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Overview of the Mineral Sector in Western Australia

in 2000–01

By
D. J. Flint



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Ferro-alloy metals

Heavy mineral sands

Diamond

Industrial minerals



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GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

OVERVIEW OF THE MINERAL SECTOR IN WESTERN AUSTRALIA IN 2000–01

**by
D. J. Flint**

**Principal Industry and Commodity Analyst
Investment Attraction Division
Department of Mineral and Petroleum Resources**

Perth 2002

MINISTER FOR STATE DEVELOPMENT
Hon. Clive Brown MLA

DIRECTOR GENERAL, DEPARTMENT OF MINERAL AND PETROLEUM RESOURCES
Jim Limerick

DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
Tim Griffin

REFERENCE

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Department of Mineral and Petroleum Resources
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Telephone: (08) 9222 3459 Facsimile: (08) 9222 3444

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Overview of the mineral sector in Western Australia in 2000–01

by D. J. Flint

Mineral exploration trends

Western Australia's prospectivity is highlighted by the continuing high proportion (61%) of Australian mineral exploration expenditure that the State attracts (Fig. 1). However, in line with worldwide trends and Australia as a whole, Western Australia experienced subdued exploration activity during 2000–01. Mineral exploration expenditure (excluding petroleum) in Western Australia, at \$438.9 million*, experienced an increase of \$23.9 million or 5.8% on the previous year. Exploration activity is now at levels of around 36% lower than the peak of activity in 1996–97 when \$691.7 million was spent. After three years of substantial falls, the turnaround and modest increase are heartening and hopefully will be sustained. Mineral exploration expenditure in Western Australia, on a quarterly basis, is hopefully showing signs of forming a base for a more sustained recovery (Fig. 2).

The current level of mineral exploration activity in Australia is well below the record levels of over \$1000 million that were achieved in 1996–97 and 1997–98. Australia-wide expenditure figures for 2000–01 showed a modest increase of \$45.1 million (6.7%) to \$721.4 million. The percentage increase is similar to that experienced in Western Australia, which still continues to attract the greatest portion of all Australian exploration expenditure (60.8% compared to 61.4% previously). This has remained relatively constant at 60–62% over the last five years throughout the large cutbacks that have occurred in exploration expenditure, especially those in the gold sector (Fig. 1).

Western Australia† still attracts the major part of the Australian exploration dollar for iron ore (99.1%), gold (74.5%), diamond (55.7%), base metals including Ni–Co (44.3%), and heavy mineral sands (22.5%). These statistics are encouraging because they apply at a time when companies are being very selective about where they explore, and the statistics also indicate that the perceived prospectivity for these commodities in Western Australia is very high.

* All amounts in \$A unless otherwise specified.

† For locations, see 'Western Australia atlas of mineral deposits and petroleum fields 2001' published by Geological Survey of Western Australia.

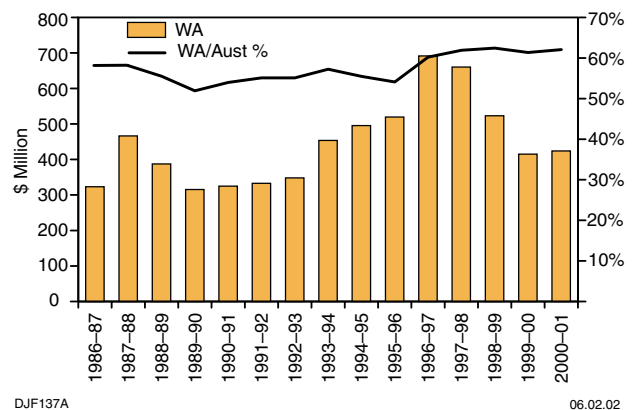


Figure 1. Mineral exploration expenditure in Western Australia, by year (dollars of the day)

The decline in mineral exploration in Australia since 1996–97 was matched by declines worldwide, but with Australia and Western Australia maintaining their share of global exploration at around 17.5 and 10% respectively (based on worldwide surveys by the Metals Economic Group of Canada). The continued decline is attributed to low metal prices in general in recent years, particularly

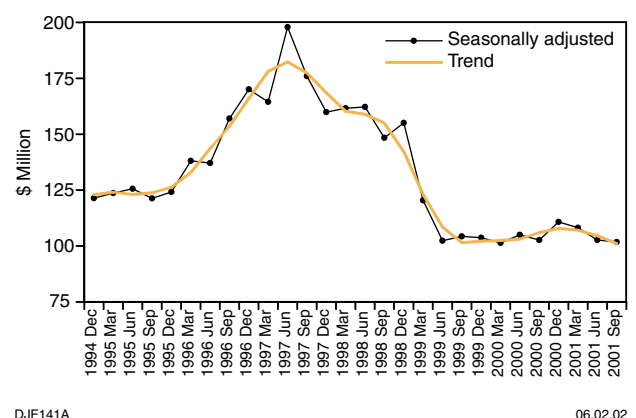


Figure 2. Mineral exploration expenditure in Western Australia, by quarter, on seasonally adjusted and trend terms (dollars of the day)

in the case of the gold price, which reached a 20-year low point in \$US terms during 1999–2000. In recent years, companies have focused on increasing their return on capital and on reducing costs. Surveys have shown that, on average, mining is often a low-profit activity, and speculative venture capital continues to be directed away from the resources sector, but not to the same extent as during the ‘dot.com’ boom of 1999–2000. The perception existed during 1999–2000 that mining was ‘old economy’ and that exploration, particularly greenfields exploration, destroyed shareholder value. This perception continued throughout 2000–01 and resulted in reduced exploration activity, less preparedness to risk funds on greenfields exploration, and a lower percentage of profits directed back as exploration expenditure. In Australia, the effect of Native Title issues on land access continues to compound the problem. These negative factors have presumably, at least to some degree, outweighed the positive impact from a weak Australian dollar.

The pace of consolidation or mergers and acquisitions, at both the international and national level, continued during 2000–01. This trend is regarded as having a negative impact on exploration expenditure in the short term at least. The merged entities often rationalize their exploration portfolio and have an exploration budget that is smaller than the aggregate of the pre-merger entities. Examples of the substantial consolidation within the industry include the takeover by Rio Tinto Ltd of North Limited and Ashton Mining Ltd, BHP merging with Billiton, Barrick Gold Corp merging with Homestake Mining Corporation, Delta Gold Ltd merging with Goldfields Ltd, Sons of Gwalia Ltd purchasing PacMin Mining Corporation Ltd from its Canadian parent Teck Cominco Ltd, Gold Fields Ltd purchasing WMC’s St Ives and Agnew gold operations, Croesus Mining NL acquiring Central Norseman Gold Corporation Ltd, and the takeover battle between AngloGold Ltd and Newmont Mining Corp for Normandy Ltd. Harmony Gold Ltd of South Africa took over New Hampton Goldfields Ltd, and also has a takeover of Hill 50 Gold NL in progress.

The trend appears to be for major companies to spend less on early-stage or greenfields exploration, instead relying on junior companies to carry the exploration risk and find the deposits for them. However, research by the Metals Economic Group of Canada indicates that the combined market capitalization of junior mining companies (those with market capitalization of less than \$US200 million) throughout the world has dropped by 28% in the three years since mid-1998. The lack of investor sentiment in this sector highlights how difficult it is for junior companies to fund exploration and advance promising projects towards feasibility. It is inevitable that the discovery rate of new deposits will decline and that this will have a negative impact in the longer term on new mine development and production, with the inevitable flow-on effect to exports.

Another trend in recent times is for direct foreign investment to be strategically focused on supporting exploration and development of selected projects. Examples include Kemet Corporation funding exploration and development of the Dalgaranga tantalite project in the

Murchison Granite–Greenstone Terrane, Inmet Mining Corporation assisting Pilbara Mines Ltd with exploration of the Teutonic Bore volcanogenic massive-sulfide deposits in the Eastern Goldfields, and Anglo American Australia Pty Ltd supporting Greenstone Resources NL in exploration of the Albany–Fraser Orogen and overlying Mount Barren Beds near Ravensthorpe (i.e. near the polymetallic Trilogy deposit that was discovered in 1997).

Mineral exploration expenditure by commodity and industry highlights

Gold remains the main focus of mineral exploration in Western Australia, accounting for about 66% of all exploration expenditure in Western Australia, followed by base metals and nickel–cobalt (19%), iron ore (5%), diamond (5%), and heavy minerals (1%). All other commodities total only 4% of recorded expenditure, with the main interest during 2000–01 being tantalum and platinum exploration.

Gold

During 2000–01, the gold industry in Western Australia staged a modest comeback after three years of substantial decline (Fig. 3). Gold exploration expenditure in Western Australia rose by 13.3% (\$33.7 million) to \$286.7 million in 2000–01, but this level is still down 46% (\$245 million) from the peak activity of \$531.7 million in 1996–97. Gold exploration expenditure is currently at levels last seen during the recession in the early 1990s. The modest recovery in the Western Australian gold sector is ahead of that in other States, reflecting the greater production base and perceived prospectivity of Western Australia. Western Australia now attracts 74.5% (67.5% in 1999–2000) of the Australian expenditure targeting gold, the highest proportion since at least 1984–85.

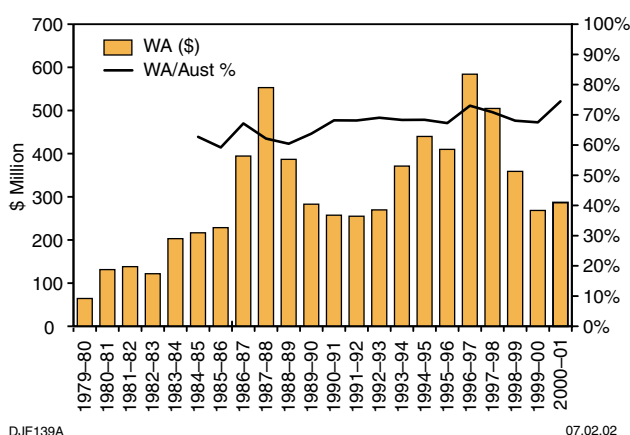


Figure 3. Gold exploration expenditure in Western Australia, by year (2000–01 dollars)

Exploration highlights for the gold sector during 2000–01 include:

- Discovery of high-grade mineralization at the Waugh prospect in the Ashburton Basin near Paraburdoo (Sipa Resources International NL).
- Successful infill drilling by St Barbara Mines Ltd at the nearby Paulsens deposit, hosted by the Hardey Sandstone of the Fortescue Group (Hamersley Basin), has allowed completion of a feasibility study, with mining planned for 2002. The proposed opencut mine, with pre-production capital costs of \$43 million, would yield 500 000 tpa of ore over four years, producing gold at the rate of up to 135 000 ounces per year.
- Further high-grade drill intersections obtained from the Raleigh prospect at Kundana near Kalgoorlie (Goldfields Ltd, Tribune Resources NL, and Rand Mining NL), the Temeraire prospect near Kambalda (Western Mining Corporation), and the Frogs Leg deposit near Kalgoorlie (Dioro Exploration NL).

Development highlights for the gold sector during 2000–01 include:

- Commencement of mining by Goldfields Ltd at the spectacularly high-grade Raleigh deposit at Kundana near Kalgoorlie (resource grades of 35–68 g/t).
- AngloGold completed a \$110 million upgrade of the Sunrise Dam treatment plant, lifting capacity from 2 Mtpa of ore to 2.5 Mtpa, and annual output to 280 000 – 300 000 ounces of gold.
- Beginning of ore production at the Wallaby mine near Laverton in the Eastern Goldfields (Delta Gold Ltd and Placer Dome Inc).
- Commencement of mining by Croesus Mining NL at the Davyhurst project (Giles opencut mine). The Giles deposit progressed from an exploration prospect to a mine in only nine months. Project resources (all types) total about 6.5 Mt of ore averaging 3.1 g/t Au, for about 650 000 ounces of contained gold. Initial production is at the rate of about 100 000 ounces of gold per annum.
- Commencement of mining by Barra Resources Ltd at the First Hit mine 150 km north-northwest of Kalgoorlie (a bulk sample taken from the first cut through the ore yielded a grade of 27.2 g/t Au).
- Announcement by LionOre Mining International Ltd and Dalrymple Resources NL of the go-ahead for construction of the world-class, low-cost Thunderbox mine near Leinster in the Eastern Goldfields. Openpit reserves are estimated at 10.89 Mt of ore averaging 2.43 g/t Au, with 849 000 ounces of contained gold. Pre-production capital costs are estimated at only \$62 million, and production is expected to commence in late 2002, with 220 000 ounces produced in the first year. Average production costs for the initial five-year mine life are forecast at only \$304 per ounce, with payback of capital in less than one year after the start of production.

Base metals and nickel–cobalt

Exploration for base metals (including nickel and cobalt) dropped slightly during 2000–01, falling by 6.6% (\$5.8 million) to \$82.5 million, and this was the third consecutive year of decline. Exploration for base metals (including nickel and cobalt) is now at a level down 29% (\$34.1 million) from the peak activity of \$117.1 million in 1997–98. Western Australia experienced a substantial growth phase in base metal exploration through the mid- to late 1990s, but this ended with the construction of the major first-phase lateritic nickel operations of Murrin Murrin, Cawse, and Bulong. At the time, Western Australia attracted up to 56.3% of all base-metal exploration expenditure in Australia, but during 2000–01 this declined sharply to only 44.3% of the total. Weak nickel and cobalt prices, ramp-up and commissioning problems at the lateritic nickel-treatment plants, and lack of significant new discoveries have all contributed to the depressed exploration activity for base metals.

Despite the drop in exploration activity, there have still been exploration successes. Highlights include:

- The true greenfields discovery by WMC Ltd in the Musgrave Complex (announced in May 2000) of a large mineralized nickel-sulfide system (with a strike length exceeding 4.5 km).
- Acclaim Exploration NL is drilling at the Wingellina lateritic nickel project in the Musgrave Complex, with the prospect containing inferred resources of 200 Mt at 1.0% Ni and 0.065% Co (based on 1960s data of Inco Ltd).
- Normandy Mining Ltd is continuing with their exploration success at the Golden Grove base metal project in the Murchison Granite–Greenstone Terrane, discovering numerous high-grade Zn–Cu–Pb–Au–Ag lenses, and establishing it as a world-class volcanic-hosted massive sulfide deposit. Development of a decline to the Amity zone commenced in May 2001, and there is consideration of a 5 km-long drive to connect Scuddles with Gossan Hill.
- The brownfields discovery by Jubilee Mines NL at Cosmos Deeps (near Leinster), below the existing Cosmos mine, and the discovery of massive and disseminated nickel sulfides at the nearby Taurus prospect.
- Drilling by Heron Resources Ltd at the Goongarrie lateritic nickel project near Kalgoorlie. Results from the Pamela Jean zone include intersections of 81 m at 1.24% Ni and 0.02% Co, 104 m at 1.33% Ni and 0.09% Co, and 83 m at 1.41% Ni and 0.15% Co.
- Deep drilling by Tectonic Resources NL at the new RAV 8 nickel-sulfide opencut mine near Ravensthorpe has intersected ore-grade zones at depths of 200–250 m below surface that are likely to provide additional ore to the underground mine already under development.
- Infill drilling by Sally Malay Mining Ltd at the Sally Malay deposit, hosted by layered mafic–ultramafic intrusions in the Halls Creek Orogen, has recorded

highly encouraging results, including intersections of 9 m at 2.09% Ni and 34 m at 1.87% Ni.

In mine development, highlights for 2000–01 include:

- LionOre Australia (Nickel) Ltd constructed the Emily Ann nickel-sulfide underground mine, west of Norseman, with the first nickel concentrate produced in November 2001. At full production, the mine will have a throughput of 250 000 tpa of ore, producing 6700 t of nickel in concentrates that will be exported to Canada for processing by Inco Ltd.
- Tectonic Resources NL commissioned the RAV 8 nickel-sulfide openpit mine near Ravensthorpe in July 2000, with the ultimate pit depth reached in August 2001. The underground mine is currently under development, and additional deeper ore-grade zones have been recently intersected in exploration drilling. All concentrate is sold under an off-take agreement to WMC Ltd.
- Mincor Resources NL has successfully constructed and brought into production two underground mines near Kambalda. Mincor Resources owns 76% of Miitel (commissioned in March 2001) and Wannaway (commissioned in October 2001). Production from the two mines totals about 13 000 tpa of contained nickel, with cash costs of production less than \$US1 per pound. Ore is trucked to WMC's Kambalda nickel operations mill, toll-treated, and sold to WMC Resources Ltd under a long-term off-take agreement.
- WMC is examining the feasibility of a \$300 million expansion of its Mount Keith nickel operation, near Leinster, possibly boosting nickel metal output to 70 000 tpa from its current capacity of 45 000 tpa.
- Titan Resources NL continues to enhance the BioHeap process used for the biological recovery of nickel from low-grade base-metal sulfide ores, with a large-scale pilot plant operating adjacent to its Radio Hill underground mine in the Pilbara Craton. This is causing a major reassessment of development options for other low-grade base-metal sulfide ores in Western Australia, with WMC acquiring the large Yakabindie disseminated nickel-sulfide project north of Leinster from Rio Tinto Ltd during 2001.

Diamond

Diamond exploration in Western Australia fell by about 7% (\$1.8 million) to \$23.0 million during 2000–01. This is the lowest exploration expenditure for diamond since 1988–89, and continues the steady decline from the peak in recent years of \$35.8 million that was spent in 1996–97. The level of diamond exploration is now well below the historical peaks of activity in 1981–82 (\$50 million) and 1993–94 (\$47 million). The fall is due to the generally difficult conditions in raising equity capital, combined with the paucity of significant discoveries in recent years.

However, the success of Kimberley Diamond Company NL at Ellendale, with mining planned to commence in mid-2002, has renewed interest in diamond exploration in Western Australia.

Iron ore

Iron-ore exploration expenditure in Western Australia has declined sharply during the last two years despite increasing production, with exploration expenditure falling by 41% (\$16.4 million) to \$23.2 million for 2000–01. This is due to a combination of factors, including uncertainty over the development scenarios of Hope Downs where access to existing railway infrastructure is yet to be obtained, and funding problems being experienced by Kingstream Steel Ltd for the Mid West project.

The iron ore industry followed the pattern of the gold sector, with substantial consolidation during 2000–01. Rio Tinto Ltd acquired North Limited, which owned a majority stake in Robe River, leading to a domination of the Western Australian iron-ore industry by Rio Tinto Ltd and BHP Billiton.

Other highlights include:

- Commencement of construction by the Robe River Iron Associates of the West Angelas project (Marra Mamba ore), with initial production scheduled for mid-2002 and reaching a rate of 15 Mtpa after five years. A mine life of at least twenty years is forecast.
- Portman Ltd, Western Australia's smallest iron ore producer, expanded production from the Koolyanobbing project from 1.7 to 2.3 Mtpa, and has plans to increase annual output to over 8 Mtpa in the next five years.
- Austeel Pty Ltd has signed a memorandum of understanding regarding construction of a steel mill in Newcastle, with ore to be sourced from its Cape Preston project (magnetite ore) southwest of Karratha.
- Launch of a prospectus by Mount Gibson Iron Ltd to progress development of the Mount Gibson deposit, 400 km northeast of Perth. The plan is for early production of direct-shipping grade hematite, with potential increased production through beneficiation of lower grade hematite, and a possible later expansion to produce high-quality magnetite concentrate suitable for the manufacture of iron pellets.

Heavy mineral sands

Exploration expenditure for heavy mineral sands in Western Australia declined by an estimated 17% (\$1.2 million) to \$5.8 million during 2000–01. The downturn is undoubtedly largely caused by the focus in recent years by explorers on heavy mineral deposits of the Murray Basin in the eastern States of Australia. However, the ongoing success by Magnetic Minerals Ltd in delineating substantial resources at its Dongara project, only 35 km from Eneabba, has rekindled interest in exploring for heavy minerals in Western Australia.

Tantalum

Tantalite was one of the glamour commodities for 2000–01 (along with platinum–palladium), with highlights for the year including:

- Ongoing expansion by Sons of Gwalia Ltd of its existing operations at Greenbushes and Wodgina. Sons of Gwalia currently produces about 25% of the world's tantalite.
- Construction of the Bald Hill tantalite mine by Haddington International Resources Ltd, based on resources of 1.14 Mt of ore averaging 472 ppm Ta_2O_5 . Initial production is at the rate of about 145 000 pounds of tantalite in concentrate per annum, but Haddington's output is being lifted to about 300 000 pounds of tantalite in concentrate with the construction (in progress) of the Cattlin Creek mine. The combined output would represent about 5% of world production of tantalite.
- Tantalum Australia Pty Ltd (Australasian Gold Mines NL 50% and Kemet Tantalum Pty Ltd 50%) operated a pilot plant at Dalgarna and constructed an open-cut mine. A total of 19 700 t of old tailings from Dalgarna and Mount Farmer were treated, yielding 1271.1 kg of contained Ta_2O_5 .
- Tantalum Australia Pty Ltd has substantially increased resources at the Mount Deans prospect near Norseman, and a feasibility study is in progress. Resources (of all classifications) within 60 m of the surface total 9.1 Mt averaging 216 g/t Ta_2O_5 , with 4.32 million pounds of contained Ta_2O_5 .

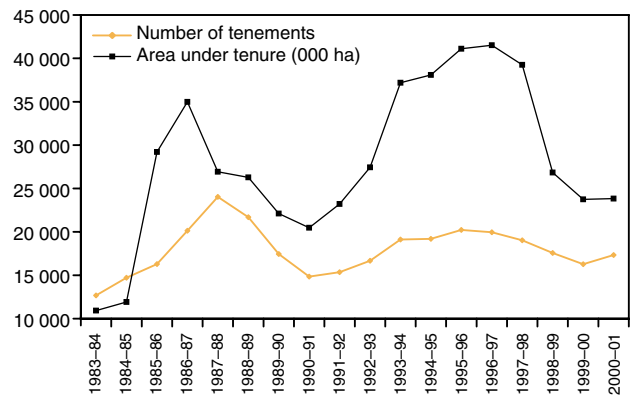
Platinum–palladium

Western Australia already produces small quantities of platinum and palladium as byproducts from the mining of nickel sulfide deposits. During 2000–01, two platinum–palladium projects advanced closer to development:

- Platinum Australia Ltd advanced the Panton Sill platinum–palladium–gold project in the Halls Creek Orogen, with completion of a prefeasibility study and commencement of a bankable feasibility study. Bulk samples, from both an open-cut and from underground exploration development, are being collected for metallurgical testing in South Africa.
- Helix Resources Ltd completed a scoping study of the Munni Munni platinum–palladium–rhodium–gold project in the Pilbara Craton, where inferred resources total 13.5 Mt averaging 3 g/t of Pt + Pa + Rh + Au. Exploration is progressing towards a full feasibility study, which will be funded by Lonmin Pty Ltd Co., the world's third largest producer of platinum.

Mineral tenement activity

In general, the trends in mineral exploration expenditure are also reflected in mineral tenement statistics. Mineral tenements in force and the area held under tenure as at 30 June 2001 show a stabilization at levels comparable to those 12 months ago (Fig. 4). For all tenement types under the Mining Acts of 1904 and 1978, the area under tenure has remained essentially unchanged at 23.8 million hectares. The number of tenements in force as at 30 June 2001 increased by a modest 6% (1046 tenements) to 17 326 after a four-year decline, but this was greatly



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Figure 4. Tenements in force (1904 and 1978 Mining Acts)

bolstered by the grant of numerous miscellaneous purposes licences related to infrastructure. The number of exploration and prospecting licences that were current at mid-2001 were both lower than a year previously.

The data are consistent with the view that large greenfields exploration tenements and related expenditure have declined substantially since the peak of the boom in 1996–97 but are stabilizing, and the number of tenements in force has also reached its low point.

Figure 4 illustrates differences between the 1986–87 and 1996–97 boom periods. The more recent boom was of much longer duration and apparently involved exploration of much new ground, with about 17% (6 million hectares) more ground under tenure by comparison with the 1986–87 boom. However, the response in tenement numbers during the more recent boom is relatively subdued. This latter effect is interpreted to be largely due to the problems of processing tenement applications through the Native Title process, with a total of 10 914 tenement applications (for all tenement types) outstanding and yet to be granted as at 30 June 2001.

The Western Australian Government recognizes that the decline in exploration expenditure is a major issue and that access to land is a key consideration, and has undertaken two initiatives:

- The State Government carried out an expert review (the 'Wand review') of Native Title negotiating principles in a bid to speed up the settlement of the State's 130 Native Title applications, and
- Established a technical taskforce to examine ways to accelerate the processing of mining, exploration, and land-title applications in areas where Native Title might survive. The taskforce is also considering options to reduce the volume of outstanding tenement applications.

In a separate exercise, the State Government is carrying out a review (the 'Keating review') to determine how to improve the system for obtaining approvals for resource projects in Western Australia.

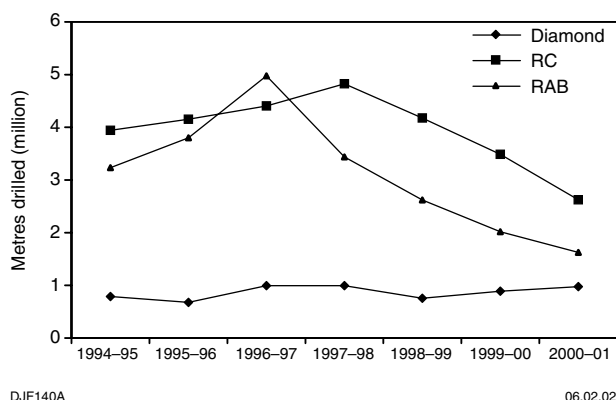


Figure 5. Mineral exploration drilling in Western Australia, by drilling type and year

Drilling activity

Drilling activity since the peak of exploration in 1996–97 clearly shows that cutbacks in exploration budgets have had a severe impact on rotary air blast (RAB) and reverse circulation (RC) drilling (Fig. 5). RAB drilling was the first to be adversely affected as companies reduced expenditure and moved away from grassroots greenfields exploration, and this was followed one year later by declining RC drilling, as expenditure cuts deepened. RAB and RC drilling have continued their decline during 2000–01, with the drilling data reported to the Department showing a decline in RAB and RC drilling of an estimated 20% (0.391 million metres) and 25% (0.860 million metres) respectively, whereas diamond drilling has increased by an estimated 10% (0.86 million metres).

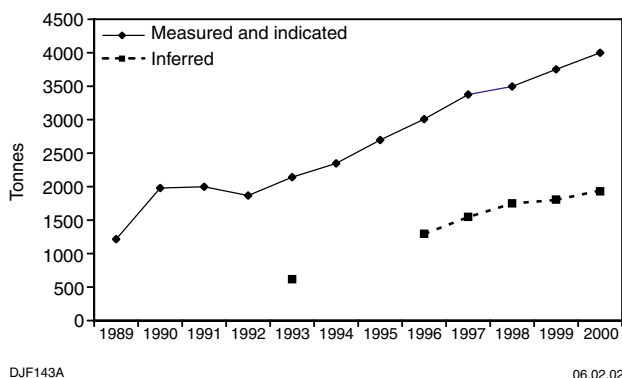


Figure 6. Estimates of gold resources in Western Australia, by year

Given that there is approximately a one-year delay in companies reporting drilling statistics (via the annual statutory mineral-exploration reports) to the Department, the stabilization of overall exploration expenditure during 2000–01 is likely to lead to a leveling off of drilling activity data during 2001–02.

The falls in RAB and RC drilling statistics from their earlier peak levels are more severe than the general fall in overall exploration expenditure. RAB and RC drilling has borne the brunt of the cutbacks. RAB drilling has now declined by 67% (3.35 million metres) since the peak activity of 4.976 million metres in 1996–97. RC drilling has declined by a substantial 45% (2.2 million metres) since the peak activity of 4.825 million metres in 1997–98. The decline in RAB and RC drilling since the peak of the boom, 67 and 45% respectively, should be

Table 1. Estimates of mineral resources for major commodities in Western Australia

Commodity	Units	1996	1997	1998	1999	2000
Measured and indicated resources						
Iron ore (high grade)	Mt	21 960	22 539	22 407	22 282	22 316
Gold	t	3 009	3 376	3 496	3 752	3 999
Bauxite ore	Mt	3 359	3 386	3 387	3 387	3 194
Mineral sands	Mt	128.9	163.4	208.7	208.7	215
Nickel	Mt	10.73	13.41	16.77	20.23	17.44
Diamond (industrial + gem)	Mct	140	177	534	534	646
Inferred resources						
Iron ore (high grade)	Mt	10 466	10 382	10 525	10 587	12 796
Gold	t	1 295	1 549	1 750	1 807	1 930
Bauxite ore	Mt	1 326	1 314	1 314	1 314	1 314
Mineral sands	Mt	52	53	73	73	68
Nickel	Mt	6.96	10.58	10.15	11.68	15.94
Diamond (industrial + gem)	Mct	86	59	59	59	34

NOTE: Data sourced from the MINEDEX database. Information nominally as at 31 December for year shown, but data extracted from the MINEDEX database on 30 June in following year
For iron ore and bauxite, it is the quantity of resources that is shown. Only high-grade iron ore resources are included. High-grade iron ore is based on iron content only, but cut-off grade (55% or 60% Fe) depends on mineralization type
For heavy minerals, the total of all heavy minerals is shown
For all other commodities, it is the contained element/mineral in the resources that is shown
t Tonnes
Mt Million tonnes
Mct Million carats

Table 2. Gold discovery costs per ounce of measured and indicated resources, Western Australia^(a)

Year	1993	1994	1995	1996	1997	1998	1999	2000
Cost (\$A) per ounce discovered	21	28	22	26	26	30	17	20

NOTE: (a) This includes any resources converted to reserves, but does not include inferred resources. Discovery costs are in dollars of the day

compared with the corresponding drop of ‘only’ 36% in total exploration expenditure. It is evident that exploration and prospect drilling has been severely curtailed in recent years, thus significantly lowering the chances of discovering new mineable deposits. Clearly, this trend must be turned around if the mineral industry is to be sustainable in the longer term.

However, diamond drilling activity has changed relatively little over the last seven years, with recent levels almost unchanged from those at the middle of the 1996–97 boom (Fig. 5). This is apparently a result of ongoing brownfields exploration where there is a need for the drilling of deep targets close to existing mine sites. Such drilling is often successful in the short-to-medium term in finding additional resources and reserves, but does not find the big discoveries in greenfield areas that are required in the longer term.

Mineral resources

The substantial resources of major mineral commodities produced in Western Australia are listed in Table 1.

Despite the gold exploration industry being at recession levels of activity, the State’s inventory of measured and indicated gold resources (including any converted to reserves) increased during 2000–01 (Fig. 6). Gold resources (measured and indicated only) increased by 247 t (6.6%) to 3999 t (Table 1). This increase was slightly less than that recorded in the previous year, but was again achieved with an average discovery cost of around \$A20 per ounce (Table 2). If inferred resources are also included, then

average discovery costs drop to about \$A16 per ounce. The data continue to highlight the gold prospectivity of Western Australia, and are also interpreted to mean that the trend to brownfields exploration since 1996–97 has been successful overall in finding additional resources to keep existing plants operating in the short-to-medium term.

The 1990s has seen an unprecedented boom in nickel exploration that has been extremely successful in converting exploration effort into resources in the ground, but nickel resources (measured and indicated) in Western Australia recorded a drop after almost seven years of increases (Fig. 7). There are two reasons why nickel resources (measured and indicated) decreased by 2.79 Mt (13.8%) to 17.44 Mt of contained metal. Firstly, substantial resources were restated with a higher cut-off grade following a lower nickel price (estimates of lateritic resources are sensitive to the cut-off grade used), and secondly some resources were reclassified to the ‘inferred’ category. Inferred resources of nickel increased by 4.35 Mt (36%) to 15.94 Mt of contained metal, the increase boosted by a new estimate of 2.0 Mt of contained nickel in the Wingellina lateritic nickel prospect. Resource estimates, by broad mineralization style and by resource category, for nickel projects in Western Australia are shown in Figures 8 and 9.

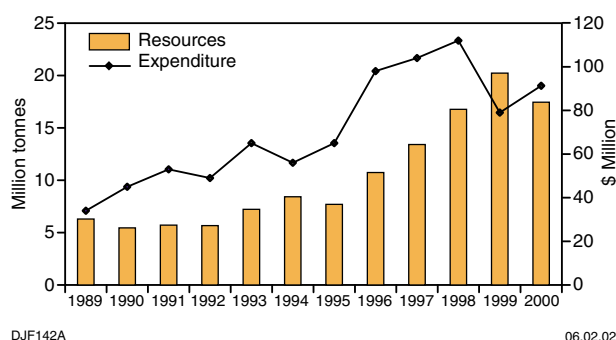


Figure 7. Nickel resources in Western Australia versus base-metal exploration expenditure, by year (dollars of the day)

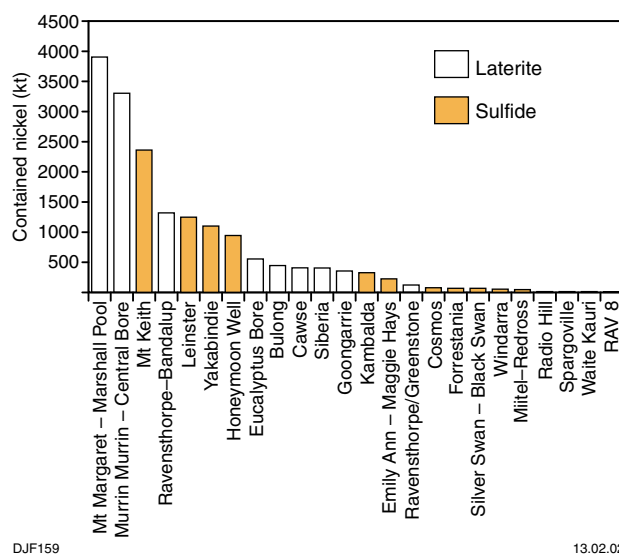


Figure 8. Ranking of nickel projects in Western Australia by contained metal in measured and indicated resources

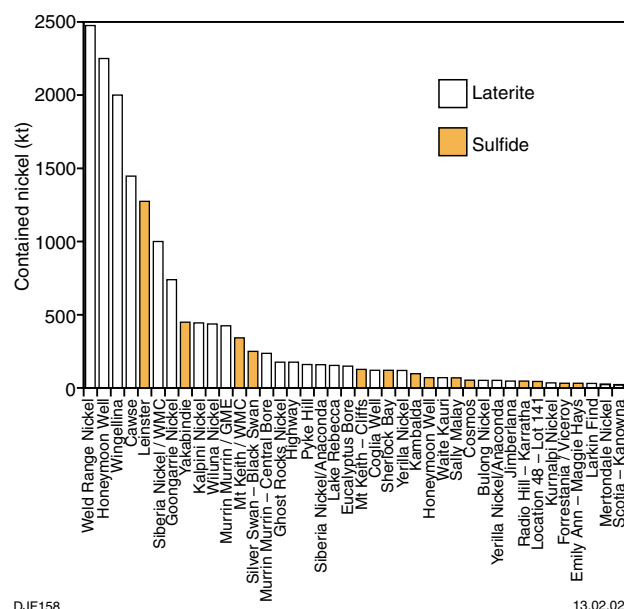


Figure 9. Ranking of nickel projects in Western Australia by contained metal in inferred resources

Mineral production

Western Australia is one of the great mineral provinces of the world. There are more than 300 commercial mining and petroleum projects in operation producing over 50 different mineral and petroleum products for distribution to markets across the globe. The minerals and petroleum sector continues to drive the State's economy, accounting for close to 70% of its export income and around 32% of gross State product. Royalties to the State Government from the resources sector totalled a record \$1.2 billion for 2000–01.

In the 2000–01 financial year, the value of mineral and petroleum production rose sharply by \$6248 million (29.3%) and totaled \$27 593 million, setting a new record for Western Australia. The value of mineral production alone (i.e. excluding petroleum) also rose sharply by \$3307 million (24.1%) to a total of \$17 037 million, with rises recorded for the value of alumina, base metals, ilmenite, upgraded ilmenite, rutile, leucocoxene, zircon, iron ore, manganese, nickel, cobalt, spodumene, tantalite, tin, and vanadium. The rise in production value of the major commodities (alumina, gold, iron ore, and nickel) during the last eight years is illustrated in Figure 10, with the increases greatly assisted by the fall in the value of the Australian dollar. During 2000–01, the value of the alumina industry exceeded the gold industry for the first time. In addition, the value of the nickel industry may exceed that of the gold industry within the next two years. For the first time ever, Western Australia became a producer of staurolite during 2000–01. Falls were recorded for the production value of coal, diamond, and garnet.

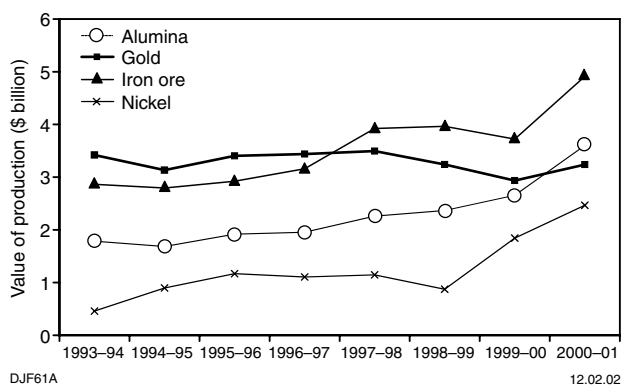


Figure 10. Comparative value of mineral production for major commodities in Western Australia, by year (dollars of the day)

In a world-market context, Western Australia continues to be a very significant producer of the following minerals or mineral products (with an estimate of the proportion of world production shown in brackets) — diamond (38%, includes industrial diamond), zircon (32%), tantalite (25%), rutile (24%), ilmenite (20%), alumina (20%), iron ore (14%, and with 34% of world seaborne trade in iron ore), nickel (14%), gold (8%), and vanadium (7%).

Acknowledgements

Mineral exploration expenditure data were compiled by the Australian Bureau of Statistics.

Information on the State's inventory of mineral resources is contained within the Department's MINEDEX (mines and mineral deposits information) database, a compilation of resource estimates that have been reported by a large number of companies. Drilling statistics for mineral exploration were extracted from the Department's WAMEX (Western Australian mineral exploration) database, and were compiled from statutory mineral exploration reports received by the Department during the period (hence there are some data in them that relate to the previous period). The Royalties Branch of the Department supplied information on the quantity and value of mineral production from Western Australia for 2000–01. Information on mining tenements in Western Australia was supplied by the Mineral Titles Division of the Department.