrate over a 25-year mine life.

In October, BeMax signed a Heads of Agreement with Nissho Iwai Corp and Sons of Gwalia Ltd to merge their Australian mineral sands assets to form a new Australian titanium dioxide producer. BeMaX will become the public entity and will be Australia's third-largest producer of TiO₂ feedstock. The amalgamation included mineral sands operations in Western Australia and consolidated the Pooncarie mineral sands project in the Murray Basin with the Murray Basin Titanium JV. Nissho Iwai will hold 20.3% of BeMaX and Sons of Gwalia will have 15.36%. The other major shareholder, National Titanium Dioxide Co (Cristal) of Saudi Arabia, will own 26.99%. Formal agreements to effect this merger were executed in February 2004.

Nickel

Australia's total resources of nickel are 42 Mt of which EDR is at a record 22.8 Mt. Western Australia has the largest nickel resources, with 90% of total Australian EDR. Australia holds the largest share of the world's EDR, with 36%.

Expenditure on nickel-cobalt exploration for 2003, as reported by ABS, was A\$70.5 million, an increase of 29% over 2002. This increase was reflected in the rate of growth in nickel EDR which increased by about 600,000 t in 2003. About 78% of exploration expenditure occurred in Western Australia and focused on the komatiite-hosted nickel sulphide deposits in the Yilgarn Craton and the mafic-ultramafic Giles Complex, which extends into South Australia. The East Kimberley region in northern Western Australia attracted growing interest.

Typical of the results reported in 2003 were:

- In a new nickel region, Westonia Mines Ltd reported nickel sulphides from drilling at its Westonia project, west of Southern Cross, WA. The mineralisation occurs in the Westonia Greenstone belt and two drill holes returned intersections of 16 m at 1.77% Ni from 44 m and 10 m at 1.61% Ni from 30 m.

- Independence Gold NL reported 15 m at 10.0% Ni, including 10.6 m at 12.8% Ni, at its Victor South project, near Kambalda, WA.
- Western Areas NL reported an intersection of 6.6 m at 7.9% Ni from 455 m depth in the Flying Fox area of its Forresteria project, WA. Further drilling intersected massive sulphides and included 2.6 m at 5.2% Ni and 5.6 m at 3.6% Ni.
- At Radio Hill in the Pilbara region, WA, Fox Resources Ltd reported 18.0 m at 3.62% Ni, 3.06% Cu, 0.2% Co and 0.5 g/t Pd and 25.4 m at 3.25% Ni, 2.01% Cu, 0.16% Co and 2.15 g/t Pd from drilling to test extensions of mineralisation.
- A measured resource of 9.0 Mt at a grade of 0.53% Ni and 0.1% Co was released by Central Kalgoorlie Gold Mines Ltd (now Sherlock Bay Nickel Corporation Ltd) for the Sherlock Bay nickel deposit near Karratha in Western Australia's Pilbara region.
- Deep diamond drilling by Sally Malay Mining Ltd at Sally Malay intersected nickel sulphides over 7.4 m at 1.58% Ni, 0.74% Cu and 0.08% Co, including a 4.4 m interval at 2.06% Ni, 0.98% Cu and 0.1% Co. The intersections were made approximately 650 m below surface and confirm that mineralisation continues at depth below the main fault zone.

Australian mine production of nickel in 2003 increased by 2.8% to 188,000 t, all from Western Australia. Production of intermediate nickel products (matte and speiss) totalled 107,000 t in 2003 and refined nickel was 130,000 t. The value of all nickel products exported was A\$2.7 billion. Australia was the world's second-largest producer, accounting for 15.6% of estimated world nickel output. ABARE forecasts that mine production will increase to 274,000 t of nickel in 2008-09.

During 2003, total nickel-in-concentrates production by WMC Resources Ltd (WMC) the world's second-largest nickel-in-concentrate producer, was 117,722 t – 16% of world nickel-in-concentrate production. This was achieved by record production from Mt Keith, increased output from Leinster and increased supply from the independent operators of WMC's divested Kambalda nickel mines. Nickel-in-matte production in 2003 from the Kalgoorlie smelter by WMC totalled 99,152 t, 8% higher than for 2002. However, refined metal production at the Kwinana refinery was 61,417 t, 6% lower than for 2002 owing to plant breakdowns. A de-bottlenecking project was started to increase annual production capacity at Kwinana to 70,000 t and is due for completion in 2004.

In February 2003, WMC commenced a major extension of its Perseverance underground mine at Leinster. Over the next eight years it will extend mining 350 m deeper to 1,100 m below the ground surface, and install a new materials-handling system to crush and hoist ore to the surface. Most of the work will be completed by late-2005.

WMC entered into a A\$1 billion agreement with China's largest producer, Jinchuan Group Ltd, to supply 90,000 t of nickel-in-matte. This agreement is in addition to a 30,000 t agreement signed last year. The company will export

a total of 120,000 t of nickel-in-matte to Jinchuan between 2005 and 2010 and when refined, this will satisfy over 20% of the expected Chinese consumption of nickel metal in 2010.

BHP Billiton has developed a proprietary atmospheric leach processes to be used on its Ravensthorpe laterite nickel project, WA. The Enhanced Pressure Acid Leaching (EPAL) hydrometallurgical process is a combination of pressure acid leach and atmospheric leach, and produces a mixed nickel and cobalt hydroxide intermediate product (MHP). The company plans annual production of MHP at Ravensthorpe containing up to 50,000 t of nickel and 1,400 t of cobalt, to be shipped from Esperance to Townsville for refining at the QNI Yabulu refinery. Production is to start in 2007.

Jubilee Mines NL commenced the mining the Cosmos Deep orebody after the completion of the Cosmos open pit. Estimated future production from the underground mine is 150,000 t/y of ore yielding 50,000 t of nickel-in-concentrate (10,000 t of contained nickel) over a mine life of 3.5 years.

Western Areas NL is carrying out a bankable feasibility study into its proposed A\$70 million development of the Forrestania project, with the aim of starting production in 2005. The company is considering a 500,000 t/y mining and processing operation, taking in five mines and a concentrator, and producing up to 12,000 t/y of contained nickel over a mine life of six years. The study is expected to be completed in July 2004.

In April 2003, Sally Malay Mining Ltd commenced construction of the Sally Malay nickel project following the securing of a A\$52 million loan and obtaining environmental approvals. The first concentrates are scheduled for shipment in mid-2004 to the Jinchuan Group Ltd smelter-refinery complex in China. The company expects the mine to produce 344,500 t of bulk concentrate containing 45,600 t of nickel, 21,750 t of copper, and 2,250 t of cobalt over a 5.5 year mine life.

Reassessment by Fox Resources of the Radio Hill mine showed that the disseminated sulphide zones could be mined economically from the existing decline with minimal new development. Up to 751,000 t of ore at 0.8% Ni, 1.0% Cu and 0.05% Co could be economically mined from the decline with an additional 107,000 t at 0.9% Ni and 1.1% Cu mined by an open pit from the B2 orebody. These resources represent about four year's production from the Radio Hill plant at its current capacity of 220,000 t/y.

MPI Mines Ltd announced plans to start open-pit mining at the Black Swan deposit by the end of 2004. Two mine options are being considered of which one would require a minimal upgrade of the existing plant to support mining 450,000 t/y to yield 3,000 t of nickel-in-concentrate. The second is to mine 1.0 Mt/y of ore, which would yield around 6,000 t of nickel-in-concentrate but this would require increased power capacity, more water and plant upgrading.

Australian Mines Ltd commenced underground development in December at the Blair mine. Ore production is expected to start during the March quarter 2004, with the concentrates being toll-treated at WMC's Kalgoorlie smelter.

Mincor Resources NL will develop the Redross mine, 70 km south of Kambalda, WA, during 2004, at a cost of about A\$11 million. The mine has a indicated and inferred resources totalling 345,000 t at 5.01% Ni.

Allegiance Mining NL received environmental approval for the first stage of development of the Avebury nickel deposit in Tasmania, which will involve construction of an access road and an 800 m long decline to enable bulk sampling and geotechnical assessment. Production will be at 300,000 t/y to produce about 5,000 t/y of nickel-in-concentrate over the initial two-to-three years.

Australia's lateritic operations at Cawse and Murrin Murrin continued to experience mixed success in 2003. The Minara Resources Ltd (formerly Anaconda Nickel Ltd) Murrin Murrin operation produced 27,890 t of nickel in 2003, which is 62% of its plant capacity (45,000 t/y of nickel) but was expected to achieve capacity by the end of 2004.

Tantalum

Australia, through Sons of Gwalia Ltd, is the world's largest producer of tantalum in the form of tantalum concentrates. The company also has the world's largest stock of tantalum resources, principally in its deposits at Greenbushes and Wodgina in Western Australia.

Australia has the world's largest EDR of tantalum at 41,000 t, all of which is accessible for mining. This is approximately 93% of world EDR. ABS does not report statistics for tantalum exploration expenditure.

Australian production of tantalum, in the form of tantalum pentoxide was about 2.2 Mlb of Ta₂O₅ in 2003, 15% lower than in 2002. Sons of Gwalia was the major producer, accounting for almost 92% of the total. Australia is the world's leading producer of tantalum and accounts for about two-thirds world output.

Sons of Gwalia's Wodgina operation in Western Australia's Pilbara region was the leading producer, with an output of 1.05 Mlb of Ta₂O₅, a reduction on the 1.3 Mlb produced in 2002. The other major producer was Sons of Gwalia's Greenbushes mine south of Perth, Western Australia. Production at Greenbushes in 2003 was just over 1 Mlb of Ta₂O₅, nearly 18% lower than in 2002.

At its Bald Hill operations in the Kambalda region, Western Australia, Haddington Resources increased production to 181,623 lb of Ta₂O₅ compared with 153,294 lb in 2002.

Tantalum Australia had processed all previously mined ore at its Dalgaranga operation near Mount Magnet, Western Australia, by the end of 2002. Although the company had located more ore in proximal leases it was not processed because of the prevailing market conditions. The Dalgaranga plant was placed on care and maintenance in January 2003.

Tin

Mine production in Australia fell again in 2003 to be 3,818 t of tin in concentrates (40% less than 2002) and 597 t of refined tin ingots (25% less than 2002). Total tin exports for 2003 were 2,862 t valued at A\$18 million.

At the start of 2003, Australia had three operating tin mines – Renison Bell underground mine (Murchison United NL) in Tasmania, Ardlethan alluvial mine (Marlborough Resources NL) in NSW and Greenbushes open-pit mine (Sons of Gwalia Ltd) in WA.

Mining and milling operations at Renison Bell were suspended following Murchison's failure to secure capital for development of a decline to access new ore reserves in the high-grade Federal orebodies. Mining in the main stoping areas had been halted earlier in the year due to difficult ground conditions and recommendations by the company's geotechnical consultants. Prior to suspension, Renison Bell had been a major producer for almost 40 years.

Ardlethan alluvial operations produced 1,031 t of tin in concentrates in 2003. Production increased steadily over the year reaching a monthly rate of 136 t tin for December. The main factors supporting the growth were commissioning of a second processing plant, increased ore grades from 1.27 kg Sn/bcm to 2.15 kg Sn/bcm by the December quarter and access to additional water supplies.

Greenbushes produced 597 t of refined tin ingots in 2003 as a by-product of tantalum ore processing.

Uranium

Australia has 689,000 t of uranium in Reasonably Assured Resources recoverable at costs of less than US\$40/kg U – this is the world's largest resource and represents 40% of world resources in this category (OECD Nuclear Energy Agency & International Atomic Energy Agency, 2004: 'Uranium 2003 Resources, Production & Demand' (in press)). Approximately 97% of Australia's total resources are in six deposits: Olympic Dam, SA, the world's largest uranium deposit, Ranger, Jabiluka, Koongarra in the Alligator Rivers region, NT, and Kintyre and Yeelirrie, WA.

Three uranium mines operated in Australia in 2003: Ranger open pit, Olympic Dam underground mine, and the Beverley in situ leach (ISL) operations. In 2003, Ranger produced 5,065 t U₃O₈, Olympic Dam 3,176 t U₃O₈, and Beverley 689 t U₃O₈ for a total of 8,931 t U₃O₈ (7573 t U), 10% higher than for 2002.

Australia, with approximately 21% of world uranium production in 2003, is the world's second-largest producer after Canada (29%).

Exports in 2003 were 9,614 t U₃O₈ (8,153 t U) valued at A\$398 million. Australia has no significant national demand for uranium and all production is exported under very stringent conditions to ensure it is used only for peaceful purposes. These conditions – referred to as 'nuclear safeguards' – require customer countries to allow inspectors from the International Atomic Energy Agency to verify that the uranium is not directed into weapons programmes. In addition, Australia requires compliance with parallel conditions under treaties it has concluded with end customer countries.

During 2003, 9.0 Mt ore were mined at Olympic Dam and the processing plant treated 8.4 Mt ore with an average grade of 2.4% Cu and 0.63 kg/t U₃O₈. Reconstructions of both the copper and uranium solvent extraction (SX) plants (destroyed by a fire in 2001) were completed in 2003 and the new uranium SX plant was operating at planned production rates by June. As a result, production increased during the first three quarters of the year. However, production was disrupted in the final quarter by the failure of a heat exchanger in the sulphuric acid plant, which resulted in a shortage of acid required for leaching and ore processing. It is anticipated that the plant will operate at full capacity of 235,000 t of copper and 4,500 t of U₃O₈ during 2004.

Ranger mine, operated by Energy Resources of Australia Ltd (ERA), achieved record production for 2003. Mining at the No. 3 orebody is expected to continue until at least 2009, after which the pit will be used for the storage of tailings. Production from stockpiled ore will continue until at least 2011.

The Beverley ISL mine was extended from the North orebody into the much larger Central orebody and plant capacity expanded to include a third train of ion-exchange columns. The company proposes to increase future production progressively to 1,000 t/y of U₃O₈, which is the project's nominal capacity.

As with Ranger, the Jabiluka deposit is surrounded by, but is not part of, Kakadu National Park. In view of World Heritage concerns about the impact of Jabiluka's development on the park, ERA Ltd had previously agreed that Jabiluka and the nearby Ranger mine would not be in full operation simultaneously. Mineralised stockpile material and waste were returned to the underground mine and the decline (1.2 km) was backfilled during the year. ERA announced that there would be no further development at Jabiluka without the support of local Aboriginal people and subject to feasibility studies and market conditions. The project remains on long-term care-and-maintenance.

In late 2001, Southern Cross Resources received Commonwealth and State environmental clearances to develop the Honeymoon *in situ* leach project in South Australia. However, development of the project is currently on hold pending improved market conditions.

Southern Cross Resources completed airborne electro-magnetic surveys over its exploration tenements in order to locate palaeochannels buried at depths of 70-120 m below surface and overlain by sands and clays. Exploration drilling was carried out to locate new uranium deposits within them.

The Prominent Hill deposit in South Australia has copper, gold, uranium, rare-earth mineralisation in hematite breccias. Its geological setting and style of mineralisation are broadly similar to the Olympic Dam deposit, approximately 150 km to the southeast. During 2003, drilling intersected significant zones of copper and gold mineralisation with low uranium grades within hematite-sandstone breccia. The average uranium grades from drill intersections at 100-200 ppm U are much lower than for Olympic Dam, which averages 400-500 ppm U.

The Western Australian Government has prohibited the mining of uranium for nuclear purposes from any mining lease granted after June 2002. The policy was ratified with an amendment to the Mining Act, which prohibits the mining and export of uranium for nuclear purposes. There are no uranium mines in Western Australia, but large deposits occur at Kintyre and Yeelirrie.

The South Australian Government commissioned an independent review of the current incident reporting procedures associated with uranium mining and related activities at Olympic Dam and ISL operations at Beverley. The review follows a series of spills, including uranium-bearing copper concentrate slurry at Olympic Dam in 2001 and leach fluids at Beverley in 2002. It recommended new regulations for reporting incidents, including releases of radioactive process materials or liquids leading to the accidental exposures of workers to radioactive materials. It also specified the minimum size and nature of spills that must be reported.

Zinc, lead, silver

Australian EDR of zinc is 35 Mt, with Queensland the holding 54%. The Northern Territory, New South Wales and Western Australia also have zinc EDR.

Australia's EDR of 19 Mt of lead is about 34% of total identified resources. Queensland has 53% of total EDR, mainly at Cannington and Mt Isa. Other holdings are in Northern Territory, New South Wales, Western Australia and Tasmania.

EDR for silver are 43,000 t, with Queensland having the largest share at 73%, mainly in the Mt Isa, Cannington, Century and Hilton deposits. Other holdings occur in the Northern Territory, South Australia, New South Wales and Western Australia.

Australia has the world's largest EDR of zinc (17% of the world), lead (25%) and silver (14%).

In 2003, exploration spending on zinc-lead-silver was A\$29.7 million, A\$6.4 million less than in 2002. The 2003 expenditure was about 22% of total base metal expenditure of A\$134.6 million compared with 27% in 2002. Some of the encouraging exploration results include:

- Inmet Mining Corp and Pilbara Mines Ltd announced an initial resource for the Jaguar deposit at Teutonic Bore, WA. Pilbara subsequently acquired Inmet's share of the project and announced a new resource of 1.72 Mt at 3.6% Cu, 11.9% Zn and 127 g/t Ag. Drilling yielded intersections including 3.67 m at 7.36% Cu, 10.95% Zn and 233 g/t Ag, and 5.03 m at 4.36% Cu, 7.49% Zn and 144 g/t Ag.
- At the old Pinnacles mine at Broken Hill, drilling by Pinnacles Mines Pty Ltd intersected mineralisation including 6.4 m at 11.16% Zn, 1.38% Pb and 0.63 g/t Au, and 2.5 m at 12.58 g/t Au.
- Kagara Zinc Ltd's drilling at Montevideo near Chillagoe, Qld, returned a 38.1 m intersection of 7.0% Zn, including 13.8 m at 11.0% Zn. Kagara also reported further good intersections from the Balcooma project, near Greenvale, Qld. In the Upper Lens, 4.6 m at 28.8% Pb and 4.53 g/t Au and 4.0 m at 4.8% Pb and 9.4 g/t Au were reported. High-grade copper intersections were 8.1 m at 16.8% Cu and 8.0 m at 13.45% Cu and 7.3% Pb.
- At Sunny Corner, near Lithgow, NSW, Golden Cross Resources Ltd, reported that reconnaissance drilling intersected 50 m at 0.4% Cu, 1.8% Pb, 3.8% Zn 1.0 g/t Au and 45 g/t Ag, and 14 m at 0.7% Cu, 2.9% Pb, 6.2% Zn, 0.07 g/t Au and 23 g/t Ag.
- Glengarry Resources Ltd reported highly anomalous silver, cobalt and tungsten intersections at its Diamantina project south of Mt Isa, Qld. A 1 m intersection at 84.6 g/t Ag, 0.32% Co and 470 ppm W was recorded at 47 m at the end of the hole.

The 2003 Australian mine production of zinc, lead and silver was 1.48 Mt, 700,000 t and 1,870 t respectively. These are a slight increase for zinc (up 10,000 t), no change for lead and a slight decrease for silver (down 2,300 t) compared to 2002. In production, Australia ranks first for lead, second for zinc after China and fourth for silver after Mexico, Peru and China. Cannington is the world's largest and lowest-cost silver and lead producer and produced almost 233,000 t of lead and 35.5 Moz of silver in 2003. Century had the largest zinc output at 503,000 t.

Consolidated Broken Hill (CBH) purchased Pasma's Elura mine (now called Endeavour) in New South Wales for a reported A\$22 million and plans to lift ore production to 1.4 Mt/y. A revised mine plan has enabled a substantial increase in reserves to 11.6 Mt at 8.3% Zn, 5.1% Pb and 50 g/t Ag. The purchase of Elura and failure to acquire Pasma's assets at Broken Hill has resulted in CBH concentrating its attention on Elura ahead of its Rasp project at Broken Hill.

Kagara Zinc will spend A\$7.5 million on an expansion of the treatment plant at the Mount Garnet operation in Queensland. The work will increase annual concentrate capacity from 90,000 t to 148,000 t. In addition it will add a

20,000 t/y copper circuit to process supergene ore from Balcooma. Kagara reported further encouraging drill intersections at Balcooma, including 10 m at 15.9% Pb and 16.1% Zn, and a high-grade copper intersection of 16.1 m at 12% Cu.

The receivers of Western Metals sold the company's Lennard Shelf, WA, zinc-lead operations to Teck Cominco for A\$26 million. Although the acquisition will add to Teck's production capacity, the operations will remain closed pending improved metal prices or better exchange rates.

Xstrata is continuing work on a feasibility study investigating the possible expansion of operations at the McArthur River mine in the Northern Territory, and the possible use of the Albion technology there.

Others commodities

Australia produces a range of other commodities for both export and domestic consumption. Included in this group are talc, silica, salt, limestone, gypsum, a range of gemstones other than diamond but including opal and sapphire, a range of clays including bentonite, kaolin, refractory clays, andalusite, kyanite and sillimanite, and construction materials including dimension stone, sand, gravel and crushed and broken stone.

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Table following page.

Selected Australian Mineral Statistics 2003 (over two pages)

	Unit	Production	Exports	Export value (A\$ million)
Aluminium				
Bauxite	1,000 t	55,602		180
Alumina	1,000 t	16,529	13,567	3,663
Aluminium	1,000 t	1,857	1,527	3,424
Coal				
Black, raw	Mt	358.37		
Black, saleable	Mt	280.7	215.57	10,863
Brown	Mt			
Copper				
Mine (contained metal)	1,000 t	869		
Concentrates	1,000 t		1,351	1,159
Blister	1,000 t	434		
Refined	1,000 t	501	343	863
Diamond	1,000 ct	31,028	31,028	766
Gold				
Mine	t	284		
Refined	t	411	313	5,546
Iron				
Ore & concentrates	1,000 t	211,879	187,264	5,080
Iron & steel	Mt	9,660	3,793	1,773
Lead				
Mine (contained metal)	1,000 t	688		
Concentrate	1,000 t		386	299
Bullion	1,000 t	169	135	148
Refined	1,000 t	270	268	193
Manganese				
Ore & concentrates	1,000 t	2,555	2142	312
Nickel				
Mine (contained metal)	1,000 t	188		498
Intermediate Ni	1,000 t	107		343
Refined Ni	1,000 t	130		1,856
Nickel			217	
Silver				
Mine (contained metal)	t	1,873		
Refined	t	651	432	109

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Tin				
Mine (contained metal)	t	3,818	2,862*	18
Refined	t	597		
Titanium				
Ilmenite	1,000 t	2,006	869	105
Leucoxene	1,000 t	58	112	30
Rutile	1,000 t	173	164	112
Synthetic rutile	1,000 t	666	447	251
TiO ₂ pigment	1,000 t	190	151	402
Uranium				
U ₃ O ₈	t	8,931	9614	398
Zinc				
Mine (contained metal)	1,000 t	1,480		
Ores & Concentrates	1,000 t		1,907	662
Refined	1,000 t	553	460	654
Zircon				
Zircon concentrates	1,000 t	462	452	261

*Tin content of tin ores and concentrate and refined tin.

Source: Sum of four quarters, 2003, data published in ABARE Australian Mineral Statistics December Quarter 2003.